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DOCUMENTO DE TRABAJO

Núm. VIII - 1987

INVESTMENT AND FINANCING INTERACTIONS AT THE FIRM'S LEVEL: AN ECONOMETRIC SIMULTANEOUS EQUATION APPROACH*

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JUNE, 1986

* The author is indebted with Proffessors Richard Eckaus, Jerry Hausman, Franco Modigliani and Stewart Myers, all from MIT, for many helpful discussions. Any remaining errors are the author's sole responsability. Financial support for this research is gratefully acknowledged from the Subcommittee on Monetary Research of the U. S. Social Science Research Council.

"Investment and financing interactions at the firm level: An econometric simultaneous-equation approach."

by

Roberto I. Villarreal

ABSTRACT

This research paper focuses on the theoretical specification and empirical implementation of a simultaneous-equation econometric model of the firm's investment and financing decisions. The model is derived analytically from a general optimization problem of the forward-looking firm concerning its investment and financing over consecutive periods. Thus, the role of expectations about the future and targets for the investment and financing variables, as well as the financial timing behavior of the firm are explained very naturally.

The model has appealing characteristics for empirical analysis using econometric methods. First, it reveals important non-linear restrictions on the coefficients across the equations, previously unnoticed in the related literature. Second, it contains as special cases several typical specifications found in the literature and, therefore, it permits to assess their statistical performance against a more general benchmark. Finally, it suggests a novel way of addressing the fact that the firm's financial targets are unobservable for the econometrician under common circumstances. The idea is to consider the firm's actual investment and financing decisions observed one period later as "observations with error" on the earlier targets for that date, and then use instrumental variable procedures to get consistent estimates of the coefficients.

The model was applied to analyze fixed assets investment and debt and equity financing in a cross-section of 141 large private firms in Mexico for the year 1980. The statistical results obtained were very satisfactory: no concluding evidence of misspecification was found, the non-linear cross-equation restrictions were not rejected in most instances and most parameter estimates exhibited the expected signs. A restricted Partial Adjustment to Targets specification proved to be adequate, but an Interdependent Adjustment specification did not. Statistically significant interdependencies between investment in fixed assets and debt and equity financing were found in a sub-sample of 93 firms not constrained by domestic bank credit.

I. INTRODUCTION.

A number of different simultaneous equation econometric models have appeared in the empirical literature of finance over the last two decades to investigate the overall relationships between the investment and financing of firms. (See: Dhrymes and Kurz (1967), Spies (1974), Fama (1974), McDonald, Jacquillat and Nussenbaum (1975), Taggart (1974, 1977), McCabe (1979), Peterson and Benesh (1983), Jalilvand and Harris (1984)). These econometric models have been useful not only to describe in a precise and systematic way the global patterns of investment and financing of firms, but also to test for the existence of statistically significant interrelationships between investment and financing decisions.

In general, these models taken together have generated considerable empirical evidence regarding the actual interdependencies between the investment and financing decisions of firms and have advanced our understanding of their determinants. Some of the main empirical findings are the following. First, investment is affected by replacement needs, expected profitability, expected demand, etc., and also by dividend payments and borrowing. (Dhrymes and Kurz (1967), McCabe (1974), and Peterson and Benesh (1983) support this result; however, Fama (1974), McDonald, Jacquillat and Nussenbaum

(1975) reach different conclusions). Second, firms manage the composition of their liabilities in a way consistent with optimal capital structure theories, that is, their financing decisions are influenced by some desired or target debt/equity ratio. (Taggart (1974,1977)). Third, the dynamic adjustment of long-term debt and equity to their desired magnitudes is not fully achieved in short periods, but only gradually over time, whereas the adjustment of dividends and short-term financing is more rapid (Spies (1974), Taggart (1974,1977), Jalilvand and Harris (1984)). Fourth, short-term debt and liquid assets seem to be used by firms as residual sources of financing (Taggart (1974,1977)). Fifth, firms make their decisions evaluating current financial-market conditions (e.g., interest rates and stock prices) in relation to expected future conditions, or in other words, firms exhibit forward-looking behavior and make timing considerations (Taggart (1974, 1977), Jalilvand and Harris (1984)). And, sixth, investment and financing behavior differs across industries and by firm size (Dhrymes and Kurz (1967), Jalilvand and Harris (1984)).

However, largely as a consequence of the fact that a unifying analytical framework for the firm's overall financial decision making process is not available in this literature, central questions regarding adequate model specification and model selection remain unanswered. Concurrently, due to the unobservable nature of variables like the firm's targets for investment and financing, timing considerations and expectations in general, the ideal variables have not been available for estimation and upon implementation these models have suffered from ubiquitous errors in variables. Moreover, the coefficients estimated from the models lack any structural interpretation and their variations across samples or over time are difficult to account for.

A unifying framework for the different econometric systems of equations depicting the investment and financing behavior of firms is not only desirable to organize and assess the empirical evidence gathered in the past, but also to guide new efforts at specifying and estimating such econometric systems in the future. Indeed, the models previously mentioned can be classified into two broad traditions on the basis of the characteristics they portray of the firm's modus operandi, as summarized in Table I.1.* (The tradition which I have labelled as Interdependent Adjustment, IDA, encompasses the works of Dhrymes and Kurz (1967), Fama (1974), McDonald, Jacquillat and Nussenbaum (1975), McCabe (1979), and Peterson and Benesh (1983); the tradition which I label as Partial

* All tables are included at the end of the paper.

Adjustment to Targets, PAT, includes the work of Spies (1974) Taggart (1974,1977), and Jalilvand and Harris (1984). Representative examples of models in each of these two traditions are presented in Appendix A). The marked differences between the two prototypical specifications favored by the IDA and the PAT traditions pose very critical questions. For example: To what extent are these specifications compatible with each other, or equivalently, to what extent do they depict the same decision-making problem of the firm? Under which assumptions would one or the other specification be more appropriate? How can notions like "targets" and "timing considerations" be rigorously referred to a rational decision-making problem of the firm? What are the necessary or sufficient conditions for a decision variable to be properly considered as a residual by the firm? Without answers to these questions, the usefulness of empirical research based on econometric systems of simultaneous equations like those mentioned before is only partial, and our understanding of the empirical relationships among the firm's investment and financing decisions is seriously hindered.

This paper pretends to improve the present state of the art in modeling the overall financial decision making of the firm, explicitly addressing the issues highlighted in the preceding paragraphs. Fortunately, recent developments in the field of corporate finance (agency theories and asymmetric information stories of assets and liabilities choice by corporations) and in the field of economics (intertemporal optimization and interrelated demands) offer the possibility of a productive cross-fertilization of ideas.

The paper is organized as follows. Section II offers a model of a stylized decision making process of the optimizing firm to arrive at its optimal investment and financing decisions. Within the analytical framework of this general model, notions like "targets" and "timing considerations" have a very natural and appealing interpretation. In Section III, it is shown that the IDA and PAT prototypical models can be obtained as special (restricted) cases of the more general model, and their particular coefficients can be interpreted in terms of the structural parameters of the latter. Section IV discusses the estimation method and the relevant parameter restrictions to be tested. Section V presents empirical results obtained from a sample of large Mexican private firms. Finally, Section VI closes with some final remarks.

II. THE MODEL. /1/

II. 1. Set up.

Two types of concerns may be recognized in the firm's "objective function" /2/. The first corresponds to the firm's purely static concern with the outstanding magnitudes of its various assets and liabilities at a given point in time (e.g., its debt/equity ratio and the ratio of current assets to short-term liabilities). The second type corresponds to the dynamic concern which the firm may have regarding the magnitudes of its assets and liabilities through consecutive points in time (e.g., the growth of its stock of net fixed assets, the proportional increase of its long term debt, etc.). In principle, both types of considerations may be relevant for the firm's decision making.

Letting K_t, W_t, D_t and N_t stand for the outstanding stocks in period t of fixed assets, working assets, debt and equity, respectively, I define the functions $P_t(K_t, W_t, D_t, N_t)$ and $Q_t(K_t-K_{t-1}, W_t-W_{t-1}, D_t-D_{t-1}, N_t-N_{t-1})$, representing the firm's static and dynamic considerations about its decision variables. (The interpretation of these functions is discussed below). Since these variables are linked by the Balance Sheet identity, $K_t + W_t = D_t + N_t$, anyone of these variables can be substituted out and the functions P_t and Q_t can be written in terms of the remaining arguments. Accordingly, W_t will be eliminated in what follows. Furthermore, it will be assumed for convenience that P_t and Q_t are second degree polynomials. Consider P_t first:

$$(1) \qquad P_t(K_t,D_t,N_t) = a_t^o + a_t^k K_t + a_t^d D_t + a_t^n N_t + [a_t^{kk}K_t^2 + a_t^{dd}D_t^2 + a_t^{nn}N_t^2 + a_t^{kd}K_tD_t + a_t^{kn}K_tN_t + a_t^{dn}D_tN_t]/2$$

or, in matrix-notation:

$$(1') \qquad P_t(K_t,D_t,N_t) = a_t^o + a_tY_t + (1/2)\ Y_t'A_tY_t$$

where the 3x1 vector Y_t is defined as $Y_t=(K_t,\ D_t,\ N_t)'$; and a_t and A_t are a 1x3 vector and a 3x3 symmetric matrix of parameters, equal to:

$$a_t = [a_t^k,\ a_t^d,\ a_t^n]; \qquad A_t = \begin{matrix} a_t^{kk} & a_t^{kd} & a_t^{kn} \\ a_t^{dk} & a_t^{dd} & a_t^{dn} \\ a_t^{kn} & a_t^{dn} & a_t^{nn} \end{matrix}$$

The polynomial P_t can be thought of as a second-order Taylor approximation to a static net revenue function. for example, if net revenue is given by

$$R(K_t) - \{c_o + [c_1(D_t/K_t)+c_2(K_t-D_t)/K_t)]^2\}K_t$$

Where $R(K_t)$ is net revenue from operations and the substracting term represents total financial cost (notice that the cost of capital is an U-shaped function of capital structure if $c_1<0<c_2$), then upon taking a second-order Taylor expansion of this function at the point (k,d) one obtains:

$$a_t^k = R' - R''k + 3(c_1-c_2)^2 f^2 - (c_1-c_2)^2 f - (c_2)^2 - c_o \gtrless 0$$

$$a_t^d = -(c_1-c_2)^2 f^2 - 2c_2(c_1-c_2) \gtrless 0$$

$$a_t^{kk} = (1/2)R'' - (c_1-c_2)^2 f^2 (1/k) < 0$$

$$a_t^{dd} = -(c_1-c_2)^2 (1/k) < 0$$

$$a_t^{kd} = (c_1-c_2)^2 (f/k) > 0$$

where f=d/k and R' and R'' are evaluated at k. It is noticeable that in the special case in which $c_1 = c_2$ (so that one is in the case in which there is not a well defined optimal financial structure for the firm), these coefficients would be equal to:

$$a_k = R' - R''k - [c_o + (c_2)^2]$$

$$a_{kk} = (1/2)R''$$

$$a_d = a_{dd} = a_{kd} = 0$$

so that the polynomial would be just a function of K_t.

Consider next the function Q_t. Its interpretation is easier to communicate if $Q_t(.)$ is seen as the sum of three parts: $Q_t^k(.)$, $Q_t^d(.)$ and $Q_t^n(.)$, referred to as the "costs of adjustment" incurred by the firm when changing its stocks of fixed assets, debt and equity, respectively, as explained below. (In practice, these elements are very difficult to identify separately, so what follows is merely an expository argument. At the end, only the sum function matters). Thus:

$$(2)\quad Q_t(K_t-K_{t-1},D_t-D_{t-1},N_t-N_{t-1}) = Q_t^k(K_t-K_{t-1},D_t-D_{t-1},N_t-N_{t-1}) + Q_t^d(K_t-K_{t-1},D_t-D_{t-1},N_t-N_{t-1}) + Q_t^n(K_t-K_{t-1},D_t-D_{t-1},N_t-N_{t-1})$$

where:

$$(3)\quad Q_t^k(K_t-K_{t-1},D_t-D_{t-1},N_t-N_{t-1}) = b_t^k(K_t-K_{t-1}) + [b_t^{kk}(K_t-K_{t-1})^2 + b_t^{kd}(K_t-K_{t-1})(D_t-D_{t-1}) + b_t^{kn}(K_t-K_{t-1})(N_t-N_{t-1})]/2$$

$$(4)\quad Q_t^d(K_t-K_{t-1},D_t-D_{t-1},N_t-N_{t-1}) = b_t^d(D_t-D_{t-1}) + [b_t^{dd}(D_t-D_{t-1})^2 + b_t^{dk}(D_t-D_{t-1})(K_t-K_{t-1}) + b_t^{dn}(D_t-D_{t-1})(N_t-N_{t-1})]/2$$

$$(5)\quad Q_t^n(K_t-K_{t-1},D_t-D_{t-1},N_t-N_{t-1}) = b_t^n(N_t-N_{t-1}) + [b_t^{nn}(N_t-N_{t-1})^2 + b_t^{nk}(N_t-N_{t-1})(K_t-K_{t-1}) + b_t^{nd}(N_t-N_{t-1})D_t-D_{t-1})]/2$$

$Q_t^k(.)$ gives the "costs of adjustment" from changes in the stock of fixed assets, which can depend not only on the change of fixed assets, but also on the way it is financed as explained by agency theories. It is usually assumed in the investment literature that $b_t^k>0$ and $b_t^{kk}>0$, i.e., the "installation cost" of fixed assets (regardless of financing) increases at an increasing rate. [See Hayashi(1982)]. Moreover, the firm may incur additional costs on top of the "installation costs" when its investment is financed with some amount of outside funds as mentioned before if outsiders realize bigger agency costs as the firm grows faster. If so, one would expect b_t^{kd} and b_t^{kn} to be positive, although perhaps b_t^{kn} would be close to zero for owner-managed firms. If financing does not affect the cost of adjustment at all (as it is often implicitly assumed in the investment literature), then one should expect $b_t^{kd}=b_t^{kn}=0$. If only the distinction between inside and outside financing matters, but the cost of adjustment is not affected by the the split of borrowing and stock issues, then $b_t^{kd}=b_t^{kn}\neq 0$.

This is illustrated graphically in Figure II.1. In the benchmark situation in which investment is financed by an equal depletion of circulating assets and there is no borrowing and no change in equity, Q_t^k consists simply of the costs directly linked with the change in fixed assets, i.e., "installation costs". This is depicted as the lower curve in the figure. The two upper curves show the $Q_t^k(.)$ function when investment is financed with a positive amount of outside funds. If $b_t^{kd}>b_t^{kn}$, the highest curve would correspond to a larger amount of borrowing for the same total amount of total outside financing.

Similarly, $Q_t^d(.)$ gives the "costs of adjustment" from changes in the stock of debt. Again, part of these costs depend on the debt change itself. (Most importantly, perhaps, the deadweight costs resulting from a higher debt/equity ratio as debtholders require a higher return on the outstanding debt to compensate for the larger probability of default. Other such costs would consist in loan application fees, fixed flotation costs and commissions on bond issues, etc.). Most likely, these costs increase with the absolute amount of borrowing, although it is unclear if at an increasing or decreasing rate. So, it would appear a priori that $b_t^d>0$ but $b_t^{dd}\gtrless 0$. The magnitude of these costs could also be affected by changes in equity and perhaps in fixed assets, as indicated in (4). As increases in equity reduce the deadweight costs from higher debt, one would expect $b_t^{dn}<0$. With regard to changes in fixed assets, if agency costs increase with fast growth, as argued before, then one would expect $b_t^{dk}>0$.

Finally, $Q_t^n(.)$ gives the "adjustment costs" from changes in equity. Once more, these costs depend partly on the change of equity itself (e.g., administrative costs of issuing new stock, or, perhaps more importantly, under asymmetric information: transferences of value from the original stockholders to the suppliers of new outside financing, as suggested by Myers and Majluf(1985)). These costs may be thought a **priori** to increase with the magnitude of the change in equity, although it is unclear if at an increasing or decreasing rate, so one would expect $b_t^n>0$ but $b_t^{nn}\gtrless 0$. Moreover, the larger the proportion of retained earnings to the increase in equity, the smaller these coefficients. Additionally, these costs may also be affected by changes in fixed assets (e.g., faster growth increases the agency costs perceived by outsiders , thus leading to believe $b_t^{nk}>0$) or by changes in debt (for the effect on the probability of default mentioned before, thus $b_t^{nd}>0$).

As mentioned already, it will be normally impossible in empirical analyses to distinguish individually the coefficients b_t^{kd} and b_t^{dk}, b_t^{kn} and b_t^{nk}, b_t^{dn} and b_t^{nd}. Therefore, for simplicity, B_t below will be considered hereafter a symmetric matrix. This will not affect the conclusions from the following theoretical analysis either, since it is only the sum of the coefficients in each of the off-diagonal pairs which is relevant in the analysis.

The final objective function of the firm.

In sum, once the functions $P_t(.)$ and $Q_t(.)$ are put together [equations (1) and (2)], the following maximand (in matrix notation) is obtained, indicating the firm's concern with both the static and the dynamic interactions among its investment and financing variables:

$$(6)\ O_t(K_t,D_t,N_t;K_{t-1},D_{t-1},N_{t-1}) = O_t(Y_t,Y_{t-1}) = P_t(Y_t) + Q_t(Y_t-Y_{t-1}) =$$

$$a_t^o + a_tY_t + (1/2)\ Y_t'A_tY_t -$$

$$b_t(Y_t-Y_{t-1}) - (1/2)\ (Y_t-Y_{t-1})'B_t(Y_t-Y_{t-1})$$

where the 3x1 vector $Y_t = (K_t, D_t, N_t)'$ contains the firm's decision variables, and the following are parameters: $a^o{}_t$, a scalar; $a_t = (a_t^k, a_t^d, a_t^n)$ and $b_t = (b_t^k, b_t^d, b_t^n)$ vectors of dimensions 1x3; finally, A_t and B_t, symmetric matrices of dimensions 3x3:

$$A_t = \begin{matrix} a_t^{kk} & a_t^{kd} & a_t^{kn} \\ a_t^{kd} & a_t^{dd} & a_t^{dn} \\ a_t^{kn} & a_t^{dn} & a_t^{nn} \end{matrix} \quad , \quad B_t = \begin{matrix} b_t^{kk} & b_t^{kd} & b_t^{kn} \\ b_t^{kd} & b_t^{dd} & b_t^{dn} \\ b_t^{kn} & b_t^{dn} & b_t^{nn} \end{matrix}$$

The objective function (6) constitutes the basis for the interpretative framework developed in what follows. It must be remarked that all parameters are sub-indexed by time, for in principle there is no reason why they must be thought to remain constant. Finally, it must be mentioned that O_t will be a globally concave function of Y_t (and, therefore have a unique well-defined maximum, if the matrix $[A_t - B_t]$ is negative definite. (See Appendix B at the end of the paper).

II.2 Optimal investment and financing decisions under parameter certainty.

Assume initially that the coefficients of the firm's objective function (a_t's and b_t's) are given constants, known by the firm at the moment it makes its investment and financing decisions. In other words, these parameters are deterministic and the firm has perfect information regarding their magnitudes in the entire decision horizon (as explained below).

Suppose the firm in period t were to maximize O_t as in equation (6) with respect to the decision vector Y_t, with Y_{t-1} predetermined. It follows then that, unless B_t were a zero-matrix, the optimal decision at t depends on the previous decision made at t-1. Thus, by the same token, if the firm would continue to exist after period t, its optimal decision at t + 1 would depend on the decision made at t, and so on. Yet, there is no warranty that the decision at t + 1 conditional on the decision at t would be optimum optimorum, unless the decision problem at t had properly contemplated the effect of the current decision upon the following period. If this were not the case, the firm would be behaving in a very myopic way, and under the present assumptions about the availability of information this behavior would be incompatible with full rationality.

Therefore, it will be assumed that the firm in period t looks forward to the subsequent effects of its current financial decision. (Of course, the firm would have a certain rate of time preference R_{t+j} for period t + j, such that the series of $R_{t+j+1} < R_{t+j}$ are given constants and $R_t = 1$).

Suppose that the firm had exogenously decided on the magnitudes of the stocks of fixed assets, debt and equity it wishes to attain in period t + 1, in other words, the firm has set a target $Y^+_{t+1} = (K^+_{t+1}, D^+_{t+1}, N^+_{t+1})'$ for period t+1./3/. Then, the firm's two-period decision problem can be posed as follows:

(M.1) Maximize, with respect to Y_t for given Y_{t-1} and Y^+_{t+1}:

$$(7) \quad O_t(Y_t, Y_{t-1}) + R_{t+1}O_{t+1}(Y^+_{t+1}, Y_t) =$$

$$a^o_t + a_tY_t + (1/2)\ Y_t'A_tY_t -$$

$$b_t(Y_t-Y_{t-1}) - (1/2)\ (Y_t-Y_{t-1})'B_t(Y_t-Y_{t-1}) +$$

$$R_{t+1}[a^o_{t+1} + a_{t+1}Y^+_{t+1} + (1/2)\ Y^+_{t+1}{}'A_{t+1}Y^+_{t+1} -$$

$$b_{t+1}(Y^+_{t+1}-Y_t) - (1/2)\ (Y^+_{t+1}-Y_t)'B_{t+1}(Y^+_{t+1}-Y_t)]$$

Clearly, (M.1) constitutes a deterministic dynamic programming problem. If the matrix $[A_t-B_t-R_{t+1}B_{t+1}]$ is negative definite, as it is assumed to be the case, then the first order conditions for a maximum of (7) are sufficient. Taking the derivative vector with respect to Y_t and equating to zero one obtains:

$$(8) \quad a_t' + A_tY_t - b_t' - B_t(Y_t-Y_{t-1}) +$$

$$R_{t+1}[\ b_{t+1}' + B_{t+1}(Y^+_{t+1}-Y_t) = 0_{3x1}$$

Define $b_{t+1}'=R_{t+1}b_{t+1}'$ and $B_{t+1}=R_{t+1}B_{t+1}$. Thus, collecting terms:

$$(8') \quad [A_t-B_t-B_{t+1}]Y^*_t + B_tY_{t-1} + B_{t+1}Y^+_{t+1} + (a_t-b_t+b_{t+1})' = 0_{3x1}$$

where Y^*_t denotes that this value of Y_t is optimal. For short, let

$M_t = [A_t - B_t - B_{t+1}]$ and $m_t' = -[a_t - b_t + b_{t+1}]'$. Then, (8') can be expressed as:

$$(9) \qquad M_t Y_t^{*} = m_t' - B_t Y_{t-1} - B_{t+1} Y_{t+1}^{*}$$

It is observed then that in this two-period case, the optimal investment and financing decisions at t depend not only on the predetermined initial conditions at t-1, but also on the target for t+1, i.e., the exogenously set terminal conditions. Once again it is evident that if $B_t = 0_{3x3}$, then previous decisions would be irrelevant at t, and similarly, if $B_{t+1} = 0_{3x3}$, then future decisions (targets) would be irrelevant for current decisions. Moreover, except in the special case in which M_t is a diagonal matrix, the optimal investment and financing decisions would be interdependent.

The qualitative nature of this optimal decision would not be altered if the exogenously determined terminal conditions (targets) had been set by the firm for a more distant period t + T (T > 1), although the expression corresponding to (9) would be in that case considerably more intricate. /4/. Thus, since the longer decision horizon adds qualitatively nothing to the picture but notational complications and unsurmountable parameter identification problems, the assumption that the firm's targets are set for the immediately following period will be maintained in the analysis.

II.3. Optimal investment and financing decisions under parameter uncertainty:

Consider now the case in which the parameters contained in the vectors and matrices a_s, A_s, b_s and B_s are perceived by the decision-maker as given and known constants only for the current period, s=t. Looking ahead from t to future periods, s>t, the decision-maker perceives these parameters as random variables distributed according to some conditional probability distribution, as explained below. The particular realizations of these random variables will be observed, in turn, once period s arrives. The idea is that the environment (summarized in these parameters) under which the firm's future decisions are to be made looks uncertain ahead in time, but this uncertainty disappears right before the actual decisions are made in every period. However, it will be assumed that the decision maker perceives at t some joint probability distribution function $h(\tilde{p}_s | I_t)$ conditional on the information I_t available at t, where $\tilde{p}_s$ denotes the vector of random parameters relevant for period s.

The optimal investment and financing decision of the firm in this context will be investigated next in the two-period horizon. As before, it is assumed that the firm has exogenously decided on the magnitudes of the stocks of fixed assets, debt and equity it wishes to attain in period t + 1, that is, it has set a target $Y^*_{t+1} = (K^*_{t+1}, D^*_{t+1}, N^*_{t+1})'$ for period t+1. Then, the firm's two-period decision problem can be posed as follows:

(M.2) Maximize, with respect to Y_t, for given Y_{t-1}, Y^+_{t+1} and I_t:

(10)
$$E_t[O_t(Y_t,Y_{t-1}) + R_{t+1}O_{t+1}(Y^+_{t+1},Y_t)] =$$
$$E_t[a^o_t + a_tY_t + (1/2)\ Y_t'A_tY_t -$$
$$b_t(Y_t-Y_{t-1}) - (1/2)\ (Y_t-Y_{t-1})'B_t(Y_t-Y_{t-1})] +$$
$$E_t[R_{t+1}[a^o_{t+1} + a_{t+1}Y^+_{t+1} + (1/2)\ Y^+_{t+1}'A_{t+}Y^+_{t+1} -$$
$$b_{t+1}(Y^+_{t+1}-Y_t) - (1/2)\ (Y^+_{t+1}-Y_t)'B_{t+1}(Y^+_{t+1}-Y_t)]]$$

The operator $E_t(x) = E_t(x|I_t)$ denotes the mathematical expectation of any variable x (perhaps a function of $\tilde{p}_{t+1}$) conditional on I_t. Technically, this expectation is calculated by integrating x times $h(\tilde{p}_{t+1}|I_t)$ over the parameter space that supports h.

Taking the derivative vector of (10) with respect to Y_t and equating to zero, one obtains:

(11)
$$E_t[a_t' + A_tY_t - b_t' - B_t(Y_t-Y_{t-1}) +$$
$$R_{t+1}[\ b_{t+1}' + B_{t+1}(Y^+_{t+1}-Y_t)]\ ] = 0_{3x1}$$

Under the present assumptions, the realization p_t has already been observed by the firm at the time (M.2) is faced, and thus a_t, A_t, b_t and B_t in (11) are constants. Also, Y_{t-1} and Y^+_{t+1} are predetermined, and R_{t+1} is a known constant. In contrast, $\tilde{p}_{t+1}$ is stochastic at that time, and Y_t is a function of $\tilde{p}_{t+1}$. Therefore, (11) can be written as:

$$\text{(12)} \qquad a_t' + A_t E_t(Y_t) - b_t' - B_t[E_t(Y_t)-Y_{t-1}] + R_{t+1}E_t(b_{t+1}') + R_{t+1}E_t[B_{t+1}(Y^+_{t+1}-Y_t)] = 0_{3x1}$$

The last expectation can be conveniently simplified, as follows. Notice that $B_{t+1}(Y^+_{t+1}-Y_t)$, equals the following 3x1 vector:

$$\begin{bmatrix} b^{kk}_{t+1}(K^+_{t+1}-K_t) + b^{kd}_{t+1}(D^+_{t+1}-D_t) + b^{kn}_{t+1}(N^+_{t+1}-N_t) \\ b^{kd}_{t+1}(K^+_{t+1}-K_t) + b^{dd}_{t+1}(D^+_{t+1}-D_t) + b^{dn}_{t+1}(N^+_{t+1}-N_t) \\ b^{kn}_{t+1}(K^+_{t+1}-K_t) + b^{dn}_{t+1}(D^+_{t+1}-D_t) + b^{nn}_{t+1}(N^+_{t+1}-N_t) \end{bmatrix}$$

and, since $E_t(u,v)=E_t(u)E_t(v)+Cov_t(u,v)$, [where Cov_t stands for the covariance operator, of course defined in terms of the probability function $h(\tilde{p}_{t+1}|I_t)$, just as the operator E_t], one can write:

$$\text{(13)} \qquad E_t[B_{t+1}(Y^+_{t+1}-Y_t)] = E_t(B_{t+1})E_t(Y^+_{t+1}-Y_t) + Z_t$$

where:

(14) $Z_t =$

$$\begin{bmatrix} Cov[b^{kk}_{t+1},(K^+_{t+1}-K_t)] + Cov[b^{kd}_{t+1},(D^+_{t+1}-D_t)] + Cov[b^{kn}_{t+1},(N^+_{t+1}-N_t)] \\ Cov[b^{kd}_{t+1},(K^+_{t+1}-K_t)] + Cov[b^{dd}_{t+1},(D^+_{t+1}-D_t)] + Cov[b^{dn}_{t+1},(N^+_{t+1}-N_t)] \\ Cov[b^{kn}_{t+1},(K^+_{t+1}-K_t)] + Cov[b^{dn}_{t+1},(D^+_{t+1}-D_t)] + Cov[b^{nn}_{t+1},(N^+_{t+1}-N_t)] \end{bmatrix}$$

$$= \begin{bmatrix} z^{kk}_t + z^{kd}_t + z^{kn}_t \\ z^{kd}_t + z^{dd}_t + z^{dn}_t \\ z^{kn}_t + z^{dn}_t + z^{nn}_t \end{bmatrix} = \begin{bmatrix} z^k_t \\ z^d_t \\ z^n_t \end{bmatrix}$$

(The definitions of the z^{ij}_t and the z^i_t (for i,j=k,d,n) are obvious from notation).

Substituting (13) and (14) into (12), the first-order conditions for a maximum of (M.6) can be written as:

(15) $$a^{\prime}_t + A_t E_t(Y_t) - b^{\prime}_t - B_t[E_t(Y_t)-Y_{t-1}] + R_{t+1}E_t(b^{\prime}_{t+1}) + R_{t+1}E_t(B_{t+1})E_t(Y^+_{t+1}-Y_t) + R_{t+1}Z_t = 0_{3x1}$$

Define this time $b_{t+1}=R_{t+1}E_t(b_{t+1})$, $B_{t+1}=R_{t+1}E_t(B_{t+1})$ and $Z_t=R_{t+1}Z_t$. Then, collecting terms, the necessary first-order conditions for a maximum of (M.2) can be written as:

(15') $$[A_t - B_t - B_{t+1}]E_t(Y_t) + B_tY_{t-1} + B_{t+1}Y^+_{t+1} + Z_t + (a_t-b_t+b_{t+1})' = 0_{3x1}$$

That value Y_t^* $[=E_t(Y_t)]$ of the decision variable Y_t which satisfies (15) is optimal for the firm. [The notation $E_t(Y_t)$ in (15′) should not be misleading. Y_t is not a random variable in the usual sense, but a variable whose value is determined optimally by the firm depending on the information available on the random parameters $\tilde{p}_{t+1}$, namely $h(\tilde{p}_{t+1}|I_t)$. This is highlighted if that value of the decision variable Y_t which satisfies (15′) is renamed Y_t^*, instead of $E_t(Y_t)$].

Compare the optimal investment and financing decisions of the firm in the certainty and uncertainty cases [equations (15′) and (8′)]. A first difference is just the interpretation of the coefficients in these equations: the parameters known with certainty in the former case are replaced by their corresponding mathematical expectation in the latter case. A second distinction, however, is of greater importance. It has to do with the presence of Z_t in the optimality conditions of the uncertainty case, a term which does not appear in the certainty case.

As it will be shown next, Z_t presents a notion of hedging which is meaningful only under conditions of parameter uncertainty: in making its optimal current decisions, the firm hedges against the possibility that the second-period adjustments, required to reach the predetermined target, may occur under relatively costly conditions. In a different language, Z_t^k, Z_t^d and Z_t^n are a rigorous interpretation of "timing" for investment, borrowing and equity changes, respectively. To explain this, take z_t^k, for example. From (14):

(16) $z_t^k =$

$$\mathrm{Cov}[b_{t+1}^{kk},(K_{t+1}^{+}-K_t)] + \mathrm{Cov}[b_{t+1}^{kd},(D_{t+1}^{+}-D_t)] + \mathrm{Cov}[b_{t+1}^{kn},(N_{t+1}^{+}-N_t)]$$

Notice first that K_t, D_t and N_t [and, ergo, $(K_{t+1}^{+}-K_t)$, $(D_{t+1}^{+}-D_t)$, $(N_{t+1}^{+}-N_t)$] are functions of p_t and $\tilde{p}_{t+1}$, reflecting the firm's optimal response to the parameters to prevail in the second period. Thus, the first term in (16) indicates how the firm expects its optimal response $K_{t+1}^{+}-K_t$ would vary together with the parameter $\tilde{b}_{t+1}^{kk}$ over the entire range of values of $\tilde{p}_{t+1}$. A large positive value of this covariance means that, given the firm's information, large values of $K_{t+1}^{+}-K_t$ will tend to coincide with large values of $\tilde{b}_{t+1}^{kk}$. Similarly, large positive values of the second (third) covariance indicate that the firm expects large values of $D_{t+1}^{+}-D_t$ $(N^{+}{}_{t+1}-N_t)$ to coincide with large values of $\tilde{b}_{t+1}^{kd}$ $(\tilde{b}^{kn}{}_{t+1})$.

Notice also from (3) that the marginal "adjustment cost" in t+1 from a change $K_{t+1}^{+}-K_t$ is equal to:

(17) $$b_{t+1}^{k}+ b_{t+1}^{kk}(K_{t+1}^{+}-K_t) + [b_{t+1}^{kd}(D_{t+1}^{+}-D_t) + b_{t+1}^{kn}(N_{t+1}^{+}-N_t)]/2$$

So, large positive values of z_t^k (the sum of the three covariances just discussed) indicate that the firm expects its investment and financing decisions in period t+1 would coincide (in probability average) with large marginal "adjustment costs" for investment in fixed assets. Or, put in another way, Z_t^k is an indicator that under the firm's available information (I_t), it appears that the marginal "adjustment costs" from investment would be high in the period t+1. Thus, one should expect that to reach its target at the end of t+1, the optimizing firm would then invest more heavily in period t, so as to reduce its investment needs in the costly period t+1. This result is indeed made clear below. Therefore, it is appropriate to refer to Z_t^k as a "timing" indicator for investment in fixed assets. (A similar analysis leads also to conclude that Z_t^d and Z_t^n are "timing" indicators for borrowing and changes in equity, respectively).

In sum, under parameter uncertainty, the firm's optimal investment and financing decisions at t depend on the predetermined initial conditions at t-1, on the target for t+1 (i.e., the exogenously set terminal conditions), and on "timing" factors (parameter covariances). As in the certainty case, these results follow from the assumption that B_t and B_{t+1} are non-zero matrices. Finally, it is also seen that the optimal investment and financing decisions are interdependent.

II.4 Econometric implications.

Writing out the matrix equation (15´) one obtains after simple algebraic manipulations:

(18) Optimality condition for K_t:

$$
\begin{aligned}
&(a^{kk}-b^{kk}-b^{kk})K_t + (a^{kd}-b^{kd}-b^{kd})D_t + (a^{kn}-b^{kn}-b^{kn})N_t + \\
&b^{kk}K_{t-1} + b^{kd}D_{t-1} + b^{kn}N_{t-1} + \\
&\mathbf{b}^{kk}K^{+}_{t+1} + \mathbf{b}^{kd}D^{+}_{t+1} + \mathbf{b}^{kn}N^{+}_{t+1} + \\
&z^{k}_{t} + [a^{k}-(b^{k}-b^{k})] = 0
\end{aligned}
$$

(19) Optimality condition for D_t:

$$
\begin{aligned}
&(a^{kd}-b^{kd}-b^{kd})K_t + (a^{dd}-b^{dd}-b^{dd})D_t + (a^{dn}-b^{dn}-b^{dn})N_t + \\
&b^{kd}K_{t-1} + b^{dd}D_{t-1} + b^{dn}N_{t-1} + \\
&\mathbf{b}^{kd}K^{+}_{t+1} + \mathbf{b}^{dd}D^{+}_{t+1} + \mathbf{b}^{dn}N^{+}_{t+1} + \\
&z^{d}_{t} + [a^{d}-(b^{d}-b^{d})] = 0
\end{aligned}
$$

(20) Optimality condition for N_t:

$$
\begin{aligned}
&(a^{kn}-b^{kn}-b^{kn})K_t + (a^{dn}-b^{dn}-b^{dn})D_t + (a^{nn}-b^{nn}-b^{nn})N_t + \\
&b^{kn}K_{t-1} + b^{dn}D_{t-1} + b^{nn}N_{t-1} + \\
&\mathbf{b}^{kn}K^{+}_{t+1} + \mathbf{b}^{dn}D^{+}_{t+1} + \mathbf{b}^{nn}N^{+}_{t+1} + \\
&z^{n}_{t} + [a^{n}-(b^{n}-b^{n})] = 0
\end{aligned}
$$

where the parameters in standard characters are implicitly subscripted by t, whereas those in bold characters denote expectations corresponding to t+1.

It must be noticed that direct econometric estimation of the optimality conditions (18)-(20) is a feasible and interesting alternative which has not been pursued in the empirical literature. Inspection of the system of simultaneous equations (18)-(20) reveals that each of the three optimality conditions is econometrically just identified by the fact that the number of exogenous variables excluded in each equation is exactly equal to the number of equations in the system minus one. Moreover, every particular parameter in (18)-(20) is also seen to be individually identified, with the only exception of the terms $[a^j-(b^j-b^j)]$, for j=k,d,n, where only the sum but not the individual parameters can be estimated. This means that, in principle, it is possible to distinguish unambiguously through the empirically observed behavior of firms, the static and the dynamic interactions among investment and financing which appear to be relevant for their optimal decisions.

In practice, however, it appears that two major difficulties will be faced when estimating a system of equations like (18)-(20). First, there is the presence of unobservable variables in these equations (the targets and the timing variables). Of cousse, this problem can only be overcome by bringing in additional information. (This is discussed in Section IV). The second practical problem would be the likely existence of multicollinearity among the variables. The importance of this problem, however, would vary from one sample to another.

III. SOME IMPORTANT SPECIAL CASES OF THE MODEL.

Two influential traditons in the empirical literature on the investment and financing behavior of firms were pointed out in Section I, namely the IDA and PAT traditions. It is shown in this section that the prototypical econometric model of each of these traditions can be seen as a special case (i.e., one obtained under particular parameter values) of the more general model developed in the preceding section (equations (18) -(20)).

III.1. The IDA model.

The non-stochastic part of the prototypical IDA model (see Appendix A) has the following form:

$$(21)\quad (K_t-K_{t-1}) = d_{12}(D_t-D_{t-1}) + d_{13}(N_t-N_{t-1}) + f_1X_t$$

$$(22)\quad (D_t-D_{t-1}) = d_{21}(K_t-K_{t-1}) + d_{23}(N_t-N_{t-1}) + f_2X_t$$

$$(23)\quad (N_t-N_{t-1}) = d_{31}(K_t-K_{t-1}) + d_{32}(D_t-D_{t-1}) + f_3X_t$$

where the d_{ij} are parameters which characterize the interdependent adjustment of the endogenous variables, X_t is a mx1 vector of exogenous variables and the f_i are 1xm vectors of parameters corresponding to these exogenous variables.

It is straight-forward to verify that this specification can be obtained as a special case of the general model. Indeed, impossing the following parameter restrictions: (24) $a^{ij}=b^{ij}$ (for i, j=k, d, n) on equations (18)-(20), one obtains after some algebraic manipulation the following equations:

(25)

$$(K_t - K_{t-1}) = (-b^{kd}/b^{kk})(D_t - D_{t-1}) + (-b^{kn}/b^{kk})(N_t - N_{t-1}) +$$
$$(b^{kk}/b^{kk})K^+_{t+1} + (b^{kd}/b^{kk})D^+_{t+1} + (b^{kn}/b^{kk})N^+_{t+1} +$$
$$(1/b^{kk})Z^k_t + \{[a^k - (b^k - b^k)]/b^{kk}\}$$

(26)

$$(D_t - D_{t-1}) = (-b^{kd}/b^{dd})(K_t - K_{t-1}) + (-b^{dn}/b^{dd})(N_t - N_{t-1}) +$$
$$(b^{kd}/b^{dd})K^+_{t+1} + (b^{dd}/b^{dd})D^+_{t+1} + (b^{dn}/b^{dd})N^+_{t+1} +$$
$$(1/b^{dd})Z^d_t + \{[a^d - (b^d - b^d)]/b^{dd}\}$$

(27)

$$(N_t - N_{t-1}) = (-b^{kn}/b^{nn})(K_t - K_{t-1}) + (-b^{dn}/b^{nn})(D_t - D_{t-1}) +$$
$$(b^{kn}/b^{nn})K^+_{t+1} + (b^{dn}/b^{nn})D^+_{t+1} + (b^{nn}/b^{nn})N^+_{t+1} +$$
$$(1/b^{nn})Z^n_t + \{[a^n - (b^n - b^n)]/b^{nn}\}$$

The analytical formulation (25)-(27) is seen to be formally equivalent to the empirical specification (21)-(23) of the prototypical IDA model reviewed previously. Thus, it is seen that such specification can be given an optimizing behavior interpretation under special assumptions, as reflected by the parameter restrictions (24), which have to be imposed on the optimality conditions. The nature of these restrictions is explored next. Rewriting (24) in the original extended notation:

(24') $a_t^{ij} = R_{t+1}E_t(b_{t+1}^{ij})$

Thus, it becomes evident that to derive a flow specification of the IDA type from the optimality conditions, it is necessary to assume explicitly that, for every pair of control variables i and j (i,j,=k,d,n), the static tradeoff at t from a marginal adjustment in i and j must be just offset by the discounted expected marginal cost from a dynamic readjustment in the subsequent period. In other words, the firm can't do better by reshuffling its current portfolio of assets and liabilities since any potential static gains in the present are lost in the following period by incurring in adjustment costs.

The formal analogy established above permits to investigate the underlying determinants of the coefficients of the IDA models. Consider first just their magnitudes. Inspection of (25)-(27) reveals that, since in the equation for Y_i the own-adjustment parameters b^{ii} is in the denominator of all coefficients in the equation, then the more costly it is to change Y_i (i.e., the larger b^{ii}), then the smaller the changes in Y_i would be. (For example, the effect of "timing considerations" would be smaller the larger the own-adjustment parameter in the corresponding dependent variable). It is also observed that the magnitude of the coefficients associated with the other jointly dependent variables or the targets depend on the cross-adjustment parameters (b^{ij} and b^{ij}), which appear in the numerators. (Thus, for example, the larger b^{kd}, i.e., the larger the agency costs of debt on investment, then the larger the effect on investment from changes in debt). These findings are all in accordance with what one would intuitively expect.

As for the signs of these coefficients, equations (25)-(27) clearly indicate how these depend on the signs of the parameters. As seen in Appendix B, the concavity of the firm's objective function itself implies that all the own-adjustment parameters (b^{ii}) must be positive, whereas the cross-adjustment parameters (b^{ij}) could be positive or negative within some specified range and the expected future cross-adjustment parameters (b^{ij}) are not restricted at all. Thus, the signs of the coefficients associated with "timing considerations", for example, are seen to be positive. (Therefore, if it is expected by the firm that high investment in the subsequent period would coincide with large costs in adjusting the stock of fixed assets, i.e., if $z_t^k>0$, then investment in the current period would be higher).

Comparing with equations (25)-(27), it is recognized that the exogenous variables actually included in the empirical specification (18)-(20) ought to be formally interpreted as proxies for the expected future (target) values of the endogenous variables. However, it is unfortunate that the parameters associated with these exogenous variables are not individually identified from the estimable coefficients.

To see this, take for example the investment equation. The exogenous variables included in this equation are usually growth of sales or output, profit rate, capital stock, depreciation, cash flow, average interest rate. It seems that change in sales, capital stock and depreciation would work well as proxies for for K^{+}_{t+1}, cash flow and the average interest rate for D^{+}_{t+1}, and the profit rate for N^{+}_{t+1}, although, of course, other interpretations could be valid. Yet, suppose one believed:

$$(28) \quad K^{+}_{t+1} = e_1(\text{Sales Growth}) + e_2(\text{Capital Stock}) + e_3(\text{Depreciation}) + \text{random disturbance}$$

Then, substituting (28) into (27) it is observed that the coefficients of these three exogenous variables in the estimated equations would correspond to $(e_1 b^{kk}/b^{kk})$, $(e_2 b^{kk}/b^{kk})$ and $(e_3 b^{kk}/b^{kk})$, respectively. Clearly, dividing for instance the coefficient of the capital stock variable into the coefficient of the sales variable, only the ratio (e_1/e_2) would be identified. More importantly, neither the individual adjustment parameters nor the ratio b^{kk}/b^{kk} could be identified. (As previously mentioned, this problem can not be overcome unless additional information is brought in for estimation. For example, the actual value K_{t+1} could be used as an observation with error of K^*_{t+1} and then sales growth, capital stock and depreciation be used as instrumental variables for consistent estimation).

III.2. The PAT model.

The non-stochastic part of the prototypical PAT model (see Appendix A) has the following form:

$$(29)\quad (K_t - K_{t-1}) = m_{11}(K^+_{t+1} - K_{t-1}) + m_{12}(D^+_{t+1} - D_{t-1}) + m_{13}(N^+_{t+1} - N_{t-1}) + n_1 X_t$$

$$(30)\quad (D_t - D_{t-1}) = m_{21}(K^+_{t+1} - K_{t-1}) + m_{22}(D^+_{t+1} - D_{t-1}) + m_{23}(N^+_{t+1} - N_{t-1}) + n_2 X_t$$

$$(31)\quad (N_t - N_{t-1}) = m_{31}(K^+_{t+1} - K_{t-1}) + m_{32}(D^+_{t+1} - D_{t-1}) + m_{33}(N^+_{t+1} - N_{t-1}) + n_3 X_t$$

where again the m_{ij} and the n_i are parameters and X_t denotes a vector of exogenous variables.

It is straight-forward to verify that this specification can be obtained as a special case of the general model. Indeed, impossing the following parameter restrictions: (32) $a^{ij}=0$ (for i,j = k,d,n) in equations (18)-(20), one obtains after some algebraic manipulation the following equations:

$$
\begin{aligned}
(33) \qquad (K_t - K_{t-1}) = {} & (b^{kk}/\ (b^{kk}+b^{kk})\ )\ (K^{+}_{t+1} - K_{t-1}) \ + \\
& (b^{kd}/\ (b^{kk}+b^{kk})\ )\ (D^{+}_{t+1} - D_{t-1}) \ + \\
& (b^{kn}/\ (b^{kk}+b^{kk})\ )\ (N^{+}_{t+1} - N_{t-1}) \ + \\
& (-(b^{kd}+b^{kd})/(b^{kk}+b^{kk})\ )\ (D_t - D_{t-1}) \ + \\
& (-(b^{kn}+b^{kn})/(b^{kk}+b^{kk})\ )\ (N_t - N_{t-1}) \ + \\
& (1/(b^{kk}+b^{kk})\ )\quad Z^{k}_{t} \ + \quad (a^{k} - (b^{k} - b^{k})\ )/(b^{kk}+b^{kk})
\end{aligned}
$$

$$
\begin{aligned}
(34) \qquad (D_t - D_{t-1}) = {} & (b^{kd}/\ (b^{dd}+b^{dd})\ )\ (K^{+}_{t+1} - K_{t-1}) \ + \\
& (b^{dd}/\ (b^{dd}+b^{dd})\ )\ (D^{+}_{t+1} - D_{t-1}) \ + \\
& (b^{dn}/\ (b^{dd}+b^{dd})\ )\ (N^{+}_{t+1} - N_{t-1}) \ + \\
& (-(b^{kd}+b^{kd})/(b^{dd}+b^{dd})\ )\ (K_t - K_{t-1}) \ + \\
& (-(b^{dn}+b^{dn})/(b^{dd}+b^{dd})\ )\ (N_t - N_{t-1}) \ + \\
& (1/(b^{dd}+b^{dd})\ )Z^{d}_{t} + (\ (a^{d} - (b^{d} - b^{d})\ )/(b^{dd}+b^{dd})\ )
\end{aligned}
$$

$$
\begin{aligned}
(35) \qquad (N_t - N_{t-1}) = {} & (b^{kn}/(b^{nn}+b^{nn})\ )\ (K^{+}_{t+1} - K_{t-1}) \ + \\
& (b^{dn}/(b^{nn}+b^{nn})\ )\ (D^{+}_{t+1} - D_{t-1}) \ + \\
& (b^{nn}/(b^{nn}+b^{nn})\ )\ (N^{+}_{t+1} - N_{t-1}) \ + \\
& (-(b^{kn}+b^{kn})/(b^{nn}+b^{nn})\ )\ (K_t - K_{t-1}) \ + \\
& (-(b^{dn}+b^{dn})/(b^{nn}+b^{nn})\ )\ (D_t - D_{t-1}) \ + \\
& (1/(b^{nn}+b^{nn})\ )Z^{n}_{t} + (\ (a^{n} - (b^{n} - b^{n})\ )/(b^{nn}+b^{nn}))
\end{aligned}
$$

The preceding equations provide an appealing interpretation of the "partial adjustment coefficients" (m_{ij}) in the empirical equations (29)-(31). For example, the coefficient m_{11} in (29), corresponding to the proportion of the difference $K^{+}_{t+1} - K_{t-1}$ that gets effectively translated into a change in $K_t - K_{t-1}$, is seen from (33) to be fundamentally determined by the ratio $b^{kk}/(b^{kk}+b^{kk})$.

Clearly, as the two parameters in the denominator would normally have the same sign, the preceding ratio is positive and less than unity, or in other words, the referred "adjustment" as a proportion of the difference $K^{+}_{t+1}-K_{t-1}$ is only "partial". As one would expect, the larger the expected marginal adjustment cost in the period from t to t+1 (b^{kk}) relative to the total marginal adjustment cost incurred in the two-period from t-1 to t+1 ($b^{kk}+b^{kk}$), the larger the fraction of the total adjustment that will be undertaken from t-1 to t. However, it is noticed that the "partial adjustment coefficients" m_{ij} for $i \neq j$ do not have to be neither positive nor less than unity in absolute value. [Spies(1974) had noticed this possibility of "over-reaction" of each endogenous variable to changes in another jointly endogenous variable, but did not provide a fundamental explanation of the determinants of the "partial adjustment coefficients"].

A second point worth noticing in equations (33)-(35) relates to "timing considerations". As it should be recalled from section I, these were thought to be important a priori in the specification of the firm's overall adjustment process, but their inclusion was only informally justified. Equations (33)-(35), in contrast, give a rigorous interpretation to the notion of "timing considerations" through the terms Z^i (for i=k,d,n).

Finally, a third point worth noticing in equations (33)-(35) relates to the interdependencies among the changes in all the endogenous variables. In equation (33), taken again for example, it is seen that (D_t-D_{t-1}) and (N_t-N_{t-1}) do appear as explanatory variables for (K_t-K_{t-1}). Thus, the optimizing firm must treat all these variables as jointly interdependent. The actual importance of these interdependencies would depend, as observed in (33)-(35), on the actual magnitude of the cross-adjustment parameters $(b^{kd}, b^{kn}, b^{dn}$ and $b^{kd}, b^{kn}, b^{dn})$.

These interdependencies have been treated in different ways in the empirical literature. Usually, it is assumed that the endogenous variables somehow "residually adjust" depending on the overall financing needs of the firm. [See, for example, Taggart(1977) and Jalilvand and Harris(1984)]. The necessary and sufficient parameter restrictions which have to be satisfied for this to be consistent with rational optimizing behavior are investigated in Villarreal (1986).

Finally, it must be remarked that the PAT specification can be given an optimizing behavior interpretation, provided that the parameter restrictions previously mentioned are imposed. The fact that the restrictions (32) must be imposed is of considerable importance, for they reveal that it must be assumed that the firm is only concerned with the dynamic adjustment costs, but not at all with the second-order terms in the static function P_t.

IV. EMPIRICAL IMPLEMENTATION.

IV. 1 Overview.

In Section II, a system of simultaneous equations depicting the firm's investment and financing behavior was derived from an explicit intertemporal optimization problem. That problem poses the firm's choice of assets and liabilities in a highly stylized fashion, characterized by a number of structural parameters. This way of conceiving the firm's overall financial decision implies some important testable restrictions across the coefficients of the system of simultananeous equations, previously unnoticed in the related literature. The purpose of this section is to highlight those restrictions (subsequently referred to as the Theoretical Cross-Equation Restrictions, TCE) and to suggest a methodology to statistically test these restrictions as well as the IDA and PAT restrictions explained before in Section III.

The system of simultaneous equations analytically derived in Section II (viz., the General Model) is presented in Table IV.1. (Time subscripts correspond to the years 1979, 1980 and 1981, looking forward to the empirical implementation). The system in the upper panel (S.1) is written in terms of the structural parameters of the firm's decision problem. The TCE restrictions on this system can be easily recognized. Notice that these non-linear restrictions are highlighted in the lower panel of the table. /5/. Thus, a test of these restrictions can proceed as follows. First, the system in the lower part of the table (S.2) is to be estimated without any restrictions by some appropriate econometric method (as explained below). Second, the system S.2 is estimated again, this time with the non-linear TCE restrictions impossed. Finally, a standard test of the null hypothesis that the TCE restrictions are true can be done on the basis of the relative goodness of fit of the unrestricted and restricted systems.

Similarly, the IDA specification (S.3) of the model is presented in Table IV.2. As explained in Section III, this specification is obtained by impossing the IDA restrictions (presented at the bottom of the table) on the General Model. Thus, a test of the IDA restrictions can be based on the relative goodness of fit of systems S.1 and S.3. Naturally, the IDA specification inherits the TCE restrictions from the General Model, as it is clear in the upper and lower panels of the table, so that these restrictions can also be tested under the maintained IDA specification (i.e., by comparing the goodness of fit of systems S.3 and S.4). However, it must be mentioned that the IDA and TCE restrictions are not all independent, Indeed, it is straight-forward to verify that the IDA restrictions imply some (although not all) of the TCE restrictions./6/.

Lastly, the PAT specification (S.5) of the model is presented in Table IV.3. The PAT restrictions (at the botton of the table) which give this specification as a special case of the General Model can also be tested by comparing the goodress of fit of system S.1 and S.5. It is evident from the upper and lower parts of the table that the PAT specification also inherits the TCE restrictions from the General Model, so that these restrictions can be tested as well within this specification. As in the preceding case, it can be verified that the PAT restrictions already imply some (but not all) of the TCE restrictions./7/. A hierarchy of models is offered in Table IV.4 summarizing the preceding ideas.

IV.2 Treatment of unobservable variables.

The estimation of the various systems of simultaneous equations previously presented must consider the fact that there are unobservable variables among the explicative variables of the model. Indeed, ordinarily the econometrician would not observe the firm's target levels for its stocks of fixed assets, debt and equity, nor would he or she observe the "timing conditions" for investment in fixed assets, borrowing and equity changes perceived by the firm at the time it makes its optimal financial decision. However, as it is explained next, it is possible to overcome these difficulties.

Consider first the issue of the target variables, and suppose, for concreteness, that the firm is to decide in 1980 on its currently optimal levels of fixed assets, debt and equity. As explained in Section II, given the values of these variables inherited from 1979, the firm makes its investment and financing decisions in 1980 considering some targets for 1981 and the information currently available on the parameters affecting its objective function in the two-year period 1980 and 1981. Then, when the firm is to make its 1981 decision, it may find that the parameters actually observed at that time are not exactly those originally expected to prevail and, thus, its 1981 actual decision may not coincide with the original target for 1981. Nevertheless, the actual 1981 decision (which is observable) would reflect the original (unobservable) target to certain extent: any discrepancy would be due to the change between 1980 and 1981 in the information relevant to the firm's decision and which, of course, could not be anticipated by the firm in 1980. In other words, the actual levels of fixed assets, debt and equity observed in 1981 can be seen as observations with error of the original target levels for that year.

Of course, if these variables observed with error were substituted for the correct explicative variables in the model, inconsistent estimates would result. However, one could use instrumental variables (i.e., variables correlated with the true targets, but uncorrelated with the information newly arrived between 1980 and 1981) to elliminate the observation error in a first stage of the estimation process, and then get consistent estimates in a subsequent stage. Numerous candidates to form instruments are usually available. For example: 1) previous profit margins on sales; 2) the ratio of interest payments to sales in the preceding period; 3) the proportion of short-term debt to total debt; 4) the growth of sales; etc.

Consider now the issue of the "timing conditions" perceived by the firm at the time of its decision making (i.e., the Z's), which are also unobservable explicative variables under ordinary circumstances. Here the researcher needs to have some indicators of the firm's beliefs regarding the likelihood of facing large adjustment cost parameters coinciding with big adjustments of its decision variables in the future. (More precisely, it is the covariance between the cost parameters and the adjustment in the decision variables which is required). This information is absolutely impossible to obtain. Perhaps the best the researcher could do is to obtain some qualitative opinion from the firm's managers, although this would unavoidably translate into observation errors in the respective indicators.

Nevertheless, this is the approach followed in the empirical implementation reported below. (The nature of the dichotomous indicators used is explained in Appendix C. The use of dummy variables as proxies for unobservable variables is discussed by Maddala (1977). In general, it is unclear if the use of dummy indicators reduces asymptotic bias relative to that which occurs in a misspecified model where the unobsevable variables are simply ignored).

IV.3 Estimation Method.

The General Model can be succintly written in matrix notation as follows:

(36) $CY = FY_{-1} + GY^{+} + HZ + U$

where the 3x1 vector Y includes the decision variables (K, D, N); Y_{-1} and Y^{+} denote their past values and corresponding targets, respectively; the 3x1 vector Z contains the "timing variables"; C, F, G, and H are parameter matrices and U is a 3x1 vector of stochastic disturbances.

As argued before:

(37) $Y^{+} = MW$

meaning that the (unobservable) targets are related to some (observable) variables contained in the vector W (M is simply a matrix of parameters). Moreover,

(38) $$Y_{+1} = Y^{*} - V$$

indicating that subsequent realizations of the decision variables can be interpreted as observations with error (V) of the earlier targets.

Equations (36) and (37) together are conceptually analogous to the Zellner-Goldberger simultaneous equation model with unobservable variables. (Zellner (1970), Goldberger (1972,1974)). (A random disturbance vector may be appended to (37), yet it would be undistinguishable in practice from V in (38)). Equation (38) is important since it brings the additional information to identify the structural parameters in F and G individually (which can't be done if only (37) is substituted into (36), as it has been implicity done in the received literature, as mentioned in Section III). This new approach has no precedent in the simultaneous equation models of the firm's investment and financing. It emerges from in the rational-expectations literature. (See: Kennan (1979), Hansen and Singleton (1982), Pindyck and Rotemberg (1983), Prucha and Nadiri (1982,1985), Wickens (1982) and Kokkelenberg (1984)). In an equivalent fashion, equation (38) may be substituted into (36) and then, because of (37), W provides the instrumental variables necessary to obtain consistent estimates of the structural parameters in (36).

The problem of identification in a simultaneous equation model with random measurement error in the exogenous variables has been studied by Chernoff and Rubin (1953), Sargan (1958), Goldberger (1974) and Hausman (1977). An order condition for identification would be fulfilled if there exist sufficient instruments in W for the endogenous variables in the right hand side as well as for the exogenous variables observed with error. As mentioned earlier, this would normally be the case.

As explained in Hausman (1977), a consistent estimation procedure is to treat Y_{+1} as another endogenous variable and to use instrumental variables (uncorrelated with the errors but correlated with Y^{+}). As shown by Sargan (1958), the use of all the predetermined variables measured without error is best asymptotically. Hausman (1977) shows that since (37) merely adds just identified equations to the system, 3SLS applied to the equation resulting from substituting (38) into (36), using all predetermined variables as instruments is asymptotically equivalent to a full-information instrumental variable estimator and both are fully efficient.

IV. 4 The data.

The data used for the empirical analysis consisted of a sample of 141 Mexican private forms. (A detailed description of the data-set is provided in Appendix C). All estimation excercises and tests of hypotheses were repeated on the entire sample, as well as on several subsamples with firms classified by size based on the book value of Total Assets in 1979: group S (0-100 million pesos; 39 firms); group M (100-250 million pesos; 29 firms); group L (250-400 million; 36 firms) and group G (over 400 million; 37 firms). Another interesting subsample consisted of those firms facing no unsatisfied demand for domestic credit from the banking system, as manifested directly by their top executives in 1980 (group NCC, 93 firms).

The analysis focussed on the year 1980 (i.e., the predetermined variables refer to 1979, whereas the targets refer to 1981; the "timing indicatiors" were qualitative appraisals expressed by the firms' managers in July of 1980). The year 1980 may be considered as "normal" for the Mexican Economy. On one hand, the impressive growth of 1978 and 1979 decelerated somehow in 1980; but, on the other hand, the severe crisis which began in the second half of 1981 was not anticipated yet. Further discussion of the financial conditions of the period is offered in Villarreal (1986).

V. RESULTS.

V.I. Model Specification.

The General Model (S.2) was estimated first on all subsamples by 2SLS, using all the available instruments: past values of the decision variables, dichotomous "timing indicators", financial ratios from the last accounting period (profit margin on sales, interest payments divided by sales, total taxes divided by sales, ratio of short-term debt to total debt, ratio of net liquid assets to total assets, growth of sales) and anticipated fixed assets expenditures for 1981. Neither the TCE, non the IDA and PAT restrictions were imposed at this stage. The unrestricted model was then reestimated by 3SLS, with an estimated covariance matrix obtained from the 2SLS residuals. Both sets of estimates did not differ much, providing some indication on the correct specification of the model. To investigate the issue more rigorously, a Hausman specification test (Hausman (1978)) was done for each of the subsamples. The null hypotheses that the model is correctly specified could not be rejected in any of the subsamples at the 95% confidence level. Therefore, 2SLS and 3SLS estimates of the coefficients of the model would be consistent.

V.2 Tests of parameter restrictions.

The General Model was estimated next with the TCE restrictions imposed, using again (non-linear) 3SLS. A quasi-likelihood ratio test proposed by Gallant and Jorgenson ( ) was used to test these restrictions on the various subsamples. Under the null hypotheses that the restrictions are true, Gallant and Jorgenson show that the difference between the minimum-distance statistics from the restricted and the unrestricted models is distributed as a chi-square with degrees of freedom iqual to the number of restrictions. The results are presented in Table V.1. The TCE restrictions could not be statistically rejected at the 95% confidence level in any of the groups, except in the L group.

The General Model was estimated once more (3SLS), this time with the IDA restrictions imposed. The results are presented also in Table V.1. Using the same test as before, the IDA restrictions are rejected at the 95% confidence level in all but the NCC and G groups. Similarly, the PAT restrictions were impossed on the General Model and tested in an identical fashion. The results are presented also in Table V.1. The PAT restrictions can not be rejected at the 95% confidence level in most samples, except in the M group. (Tests of the TCE restrictions under the maintained PAT specification lead to their rejection only in the L group, as before. Under the maintained IDA specification, the TCE restrictions are rejected only in the M group).

In sum, the TCE restrictions revealed by the model of Section II could not be rejected in the large mayority of cases. Additionally the PAT specification seemed to perform better than the IDA specification in most cases.

V.3 Estimated coefficients.

The 3SLS estimates of the TCE-restricted General Model are reported in Tables V.2a to V.2c. The difference in magnitudes, signs and statistical significance of the estimated coefficients for the entire sample ("ALL") compared to the subsample of firms without unsatisfied demands for domestic credit (NCC) in noteworthy. (As 56% of the "credit constrained" firms concentrates in the Mand L groups, representig 48% and 36% of the firms included in those groups, the existence of binding credit constraints may explain the contrasting results obtained from these groups relative to the others in Section V.2). Consequently, attention will be focussed in what follows exclusively on the results obtained from the NCC, S and G groups. In this respect, an interesting finding from Table W.2a to V.2c is that the maginitudes and statistical significance of the coefficients associated with past values of the decision variables in the three equations are larger for the G than for the S group (with the NCC group inbetween), whereas the opposite is true regarding the coefficients associated with the target variables.

The 3SLS estimates of the coefficients of the TCE restricted PAT model are reported in Tables V.3a to V.3c. The main findings are the following. Consider first the direct interactions between current investment and financing:

a) In the investment equation, current borrowing and equity increases have positive signs, as should be expected from the sources-equal-uses identity. It is noteworthy that in the NCC group the effect of current borrowing and equity increases on investment have exactly the same magnitude, although the latter is statistically more significant. In the S group, although the coefficient of borrowing is larger, it is not significant, indicating that investment by firms in this group is systematically more related to equity increases than to borrowing. In the G group, the coefficient of equity increases appears to be larger and also more significant than the coefficient of borrowing. These findings confirm the common belief on the preeminence of equity financing (e.g., retained earnings) among Mexican firms and highlight its still greater importance among smaller firms.

b) With regard to the use of additional financing, the estimated coefficients (see Table IV. 3a.) indicate that, controlling for all other factors, in the NCC group current investment is increased by 50% of current additional debt or equity financing and, presumably, the remaining 50% goes into circulating assets. In contrast, in the S group only 25% of current increases in equity goes to investment in fixed assets. (The estimate for borrowing could not be precisely estimated, but nevertheless the 30% figure is suggestive and reasonable). Thus, in the S group a larger proportion of financing presumably goes to increases in circulating assets. Finally, in the G group, the estimated coefficients indicate that current investment is increased by about 60% of current borrowing and by 80% of current equity increases. Thus, the proportion of additional debt or equity financing going into circulating assets is considerably smaller in the G than in the S and NCC groups. These findings seem qualitatively reasonable, given the importance of working capital in smaller firms. Quantitatively, the 50-50 split in the NCC group appears to be sensible and the corresponding figures for the S and G groups do not seem unplausible.

c) The counterpart to the previous findings is observed in the equations for borrowing and equity increases (Tables IV. 3b and IV. 3c). The effect of current investment on current borrowing and equity changes is positive and significant for the three groups. In the NCC group, the coefficient of investment on borrowing is not very different from the coefficient on equity increases. For the S group, investment appears to have a larger effect on equity changes than on borrowing.

d) Lastly, among the contemporaneous interactions between investment and financing, consider the effects of current borrowing on equity increases, and vice versa. The corresponding estimated coefficients (see Tables IV. 3b and IV. 3c) are negative and significant in the three groups. In the NCC group, for example, current borrowing would be reduced by 83% of the current increase in equity; in the S group this figure would be 140%, and in the G group 72%. It must be emphasized that these figures denote the substitution between the two alternative sources of financing at a point in time (short-run). As it will be seen next, when adjusting to targets (over the medium-run) both sources of financing move in the same direction.

Indeed, consider next the effects from adjustment to targets which are present beyond the contemporaneous interactions just described. The model suggests that the following phenomena are going on:

e) The investment and financing behavior of firms in the NCC and S groups exhibits strong characteristics depicting the influence of targets. The behavior of firms in the G group differs remarkably, since only the contemporaneous interactions previously described, but not the targets, appear to be important in this group. (Indeed, all the adjustment coefficients in the G group are small and statistically insignificant when considered individually). In any case, the own-adjustment coefficients of each of the three variables are positive (as required by theory) and less than unity (denoting that the adjustment of the corresponding variable towards its target is only partial).

f) In the NCC and S groups, investment reflects partial adjustment towards the own target for fixed assets and, very interestingly, this adjustment is significantly influenced by the adjustment of the financial variables towards their corresponding targets. (See Table IV. 3a). The estimated coefficients indicate that in these two groups, the adjustment towards the target for fixed assets set for two years into the future is of 50% in the first year. On top of this effect, investment is significantly and negatively affected by the adjustment to financial targets which takes place at the same time. In the NCC group, investment in the first period is reduced by 25% of the debt increase desired over the two-year period, and by 27% of the desired adjustment to equity. (In the S group, investment in the first year would be reduced by 37% of the desired increase in debt, and by 28% of the desired increase in equity).

An example is useful to illustrate this point. If a representative firm in the NCC group planned to invest one dollar by the end of a two-year period, the magnitude of the estimated coefficients indicates that it would invest about fifty cents by the end of the first year if it planned to finance this investment entirely by an equivalent depletion of circulating assets. Instead, if it planned to finance this investment entirely by increasing its outstanding levels of debt or equity, the firm would invest only 25 cents by the end of the first year. Moreover, it would not matter very much whether these additional financing consisted of new debt or equity. (Of course, on top of this there would also be the effects from contemporaneous borrowing and equity changes, as explained before: current investment would be increased by 50% of current additional debt or equity financing. The total effect is discussed below). This behavior suggests that there must be some costs to the firm which make investment less attractive when it is to be externally financed. Agency stories go in this direction, providing some theoretical explanation. However, it is remarkable that the estimated coefficients for the NCC group indicate that the agency costs of debt are about the same that the agency costs of equity.

g) Borrowing behavior also exhibits characteristics of partial adjustment to targets in the NCC and S groups. (See Table IV. 3b). The estimates indicate that in the NCC group, current borrowing is increased in the first year by 43% of the desired increase in debt over the two-year period. (This partial adjustment appears to be somehow slow, since it has been already seen, for example, that the partial adjustment of fixed assets is of 50% in the first year. As it will be seen later, the partial adjustment of equity is of 62% in the first year). Moreover, borrowing is also increased by 47% of the desired increase in equity over the same two-year period. (Thus, in contrast to the previous finding with regard to the contemporaneous interactions between debt and equity, it is seen that over longer periods of time these variables are adjusted by firms in the same direction). Lastly, the estimated coefficients indicate that current borrowing is decreased by 90% of the desired increase in fixed assets for the two-year period. (Thus, there appears to be some evidence that growth makes external financing relatively less attractive). The corresponding estimates for the S group reveal that borrowing is relatively less sensitive to adjustments towards the targets for equity and fixed assets.

h) Equity changes in the NCC and S groups also reflect some adjustment to targets. (See Table IV. 3c). In the NCC group, equity increases in the first year by about 60% of the total desired increase over the two year period (indicating a faster adjustment than the one of debt towards its own target). Equity is increased also by about 50% of the desired increase in debt (corroborating that these variables are adjusted by firms in the same direction over longer periods of time). Finally, the estimates show that in the NCC group the flow of equity is reduced by 104% of the desired increase in fixed assets over a two-year period. (This percentage is larger than the corresponding one affecting borrowing. In principle, one would suspect that if equity does not come via new share issues, then growth would create lower costs for equity than for debt financing. This finding is therefore unexpected). In the S group, current changes in equity seem relatively more sensitive to the desired adjustments in fixed assets and debt.

i) It is observed that the coefficients of the "timing" indicators are all small and statistically insignificant. As mentioned previously, this could reflect either that Mexican firms were not "timing" their investment and financing during 1980, or that the dichotomous indicators used are just poor measures of the "timing" factors relevant for the firms' decisions. [Other studies, e.g., Taggart(1977) and Marsh(1982) have found significant "timing" effects].

Before concluding, it is worth mentioning that the structural parameters were also estimated individually using non-linear 3SLS on systems S.1 and S.5. As explained in Villarreal (1986), only dichotomous indicators were available, instead of the correct timing variables; and so the coefficients corresponding to these variables were treated as free parameters not subject to the respective TCE restrictions. (Identification of the individual parameters requires under these circunstances a normalization. Accordingly, the value of b^{dd} was set equal to unity). The results, are reported in Tables V.4 and V.5. Although these parameters could not be estimated very precisely, their magnitudes and signs exhibit several interesting features. First, they satisfy the conditions for the objective function of the firm to be globally concave (as explained in Appendix B). Second, the signs of b^{ij} and b^{ij} are usually the same (for i,j=k,d,n), suggesting that the function $Q_t(.)$ in Section II does have some "stability" over time. Lastly, they are consistent with the estimates of the coefficients presented before in Tables V.3 and V.3. Future efforts should be directed at estimating these structural parameters with greater precision as well as at investigating more carefully their magnitudes across different groups of firms and over time.

VI. SUMMARY AND CONCLUSIONS.

This paper addressed the firm's overall decision-making problem regarding its investment and financing, i.e., the wider problem encompassing the particular decisions on investment in fixed assets, debt financing, equity financing, etc.

Building on elements of finance theory and the recent economics literature on interrelated demands by a forward-looking firm, an explicit conceptual framework was developed, within which the firm's optimal financial decisions could be rigorously analyzed.

This framework explains in a very simple manner how the particular optimal decisions of the firm regarding its investment and financing fit together. For example, it explains in terms of a few structural parameters the pattern of contemporaneous interactions between investment and financing and their linkages to corresponding targets for subsequent periods (i.e., it explains the interactions between investment and financing in both the short-run and the medium-run). The framework also provides an explanation of "timing behavior" as hedging against the possibility of having to adjust investment and financing in future periods under relatively costly conditions.

The framework is also convenient for econometric analysis. Moreover, it improves in several important respects the methodologies of analysis followed in the literature on simultaneous equation models of the firm's investment and financing:

First, it provides rigorous theoretical foundations for the specification of this kind of models, rationalizing the inclusion/exclusion of variables (e.g., targets and timing variables) and revealing the existence of appealing restrictions on the coefficients across the equations. These cross-equation restrictions have been previously unnoticed in the literature.

Second, the model offered here contains as special (restricted) cases the prototypical specifications most often found in the literature, namely the Interdependent Adjustment (IDA) Model and the Partial Adjustment to Targets (PAT) Model. Therefore, the statistical validity of these special models can be tested against a more general benchmark, rather than taken for granted as it has been done so far in the literature.

Finally the conceptual framework, by illuminating the notion of "targets" in a context of unfolding information, permitted to gain the insight that the firm's empirically unobservable "targets" at a period of time (viz., unobservable for the econometrician) could be inferred from the actually observed decisions of the firm in subsequent periods. Therefore, readily available instrumental variable techniques can be used for estimation, instead of contructing artificial proxies for the unobservable targets. In this fashion, consistent estimates of the model's corresponding coefficients can be obtained, unconditional on the researcher's artificially constructed proxies.

The empirical performance of the proposed framework was tested on a sample of 141 Mexican private firms for the year 1980, obtaining quite satisfactory results. The general model just described was estimated using an instrumental variable procedure. A rigorous specification test did not indicate statistical misspecification of the model, either on the entire sample or in any of various sub-samples of firms. It was found that the cross-equation restrictions on the coefficients of the model (whose significance was highlighted by the conceptual framework) could not be rejected in practice in most instances. The signs of most parameter estimates were found to be as expected, and the magnitudes of the corresponding coefficients were also in accordance with what the analytical framework indicated (for example, all the estimated "partial adjustment coefficients" were positive and less than unity). These findings give empirical support to the conceptual structure offered in this dissertation.

It was also found that the Partial Adjustment to Targets (PAT) specification of the model was generally not rejected statistically. In contrast, the Interdependent Adjustment (IDA) specification was statistically rejected in most instances. The coefficients of the Partial Adjustment to Targets Model could be estimated with considerable precision, and most of them were found to be significantly different from zero.

Comparisons of the results obtained from various sub-samples of firms did suggest the presence of binding constraints on the demand for domestic credit by firms in several sub-samples. In the group of all non-constrained firms, it was found that there existed statistically significant interactions between investment and financing decisions in the short-run and in the medium-run.

All the features mentioned above indicate that the framework offered in this paper is appealing for both abstract understanding and empirical research about the firms' overall investment and financing decision making. Its use in the future looks very promising. Future related work should explore further the basic ideas of this framework. In particular, it is highly desirable to explain at a more profound level the parameters of this framework, either from the perspective of financial market equilibrium or from the viewpoint of a firm-centered behavioral analysis.

Table I.1

COMPARISON OF THE IDA AND PAT TRADITIONS(*).

	IDA Tradition	PAT Tradition
Main focus:	Interactions between investment and financing decisions.	Interactions between financing decisions, given the firm's deficit.
Nature of interactions studied:	At a point in time. (Short-run).	Over several points in time. (Short/Medium-run).
Explanatory elements:	Exogenous variables[1] and the endogenous flow-variables[2] themselves.	Exogenous variables[3] and past values of the stocks[4] of the endogenous variables.
Conceptual framework of interactions:	Jointly dependent endogenous variables, with unrestricted matrix of interactions.	Simultaneous partial adjustment to targets for endogenous vars., restricted by adding-up constraint.

Notes:
1/ Accelerator variables, profits or profit rate variables, depreciation, financial risk variables, interest rate variables, etc.
2/ Investment in production assets, new debt financing, dividends.
3/ Total financing deficit, debt to equity targets, liquid assets targets, debt and stock financing timing indicators, etc.
4/ Long-term debt, equity, dividends, short-term debt, liquid assets.

* IDA and PAT are mnemonics for Interdependent Adjustment and Partial Adjustment to Targets, respectively, as explained in the text.

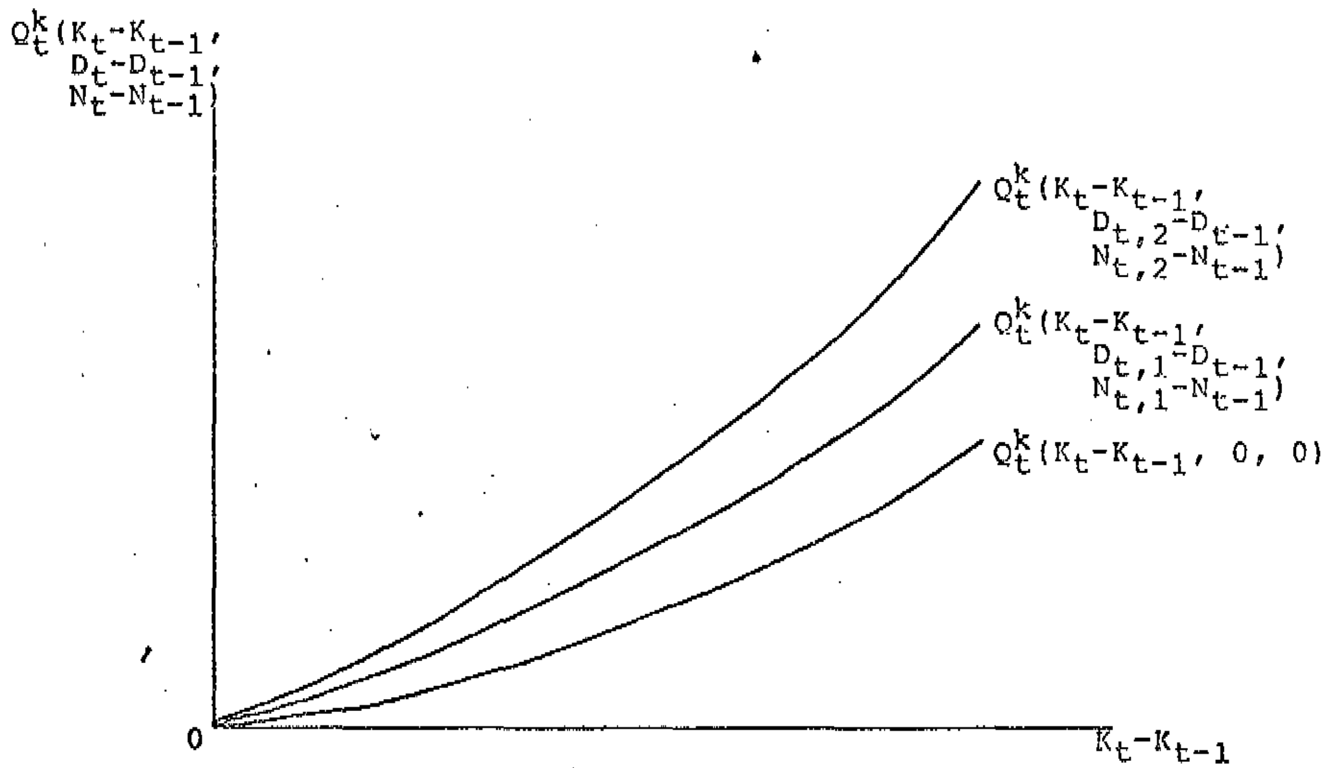
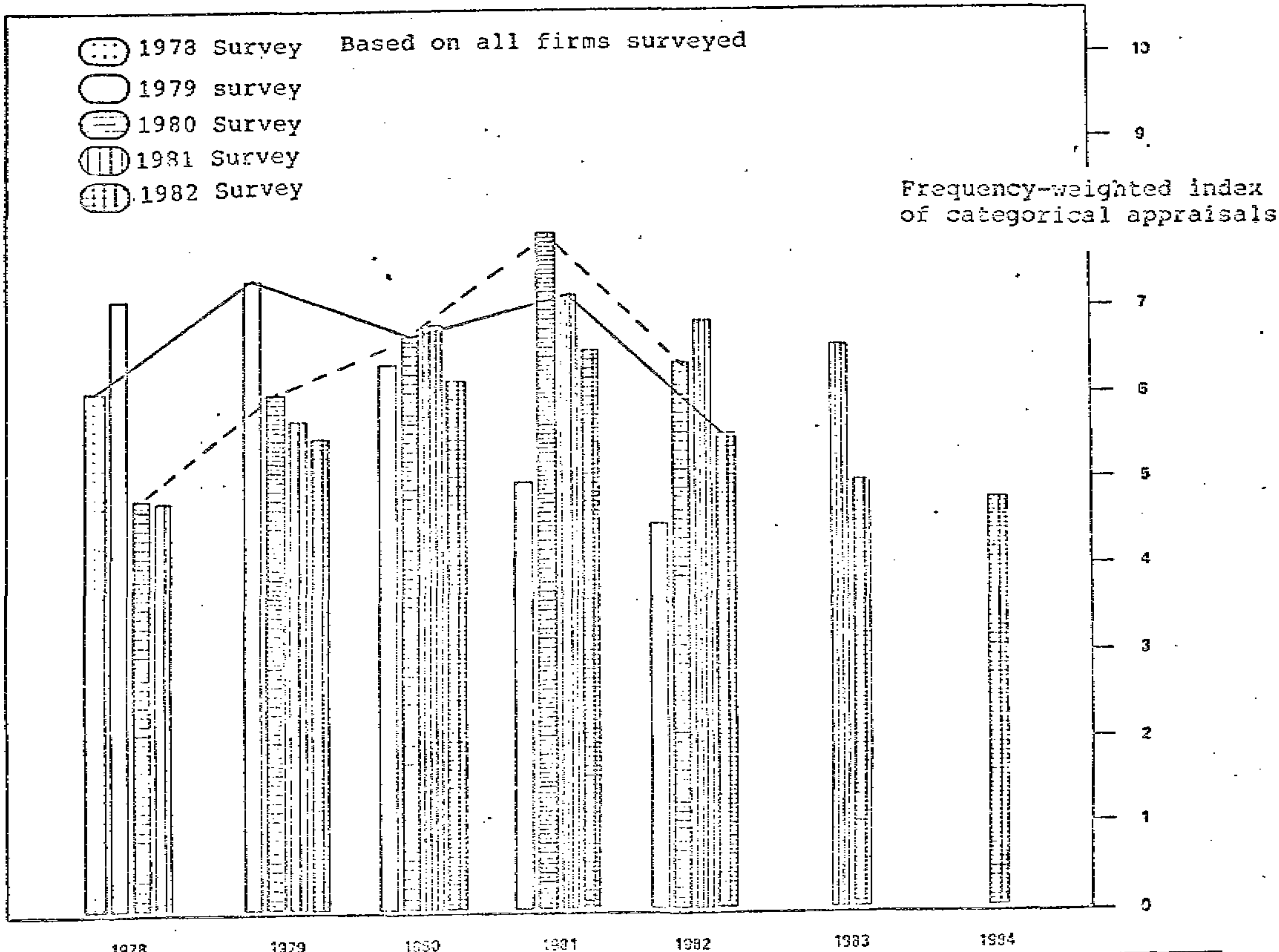


Figure II.1 The Cost-of-Adjustment function of the firm's stock of fixed assets.

Figure III.1

MEXICO: FIRMS' QUALITATIVE APPRAISALS OF INVESTMENT LEVELS, 1978-1984.



SOURCE: "Encuesta sobre la Actividad Economica Empresarial, 1982", Oficina de Asesores del C. Presidente de la Republica, Mexico, 1982.

TABLE IV.1
GENERAL MODEL

A. Version with structural parameters explicitly written. (S.1)

$$K_{80} = -\frac{f^{kd}}{g_k}D_{80} - \frac{f^{kn}}{g_k}N_{80} - \frac{b^{kk}}{g_k}K_{79} - \frac{b^{kd}}{g_k}D_{79} - \frac{b^{kn}}{g_k}N_{79} - \frac{b^{kk}}{g_k}K^{+}_{81} - \frac{b^{kd}}{g_k}D^{+}_{81} - \frac{b^{kn}}{g_k}N^{+}_{81} - \frac{1}{g_k}Z^{k}_{80} - \frac{c^{k}}{g_k}$$

$$D_{80} = -\frac{f^{kd}}{g_d}K_{80} - \frac{f^{dn}}{g_d}N_{80} - \frac{b^{kd}}{g_d}K_{79} - \frac{b^{dd}}{g_d}D_{79} - \frac{b^{dn}}{g_d}N_{79} - \frac{b^{kd}}{g_d}K^{+}_{81} - \frac{b^{dd}}{g_d}D^{+}_{81} - \frac{b^{dn}}{g_d}N^{+}_{81} - \frac{1}{g_d}Z^{d}_{80} - \frac{c^{d}}{g_d}$$

$$N_{80} = -\frac{f^{kn}}{g_n}K_{80} - \frac{f^{dn}}{g_n}D_{80} - \frac{b^{kn}}{g_n}K_{79} - \frac{b^{dn}}{g_n}D_{79} - \frac{b^{nn}}{g_n}N_{79} - \frac{b^{kn}}{g_n}K^{+}_{81} - \frac{b^{dn}}{g_n}D^{+}_{81} - \frac{b^{nn}}{g_n}N^{+}_{81} - \frac{1}{g_n}Z^{n}_{80} - \frac{c^{n}}{g_n}$$

Addendum:

$a^{kk} = g_k + b^{kk} + b^{kk}$, $a^{dd} = g_d + b^{dd} + b^{dd}$, $a^{nn} = g_n + b^{nn} + b^{nn}$,

$a^{kd} = f^{kd} + b^{kd} + b^{kd}$, $a^{kn} = f^{kn} + b^{kn} + b^{kn}$, $a^{dn} = f^{dn} + b^{dn} + b^{dn}$,

B. Equivalent version with structural parameters not explicitly written. (S.2)

$$K_{80} = p_{11}D_{80} + p_{12}N_{80} + p_{13}K_{79} + p_{14}D_{79} + p_{15}N_{79} + p_{16}K^{+}_{81} + p_{17}D^{+}_{81} + p_{18}N^{+}_{81} + p_{19}Z^{k}_{80} + p_{110}$$

$$D_{80} = p_{21}K_{80} + p_{22}N_{80} + p_{23}K_{79} + p_{24}D_{79} + p_{25}N_{79} + p_{26}K^{+}_{81} + p_{27}D^{+}_{81} + p_{28}N^{+}_{81} + p_{29}Z^{d}_{80} + p_{210}$$

$$N_{80} = p_{31}K_{80} + p_{32}D_{80} + p_{33}K_{79} + p_{34}D_{79} + p_{35}N_{79} + p_{36}K^{+}_{81} + p_{37}D^{+}_{81} + p_{38}N^{+}_{81} + p_{39}Z^{n}_{80} + p_{310}$$

subject to the cross-equation constraints:

$$\frac{p11}{p21} = \frac{p14}{p23} = \frac{p17}{p26} = \frac{p19}{p29}, \quad \frac{p12}{p31} = \frac{p15}{p33} = \frac{p18}{p36} = \frac{p19}{p39}, \quad \frac{p22}{p32} = \frac{p25}{p34} = \frac{p28}{p37} = \frac{p29}{p39}.$$

TABLE IV.2
INTERDEPENDENT ADJUSTMENT (IDA) MODEL*

A. Version with structural parameters explicitly written. (S.3)

$$(K_{80}-K_{79}) = -\frac{b^{kd}}{b_{kk}}(D_{80}-D_{81}) - \frac{b^{kn}}{b_{kk}}(N_{80}-N_{79}) - \frac{b^{kk}}{b_{kk}}K^{+}_{81} - \frac{b^{kd}}{b_{kk}}D^{+}_{81} - \frac{b^{kn}}{b_{kk}}N^{+}_{81} - \frac{1}{b_{kk}}Z^{k}_{80} - \frac{c^{k}}{b_{kk}}$$

$$(D_{80}-D_{79}) = -\frac{b^{kd}}{b_{dd}}(K_{80}-K_{81}) - \frac{b^{dn}}{b_{dd}}(N_{80}-N_{79}) - \frac{b^{kd}}{b_{dd}}K^{+}_{81} - \frac{b^{dd}}{b_{dd}}D^{+}_{81} - \frac{b^{dn}}{b_{dd}}N^{+}_{81} - \frac{1}{b_{dd}}Z^{d}_{80} - \frac{c^{d}}{b_{dd}}$$

$$(N_{80}-N_{79}) = -\frac{b^{kn}}{b_{nn}}(N_{80}-N_{81}) - \frac{b^{dn}}{b_{nn}}(D_{80}-D_{79}) - \frac{b^{kn}}{b_{nn}}K^{+}_{81} - \frac{b^{dn}}{b_{nn}}D^{+}_{81} - \frac{b^{nn}}{b_{nn}}N^{+}_{81} - \frac{1}{b_{nn}}Z^{n}_{80} - \frac{c^{n}}{b_{nn}}$$

B. Equivalent version with structural parameters not explicitly written out. (S.4)

$$(K_{80}-K_{79}) = q_{11}(D_{80}-D_{79}) + q_{12}(N_{80}-N_{79}) + q_{13}K^{+}_{81} + q_{14}D^{+}_{81} + q_{15}N^{+}_{81} + q_{16}Z^{k}_{80} + q_{17}$$

$$(D_{80}-D_{79}) = q_{21}(K_{80}-K_{79}) + q_{22}(N_{80}-N_{79}) + q_{23}K^{+}_{81} + q_{24}D^{+}_{81} + q_{25}N^{+}_{81} + q_{26}Z^{d}_{80} + q_{27}$$

$$(N_{80}-N_{79}) = q_{31}(K_{80}-K_{79}) + q_{32}(D_{80}-D_{79}) + q_{33}K^{+}_{81} + q_{34}D^{+}_{81} + q_{35}N^{+}_{81} + q_{36}Z^{n}_{80} + q_{37}$$

subject to the cross-equation constraints:

$$\frac{q11}{q21} = \frac{q14}{q23} = \frac{q16}{q26}, \quad \frac{q12}{q31} = \frac{q15}{q33} = \frac{q16}{q36}, \quad \frac{q22}{q32} = \frac{q25}{q34} = \frac{q26}{q36}.$$

* This IDA specification is obtained from the General Model by impossing the restrictions $a^{kk}=b^{kk}$, $a^{kd}=b^{kd}$, $a^{kn}=b^{kn}$, $a^{dd}=b^{dd}$, $a^{dn}=b^{dn}$, $a^{nn}=b^{nn}$ in version A. Alternatively, it is obtained by imposing the following restrictions in the equivalent version B:

$p_{13}=1$, $p_{11}=-p_{14}$, $p_{12}=-p_{15}$; $p_{24}=1$, $p_{21}=-p_{23}$, $p_{22}=-p_{25}$; $p_{35}=1$, $p_{31}=-p_{33}$, $p_{32}=-p_{34}$.

TABLE IV.3

PARTIAL ADJUSTMENT TO TARGETS (PAT) MODEL*

A. Version with structural parameters explicitly written. (S.5)

$$(K_{80}-K_{79}) = -\frac{b^{kd}+b^{kd}}{b_{kk}+b_{kk}}(D_{80}-D_{79}) - \frac{b^{kn}+b^{kn}}{b_{kk}+b_{kk}}(N_{80}-N_{79}) +$$

$$\frac{b^{kk}}{b_{kk}+b_{kk}}(K^{+}_{81}-K_{79}) + \frac{b^{kd}}{b_{kk}+b_{kk}}(D^{+}_{81}-D_{79}) + \frac{b^{kn}}{b_{kk}+b_{kk}}(N^{+}_{81}-N_{79}) + \frac{1}{b_{kk}+b_{kk}}z^{k}_{80} + \frac{c^{k}}{b_{kk}+b_{kk}}$$

$$(D_{80}-D_{79}) = -\frac{b^{kd}+b^{kd}}{b_{dd}+b_{dd}}(K_{80}-K_{79}) - \frac{b^{dn}+b^{dn}}{b_{dd}+b_{dd}}(N_{80}-N_{79}) +$$

$$\frac{b^{kd}}{b_{dd}+b_{dd}}(K^{+}_{81}-K_{79}) + \frac{b^{dd}}{b_{dd}+b_{dd}}(D^{+}_{81}-D_{79}) + \frac{b^{dn}}{b_{dd}+b_{dd}}(N^{+}_{81}-N_{79}) + \frac{1}{b_{dd}+b_{dd}}z^{d}_{80} + \frac{c^{d}}{b_{dd}+b_{dd}}$$

$$(N_{80}-N_{79}) = -\frac{b^{kn}+b^{kn}}{b_{nn}+b_{nn}}(K_{80}-K_{79}) - \frac{b^{dn}+b^{dn}}{b_{nn}+b_{nn}}(D_{80}-D_{79}) +$$

$$\frac{b^{kn}}{b_{nn}+b_{nn}}(K^{+}_{81}-K_{79}) + \frac{b^{dn}}{b_{nn}+b_{nn}}(D^{+}_{81}-D_{79}) + \frac{b^{nn}}{b_{nn}+b_{nn}}(N^{+}_{81}-N_{79}) + \frac{1}{b_{nn}+b_{nn}}z^{n}_{80} + \frac{c^{n}}{b_{nn}+b_{nn}}$$

(continued)

TABLE IV.3

PARTIAL ADJUSTMENT TO TARGETS (PAT) MODEL* (cont).

B. Equivalent version with structural parameters not explicitly written. (S.6)

$$(K_{80}-K_{79}) = r_{11}(D_{80}-D_{79}) + r_{12}(N_{80}-N_{79}) + r_{13}(K^{+}_{81}-K_{79}) + r_{14}(D^{+}_{81}-D_{79}) + r_{15}(N^{+}_{81}-N_{79}) + r_{16}Z^{k}_{80} + r_{17}$$

$$(D_{80}-D_{79}) = r_{21}(K_{80}-K_{79}) + r_{22}(N_{80}-N_{79}) + r_{23}(K^{+}_{81}-K_{79}) + r_{24}(D^{+}_{81}-D_{79}) + r_{25}(N^{+}_{81}-N_{79}) + r_{26}Z^{d}_{80} + r_{27}$$

$$(N_{80}-N_{79}) = r_{31}(K_{80}-K_{79}) + r_{32}(D_{80}-D_{79}) + r_{33}(K^{+}_{81}-K_{79}) + r_{34}(D^{+}_{81}-D_{79}) + r_{35}(N^{+}_{81}-N_{79}) + r_{36}Z^{n}_{80} + r_{37}$$

subject to the cross-equation constraints:

$$\frac{r11}{r21} = \frac{r14}{r23} = \frac{r16}{r26}, \quad \frac{r12}{r31} = \frac{r15}{r33} = \frac{r16}{r36}, \quad \frac{r22}{r32} = \frac{r25}{r34} = \frac{r26}{r36}.$$

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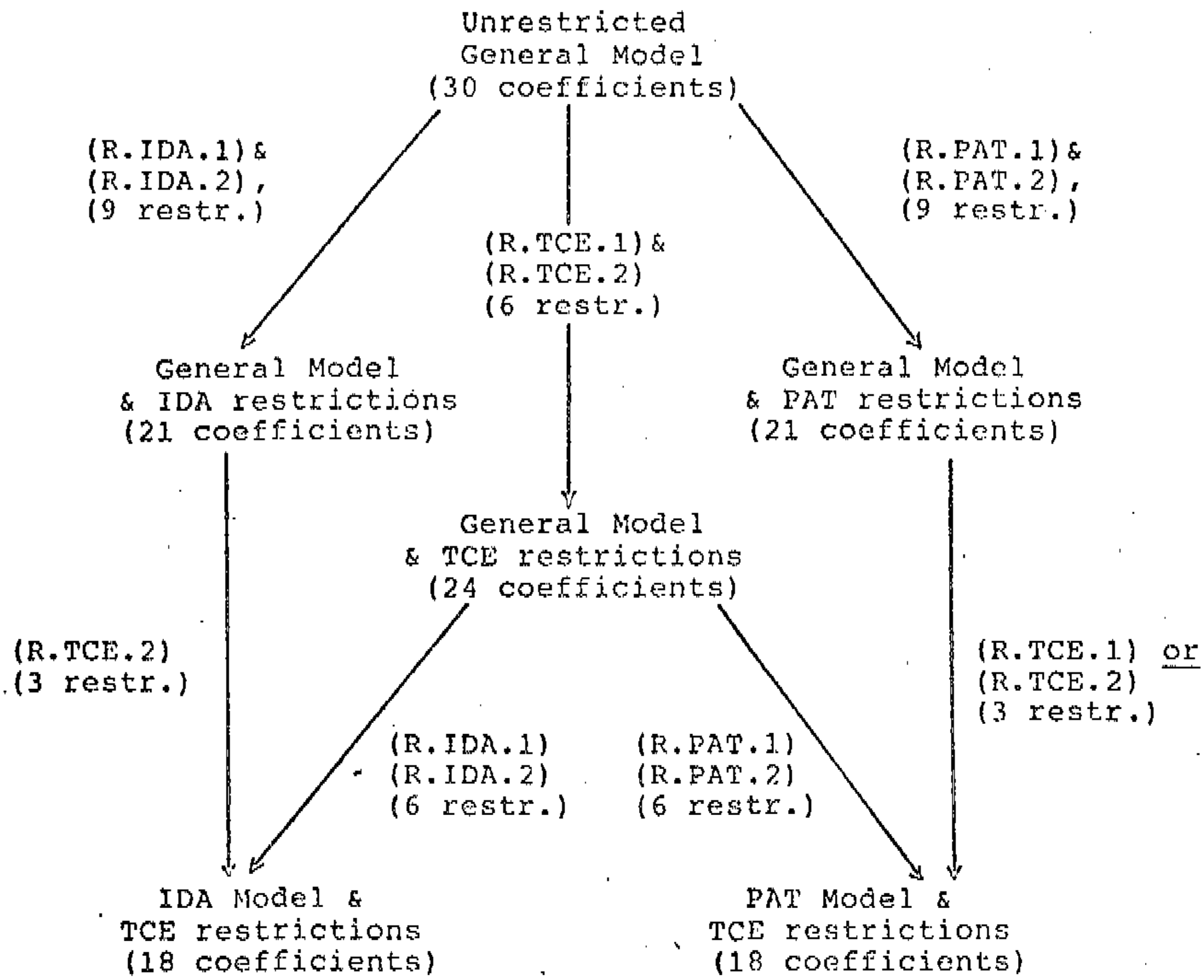
* This PAT specification is obtained from the General Model by impossing the restrictions $a^{kk} = a^{kd} = a^{kn} = a^{dd} = a^{dn} = a^{nn} = 0$ in version A. Alternatively, it is obtained by impossing the following restrictions in the equivalent version B: $p_{11}=-(p_{14}+p_{17})$, $p_{12}=-(p_{15}+p_{18})$, $p_{13}+p_{16}=1$; $p_{21}=-(p_{23}+p_{26})$, $p_{22}=-(p_{25}+p_{28})$, $p_{24}+p_{27} = 1$; $p_{31}=-(p_{33}+p_{36})$, $p_{32}=-(p_{34}+p_{37})$, $p_{35}+p_{38} = 1$.

Table IV.4

HIERARCHY OF MODELS *



* The restrictions on the coefficients of the "timing variables" are not considered since dichotomous indicators are used instead of the original "timing variables".

Table V.1

MINIMUM-DISTANCE STATISTICS, BY MODEL AND FIRM GROUP(*).

Group	Model	Unrestricted	Restricted**	Difference
All Firms	General	19.4571	20.5749	1.1178
	IDA	38.4052 (18.9481)	46.0464 (26.5893)	7.6412
	PAT	26.6290 (7.1715)	26.9050 (7.4479)	0.2790
Group NCC	General	3.7235	6.6909	2.9674
	IDA	12.0376 (8.3141)	13.1441 (9.4206)	1.1065
	PAT	5.3010 (1.578)	7.1598 (3.4363)	1.8588
Group S	General	12.5682	16.1946	3.6264
	IDA	39.1907 (26.6225)	39.3624 (26.7942)	0.1717
	PAT	20.6341 (8.0659)	21.3040 (8.7358)	0.6699
Group M	General	5.2610	16.1364	10.8753
	IDA	28.6750 (23.4140)	38.1622 (32.9012)	9.4872
	PAT	26.1894 (20.928)	26.9058 (21.6448)	0.7164

(cont.)

Table V.1 (cont.)

MINIMUM-DISTANCE STATISTICS, BY MODEL AND FIRM GROUP(*).

Group	Model	Unrestricted	Restricted**	Difference
Group L	General	1.6769	17.5348	15.8578
	IDA	28.9443 (27.2674)	55.5093 (53.8324)	26.5650
	PAT	6.9567 (5.280)	23.4567 (21.7797)	16.4999
Group G	General	10.9208	13.7886	2.8678
	IDA	12.7286 (1.8078)	14.3237 (3.4029)	1.5951
	PAT	15.7840 (4.863)	17.1560 (6.2352)	1.3720

Addendum: Number of estimated coefficients by model

	Unrestricted	Restricted
General	30	24
IDA	21	18
PAT	21	18

Chi-square (95%):	7.8147	12.5916	16.9190	21.0261
Degrees of freedom:	3	6	9	12

(*) This Minimum-Distance statistic is equal to $\hat{e}'(S^{-1} \otimes P_z)\hat{e}$, where $\hat{e}$ is the stacked vector of residuals from the model, S is a consistent estimate of the covariance of the disturbances, $P_z = Z(Z'Z)^{-1}Z'$ is the projection matrix of the instruments and $\otimes$ is the Kroeneker-product operator. The S actually used was computed from the 2SLS residuals of the general unrestricted model.

The figures in parentheses under the statistics of the IDA and PAT models are the corresponding differences respect to the minimum-distance statistic of the group's general unrestricted model.

** Cross-equation restrictions from the theoretical model.

Table V.2a

ESTIMATED COEFFICIENTS, TCE-RESTRICTED GENERAL MODEL: INVESTMENT EQUATION.(*)
(Absolute value of t-statistics in parenthesis)

A. Investment Equation

Var.	All	NCC	S	M	L	G
D80	-0.0188 (0.0733)	0.4807 (3.3303)	0.2314 (0.8150)	1.6114 (3.7984)	1.5339 (8.7629)	0.5741 (4.6495)
N80	0.3076 (1.2847)	0.4860 (4.5191)	0.1899 (1.4027)	-0.6434 (1.9076)	0.6322 (7.6107)	0.7509 (5.9984)
K79	0.4330 (2.4972)	0.4684 (2.1511)	0.4551 (2.7358)	1.0533 (3.7963)	0.3253 (2.6567)	1.0147 (6.6327)
D79	-0.0739 (0.2419)	-0.2168 (1.3592)	0.0400 (0.2476)	-0.1705 (0.4934)	-0.1044 (0.5251)	-0.5916 (3.3722)
N79	-0.1153 (1.0463)	-0.1918 (1.5135)	0.0601 (0.4668)	-0.6345 (1.6997)	-0.2149 (2.5997)	-0.7804 (4.5151)
K81	0.4957 (3.9526)	0.5262 (3.1982)	0.4891 (3.0683)	0.0287 (0.1653)	0.5373 (5.9522)	0.1510 (1.3746)
D81	0.0870 (0.3577)	-0.2711 (2.1479)	-0.3857 (1.4162)	-0.6089 (3.0014)	-1.0996 (8.0073)	-0.0649 (0.9950)
N81	-0.1792 (1.2297)	-0.2901 (2.4796)	-0.2872 (2.3640)	0.5143 (2.0643)	-0.3402 (4.3078)	-0.0835 (0.8821)
KT80	0.0101 (0.0242)	0.0019 (0.1588)	-0.0091 (0.1802)	0.0041 (0.0929)	-0.0070 (0.7511)	0.0231 (0.5403)
CK	-0.0120 (0.2524)	-0.0179 (0.5469)	0.0868 (1.0291)	0.2871 (2.3597)	-0.0133 (0.4567)	-0.0361 (1.1305)

(*)
3SLS estimates with 2SLS residual covariance matrix from unrestricted general model.

Table V.2b

ESTIMATED COEFFICIENTS, TCE-RESTRICTED GENERAL MODEL: DEBT EQUATION.(*)
(Absolute value of t-statistics in parenthesis)

B. Debt Equation						
Var.	All	NCC	S	M	L	G
K80	0.0254 (0.0675)	1.7470 (2.2314)	0.3081 (0.9528)	0.2226 (1.7747)	0.5262 (4.0836)	1.6042 (4.0452)
N80	0.2126 (1.0435)	-0.7604 (1.9481)	-0.4094 (2.1124)	0.6115 (3.4302)	-0.3692 (4.2216)	-1.0616 (4.2530)
K79	0.1003 (0.4211)	-0.7878 (1.7100)	0.0533 (0.2473)	-0.0236 (0.4646)	-0.0358 (0.5201)	-1.6530 (4.2502)
D79	0.5770 (2.4211)	0.4172 (0.9902)	0.3719 (1.1276)	-0.0575 (0.2499)	0.0575 (0.3337)	0.9404 (3.4531)
N79	-0.1282 (1.1469)	0.3108 (1.0581)	0.1447 (1.0266)	-0.0492 (0.3581)	0.0235 (0.4861)	1.1250 (3.9970)
K81	-0.1179 (0.4588)	-0.9854 (1.5088)	-0.5136 (2.3792)	-0.0841 (1.5259)	-0.3772 (3.3918)	-0.1815 (0.8862)
D81	0.3455 (1.2054)	0.6230 (1.1211)	0.6824 (2.7205)	0.4223 (3.8944)	0.7602 (8.3298)	0.0335 (0.1907)
N81	0.0069 (0.0506)	0.5255 (1.1947)	0.2061 (1.4236)	-0.2622 (2.0985)	0.2675 (3.5576)	0.0453 (0.2851)
DT80	0.0211 (0.5481)	0.0063 (0.1159)	0.0149 (0.2280)	0.0037 (0.2038)	-0.0176 (1.8811)	0.0090 (0.1818)
CD	-0.0374 (0.5118)	-0.0154 (0.1063)	0.1550 (1.4464)	-0.1896 (3.0965)	0.0237 (0.8523)	0.0925 (0.8451)

(*)
3SLS estimates with 2SLS residual covariance matrix from unrestricted general model.

Table V.2c

ESTIMATED COEFFICIENTS, TCE-RESTRICTED GENERAL MODEL: EQUITY EQUATION.(*)
(Absolute value of t-statistics in parenthesis)

C. Equity Equation

Var.	All	NCC	S	M	L	G
K80	1.1058 (2.0421)	2.0308 (3.7761)	0.4849 (1.0132)	-0.1878 (1.2395)	1.5526 (6.4770)	1.2972 (6.0234)
D80	0.6061 (1.5627)	-0.8806 (2.2943)	-1.5246 (2.4686)	1.4745 (3.6273)	-2.3090 (7.2212)	-0.7194 (3.2960)
K79	0.3713 (1.5564)	-0.8014 (1.6386)	0.1536 (0.4883)	-0.1853 (1.4889)	-0.5277 (2.1907)	-1.3481 (4.6510)
D79	-0.3655 (0.9898)	0.3599 (0.8845)	0.5387 (1.0323)	0.1186 (0.3614)	0.1470 (0.4813)	0.7623 (2.7743)
N79	0.2950 (1.3276)	0.3117 (0.9369)	-0.0363 (0.1068)	0.0594 (0.2064)	0.3756 (2.1848)	1.0099 (4.7941)
K81	-0.6442 (1.8295)	-1.2125 (2.0926)	-0.7335 (1.5320)	0.1501 (1.4228)	-0.8356 (4.7276)	-0.1442 (0.8490)
D81	0.0197 (0.0495)	0.6085 (1.5252)	0.7675 (1.2639)	-0.6321 (4.0281)	1.6728 (6.9191)	0.0307 (0.2895)
N81	0.5769 (3.8738)	0.7184 (1.9830)	0.5552 (2.2044)	0.3761 (3.1203)	0.5323 (4.7025)	0.0788 (0.4801)
NT80	-0.0352 (0.8985)	-0.0047 (0.1531)	-0.0583 (0.5631)	-0.0005 (0.0097)	-0.0041 (0.2120)	0.0050 (0.1469)
CN	0.0192 (0.1613)	-0.0053 (0.0439)	0.4706 (1.9517)	0.2788 (3.4766)	0.0160 (0.2985)	0.0699 (1.0138)

(*)
3SLS estimates with 2SLS residual covariance matrix from unrestricted general model.

Table V.3a

ESTIMATED COEFFICIENTS, TCE-RESTRICTED PAT MODEL: INVESTMENT EQUATION. (*)
(Absolute value of t-statistics in parenthesis)

A. Investment Equation

Var.	All	NCC	S	M	L	G
$(D_{80}-D_{79})$	-0.0147 (0.0936)	0.4966 (3.7203)	0.3041 (1.0849)	1.0721 (5.5476)	1.2651 (13.4582)	0.5771 (5.2499)
$(N_{80}-N_{79})$	0.3677 (1.6837)	0.5036 (5.7078)	0.2478 (2.1336)	-0.4448 (2.3471)	0.6566 (10.5930)	0.7978 (6.8907)
$(K^{+}_{81}-K_{79})$	0.4770 (4.1936)	0.5052 (3.1785)	0.5039 (3.0271)	0.3307 (3.6698)	0.6255 (7.1524)	0.1224 (1.1009)
$(D^{+}_{81}-D_{79})$	0.2411 (0.0973)	-0.2479 (2.3785)	-0.3748 (1.2427)	-0.3986 (4.4203)	-0.9008 (7.0602)	-0.0374 (0.5136)
$(N^{+}_{81}-N_{79})$	-0.2038 (1.5405)	-0.2749 (2.7730)	-0.2821 (2.4839)	0.1920 (2.2104)	-0.4165 (5.4563)	-0.705 (0.6959)
KT80	0.0029 (0.0696)	0.0014 (0.1222)	-0.0025 (0.0490)	-0.0098 (0.2371)	-0.0022 (0.2487)	0.0248 (0.6246)
CK	-0.0132 (0.3271)	-0.0245 (0.9293)	0.0215 (0.3687)	0.0375 (1.0813)	-0.0008 (0.0311)	-0.0466 (1.7644)

(*)
3SLS estimates with 2SLS residual covariance matrix from unrestricted general model.

Table V.3b

ESTIMATED COEFFICIENTS, TCE-RESTRICTED PAT MODEL: BORROWING EQUATION. (*)
(Absolute value of t-statistics in parenthesis)

B. Borrowing Equation

Var.	All	NCC	S	M	L	G
$(K_{80}-K_{79})$	0.0725	1.7942	0.5278	0.7094	0.7081	1.4061
	(0.1872)	(3.5154)	(1.6079)	(4.5267)	(8.6767)	(5.3971)
$(N_{80}-N_{79})$	0.1004	-0.8293	-0.4784	0.5224	-0.4806	-1.0791
	(0.8729)	(2.9374)	(3.1047)	(6.2299)	(7.8407)	(4.5278)
$(K^{+}_{81}-K_{79})$	-0.1186	-0.8959	-0.6506	-0.2638	-0.5042	-0.0911
	(0.5464)	(2.0852)	(3.0407)	(3.2563)	(5.7712)	(0.4851)
$(D^{+}_{81}-D_{79})$	0.2836	0.4332	0.7241	0.3430	0.7401	0.03754
	(1.5855)	(1.5096)	(3.0329)	(4.5484)	(7.7015)	(0.2558)
$(N^{+}_{81}-N_{79})$	0.0476	0.4742	0.3442	-0.1912	0.3474	0.0146
	(0.6716)	(1.6883)	(2.3602)	(3.9908)	(5.3395)	(0.0955)
DT80	0.0318	-0.0009	-0.0025	-0.0005	-0.0135	0.0201
	(0.9037)	(0.0202)	(0.0409)	(0.0289)	(1.4676)	(0.5273)
CD	0.0019	0.0457	0.0810	-0.0310	0.0083	0.0593
	(0.0520)	(0.6815)	(1.3968)	(1.0091)	(0.3693)	(1.1986)

(*)
3SLS estimates with 2SLS residual covariance matrix from unrestricted general model.

Table V.3c

ESTIMATED COEFFICIENTS, TCE-RESTRICTED PAT MODEL: EQUITY CHANGE EQUATION. (*)
(Absolute value of t-statistics in parenthesis)

C. Equity Change Equation

Var.	All	NCC	S	M	L	G
$(K_{80}-K_{79})$	1.1967	1.9138	0.9456	-1.0393	1.4944	1.2504
	(2.6307)	(4.5783)	(1.8623)	(3.5135)	(11.1830)	(6.9522)
$(D_{80}-D_{79})$	0.4137	-0.8871	-1.4159	1.5754	-1.8584	-0.7244
	(1.1102)	(2.5476)	(2.3081)	(8.4212)	(13.5889)	(3.9753)
$(K^{+}_{81}-K_{79})$	-0.6633	-1.0449	-1.0763	0.4487	-0.9479	-0.1105
	(2.3313)	(2.4328)	(2.4436)	(3.3072)	(6.6279)	(0.6838)
$(D^{+}_{81}-D_{79})$	0.1961	0.5072	1.0189	-0.5766	1.3432	0.0098
	(0.7777)	(1.9696)	(1.7309)	(4.6263)	(7.1797)	(0.0962)
$(N^{+}_{81}-N_{79})$	0.5899	0.6150	0.6829	0.3559	0.6338	0.0536
	(4.2152)	(2.2623)	(2.8509)	(4.8648)	(6.0705)	(0.3261)
NT80	-0.0451	-0.0038	-0.0113	-0.0177	-0.0084	0.0008
	(1.1671)	(0.1267)	(0.1247)	(0.4552)	(0.5780)	(0.0239)
CN	-0.0246	0.0363	0.1252	0.0620	0.0078	0.0603
	(0.4510)	(0.5477)	(1.3062)	(1.1253)	(0.1959)	(1.1755)

(*)
3SLS estimates with 2SLS residual covariance matrix from unrestricted general model.

Table V.4
ESTIMATED STRUCTURAL PARAMETERS, GENERAL MODEL. (*)
(Absolute value of t-statistics in parenthesis)

Parameter	All	NCC	S	M	L	G
b^{kk}	0.8384 (0.5794)	4.0644 (1.0243)	1.2729 (0.8644)	4.2044 (0.9515)	3.7429 (1.9463)	2.7275 (2.0195)
b^{kd}	0.1719 (0.3828)	-1.8924 (1.4029)	0.1278 (0.2136)	-2.4754 (1.1799)	-2.3036 (3.3840)	-1.6313 (2.8018)
b^{kn}	-0.2835 (0.6229)	-1.6619 (0.9539)	0.0957 (0.2771)	0.6132 (0.8277)	-2.3799 (1.9583)	-2.0742 (2.0996)
b^{dd} (**)	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
b^{dn}	-0.2144 (0.9617)	0.7536 (1.0177)	0.3484 (0.9663)	-0.1202 (0.7892)	1.5392 (3.3256)	1.1535 (3.2696)
b^{nn}	0.1799 (0.7313)	0.6429 (0.6409)	-0.0131 (0.0377)	-0.0146 (0.1017)	1.5859 (1.9033)	1.5410 (1.9850)
b^{kk}	1.0782 (0.6283)	4.5349 (0.7903)	1.5966 (0.9746)	1.8695 (0.7666)	1.3663 (1.1159)	0.4037 (0.9146)
b^{kd}	-0.0288 (0.0688)	-2.3412 (0.7414)	-1.4815 (0.9682)	-0.7936 (0.9562)	-0.8908 (1.7329)	-0.1638 (0.7341)
b^{kn}	-0.4447 (0.7201)	-2.4962 (0.7690)	-0.7541 (0.9832)	0.1204 (0.6144)	-0.9129 (1.1192)	-0.2285 (0.7195)
b^{dd}	0.6125 (0.8442)	1.4982 (0.5864)	1.8176 (0.8946)	1.0981 (0.9197)	1.1542 (2.3238)	0.0448 (0.2515)
b^{dn}	-0.0213 (0.0796)	1.2472 (0.6643)	0.7283 (0.9350)	-0.3700 (0.7542)	0.4971 (1.6077)	0.0481 (0.2868)
b^{nn}	0.3802 (0.7531)	1.4758 (0.7451)	0.5805 (0.9489)	0.2168 (0.7645)	0.6416 (1.1161)	0.1290 (0.4567)

(*) 3SLS estimates with 2SLS residual covariance matrix from unrestricted general model. (**) The value of this parameter was set equal to unity as a normalization.

(continued...)

Table V.4 (cont.)
ESTIMATED STRUCTURAL PARAMETERS, GENERAL MODEL.
(Absolute value of t-statistics in parenthesis)

Parameter	All	NCC	S	M	L	G
a^{kk}	-0.1245	-0.0423	-0.1540	1.0129	-0.4744	0.4487
	(0.4121)	(0.0411)	(0.3923)	(0.7236)	(0.6830)	(1.4223)
a^{kd}	-0.0446	-0.0669	-0.3898	-0.4351	0.1952	-0.2336
	(0.2757)	(0.1129)	(0.8829)	(0.8389)	(0.7166)	(1.4528)
a^{kn}	0.0442	0.0350	-0.1005	0.0903	0.3183	-0.3044
	(0.3453)	(0.0720)	(0.4088)	(0.6212)	(0.6959)	(1.3647)
a^{dd}	-0.1638	0.0996	0.0742	-1.5193	-0.4379	0.0290
	(0.5041)	(0.1506)	(0.1009)	(0.7203)	(1.6709)	(0.1015)
a^{dn}	0.1634	0.1837	-0.2602	0.6324	-0.01904	0.1197
	(0.7246)	(0.3415)	(0.4511)	(0.7689)	(0.1076)	(0.7196)
a^{nn}	-0.0986	0.0600	-0.4430	-0.2655	-0.1726	0.1319
	(0.4669)	(0.1553)	(0.7292)	(0.6921)	(0.5656)	(0.6282)
Addendum:						
$a^{kk}-b^{kk}-b^{kk}$						
	-2.0412	-8.6415	-3.0236	-5.0609	-5.5836	-2.6824
	(0.6134)	(0.9219)	(0.9515)	(0.8311)	(1.7758)	(1.8116)
$a^{dd}-b^{dd}-b^{dd}$						
	-1.7763	-2.3986	-2.7434	-3.6174	-2.5922	-1.0157
	(2.3822)	(1.0294)	(1.1416)	(1.1228)	(3.5549)	(3.8599)
$a^{nn}-b^{nn}-b^{nn}$						
	-0.6588	-2.0587	-1.0105	-0.4677	-2.4002	-1.5381
	(0.7549)	(0.8485)	(0.9789)	(0.7660)	(1.7760)	(1.7875)
$a^{kd}-b^{kd}-b^{kd}$						
	-0.1878	4.1642	0.9638	2.8338	3.3896	1.5615
	(0.2790)	(1.0158)	(0.3026)	(1.1027)	(2.8519)	(2.3369)
$a^{kn}-b^{kn}-b^{kn}$						
	0.7723	4.1930	0.5578	-0.6433	3.6110	1.9983
	(0.6801)	(0.8986)	(0.8259)	(0.7986)	(1.7762)	(1.8826)
$a^{dn}-b^{dn}-b^{dn}$						
	0.3991	-1.8172	-1.3369	1.1227	-2.0554	-1.0819
	(0.8678)	(0.9326)	(1.1303)	(0.8456)	(2.9459)	(2.6236)

ESTIMATED STRUCTURAL PARAMETERS, PAT MODEL. (*)
(Absolute value of t-statistics in parenthesis)

Parameter	All	NCC	S	M	L	G
b^{kk}	0.4858	3.1440	2.3966	0.6946	0.7978	2.1651
	(0.6872)	(1.6409)	(0.8639)	(3.5281)	(5.1794)	(3.1384)
b^{kd}	0.0962	-1.5833	0.4259	-0.6864	-0.7861	-1.3517
	(0.3814)	(2.5200)	(0.5521)	(4.0017)	(7.6119)	(5.4554)
b^{kn}	-0.1726	-1.4499	0.1204	0.2964	-0.5237	-1.7793
	(0.7047)	(1.4191)	(0.2831)	(2.2884)	(5.3595)	(2.8858)
b^{dd} (**)	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
b^{dn}	-0.1936	0.6325	0.4708	-0.5030	0.5148	1.1032
	(0.9771)	(1.5737)	(1.0846)	(4.8923)	(7.4171)	(4.2584)
b^{nn}	0.1275	0.6374	0.3895	0.3231	0.3545	1.4744
	(0.7506)	(0.9282)	(0.8072)	(4.1313)	(5.2359)	(2.4968)
b^{kk}	0.4970	3.1913	2.7181	0.3726	1.3078	0.2972
	(0.7097)	(1.2093)	(0.9534)	(2.2863)	(1.9557)	(0.8710)
b^{kd}	-0.0655	-1.5693	-2.2818	-0.4149	-1.8067	-0.0812
	(0.3495)	(1.1633)	(0.9425)	(2.7616)	(2.0608)	(0.4097)
b^{kn}	-0.2203	-1.7317	-1.3430	0.2297	-0.8761	-0.1729
	(0.8054)	(1.1850)	(0.9874)	(2.3808)	(1.9508)	(0.6156)
b^{dd}	0.3794	0.7697	2.5204	0.5202	2.5895	0.0341
	(1.1889)	(0.8811)	(0.8692)	(3.0052)	(2.1061)	(0.2164)
b^{dn}	0.0599	0.8333	1.2393	-0.2904	1.2297	0.0149
	(0.6232)	(1.0410)	(0.9522)	(2.9299)	(2.0397)	(0.0939)
b^{nn}	0.1866	1.0142	0.8655	0.1766	0.5815	0.0851
	(0.8328)	(1.1224)	(0.9284)	(2.6246)	(1.8558)	(0.3162)

(*) 3SLS estimates with 2SLS residual covariance matrix from unrestricted general model. (**) The value of this parameter was set equal to unity as a normalization.

APPENDIX A.

REPRESENTATIVE EXAMPLES OF MODELS IN THE IDA AND PAT TRADITIONS.

As a quick reference regarding the actual specification of the simultaneous equation econometric models of the firm's investment and financing decisions, this Appendix presents concise descriptions of one prototypical model in each of the two basic traditions described in the Introduction. The model of Dhrymes and Kurz(1967) is considered an illustrative example of the models in the IDA tradition, and the model by Taggart(1977) is offered as representative of the PAT tradition.

1. Dhrymes and Kurz(1967). The purpose of the article is to empirically elucidate the extent to which the investment, dividend and external financing behavior of firms are interdependent. Dhrymes and Kurz point out that previous econometric investigations of the firm's investment (and dividend) behavior have been deficient in the sense that the interactions between investment and financing variables were substantially overlooked. They specify the following three simultaneous equations:

$$(D.1)\quad (I_t/S_t) = a_1(D_t/S_t) + a_2(ND_t/S_t) + b_1(P_{t-1}/K_{t-1}) + b_2(S_t-S_{t-3})/S_{t-3} + b_3(N_t/K_t) + \text{industry dummies}$$

$$(D.2)\quad (ND_t/S_t) = a_3(I_t/S_t) + a_4(D_t/S_t) + b_4LTD_t/(K_t-LTD_t) + b_5(R_t/LTD_t) + b_6(DEP_t/K_t) + b_7(P_t/K_t) + \text{constant}$$

$$(D.3)\quad (D_t/S_t) = a_5(I_t/S_t) + a_6(ND_t/S_t) + b_8(P_t/K_t) + b_9(N_t/K_t) + \text{industry dummies}$$

where the following definitions are actually employed:

I_t : gross fixed investment

ND_t : net long-term borrowing, calculated as first-difference of the book value of debt outstanding.

D_t : common dividends

S_t : sales, undeflated

K_t : book value of capital stock at the beginning of t

P_t : net profits after taxes, undeflated

LTD_t : net long-term outstanding, in nominal terms

DEP_t : depreciation allowances

N_t : net current position, defined as the excess of inventories, cash, short-term securities and accounts receivable over accounts payable and other short-term liabilities.

R_t : interest payments on long-term debt outstanding

2.Taggart(1977). The purpose of the article is to specify and estimate an integrated model of corporate financing patterns, drawing on the theory of optimal capital structure and extending it to the context of the overall financing decision. In particular, Taggart considered the interdependent nature of the financing decisions, taking the size of the external financing deficit as given. He modelled the changes in short-term debt (dSDBT), changes in long-term debt (dLDBT), changes in equity (or, more precisely, gross stock issues and stock retirements, dGSTK and SRET) and changes in liquid assets (dLIQ), undertaken by the firm to finance its predetermined deficit. (The preceding notation indicates $dSDBT_t = SDBT_t - SDBT_{t-1}$, etc. The external financing deficit is defined as expenditures on plant and equipment and working assets minus retained earnings. It is denoted by dA-RE). The model is as follows:

$$(T.1)\ dLDBT_t = a_1(LDBT_t^* - LDBT_{t-1}) + a_2(PCB_t^* - PCB_{t-1} - RE_t) + a_3STOCKT_t + a_4RT_t$$

$$(T.2)\ dGSTK_t = b_1(LDBT_t^* - LDBT_{t-1}) + b_2(PCB_t^* - PCB_{t-1} - RE_t) + b_3STOCKT_t + b_4RT_t$$

$$(T.3)\ SRET_t = n_1(LDBT_t^* - LDBT_{t-1}) + n_2(PCB^* - PCB_{t-1} - RE_t) + n_4RT_t$$

$$(T.4)\quad dLIQ_t = f_1(SALES_t - SALES_{t-1}) + f_2(RATE_t - RATE_{t-1}) + c_2(TC_t^* - TC_{t-1}) + c_3(dA_t - RE_t) + c_4 RT_t$$

$$(T.5)\quad dSDBT_t = f_1(SALES_t - SALES_{t-1}) + f_2(RATE_t - RATE_{t-1}) + d_2(TC_t^* - TC_{t-1}) + d_3(dA_t - RE_t) + d_4 RT_t$$

The targets and timing indicators are considered to be exogenously given and were actually defined by the author as follows (all balance-sheet items were standardized by total assets upon estimation):

PCB_t^* = targeted permanent capital, defined as the net stock of fixed capital (book value of gross capital stock at t minus accumulated depreciation at t) plus net permanent working assets (calculated as the average book value of net working assets over the eight periods ending with t).

TC_t^* = targeted temporary capital, defined as total assets (exogenous) minus the target in permanent capital.

$LDBT_t^*$ = targeted long-term debt, defined as the average debt to equity ratio in market values, times the market value of equity. (To approximate the market value of debt in the mentioned ratio, it is assumed that the amount of long-term debt recorded in books consists only of consols, whose market value is then a function of observable interest rates).

$STOCKT_t$ = timing variable for stock issues, defined as the average market value of equity over the two periods ending at t divided by the average market value of equity over the last twelve periods ending at t.

RT_t = interest rate timing variable, defined as a weighted average of the two most recent periods' changes in the commercial paper rate, with weights (0.67,0.33). Low values of this index are expected to stimulate issues of long-term debt, whereas higher values should lead to postponements.

$SALES_t$ is supposed to influence the target level of liquid assets. It was defined as an eight-period moving average of nominal sales.

$RATE_t$ also affects the target level of liquid assets. It was chosen as the current interest rate on commercial loans.

APPENDIX B

CONCAVITY OF THE FIRM'S OBJECTIVE FUNCTION.

The objective function of the firm has been assumed in Section II to be additively separable in discrete time periods. Consider, for simplicity, the optimization problem at time t in the two-period case (see problems M.1 or M.2 in Section II):

(M.1) Maximize, with respect to Y_t for given Y_{t-1} and Y^+_{t+1}:

(A.1)
$$O_t(Y_t, Y_{t-1}) + R_{t+1} O_{t+1}(Y^+_{t+1}, Y_t) =$$
$$a^o_t + a_t Y_t + (1/2)\ Y_t' A_t Y_t -$$
$$b_t(Y_t - Y_{t-1}) - (1/2)\ (Y_t - Y_{t-1})' B_t (Y_t - Y_{t-1}) +$$
$$R_{t+1}\{a^o_{t+1} + a_{t+1} Y^+_{t+1} + (1/2)\ Y^+_{t+1}{}' A_{t+1} Y^+_{t+1} -$$
$$b_{t+1}(Y^+_{t+1} - Y_t) - (1/2)\ (Y^+_{t+1} - Y_t)' B_{t+1} (Y^+_{t+1} - Y_t)\}$$

A well defined maximum to this optimization problem will exist and it will be unique if its Hessian (i.e., matrix of second order derivatives with respect to the control variables) is negative semidefinite. [See Samuelson(1947), Mathematical Appendix A, Section III]. The objective of this appendix is to investigate the necessary and sufficient conditions to be satisfied by the parameters of the firm's objective function if it is to have a unique maximum.

From (A.1), the Hessian (H) of this problem is equal to:

(A.2) $$H = A_t - B_t - R_{t+1}B_{t+1}$$

or, in the notation of Chapter II ($B_{t+1}=R_{t+1}B_{t+1}$):

(A.3)

$$H = \begin{bmatrix} a^{kk} & a^{kd} & a^{kn} \\ a^{kd} & a^{dd} & a^{dn} \\ a^{kn} & a^{dn} & a^{nn} \end{bmatrix} - \begin{bmatrix} b^{kk} & b^{kd} & b^{kn} \\ b^{kd} & b^{dd} & b^{dn} \\ b^{kn} & b^{dn} & b^{nn} \end{bmatrix} - \begin{bmatrix} b^{kk} & b^{kd} & b^{kn} \\ b^{kd} & b^{dd} & b^{dn} \\ b^{kn} & b^{dn} & b^{nn} \end{bmatrix}$$

$$= \begin{bmatrix} a^{kk}-b^{kk}-b^{kk} & a^{kd}-b^{kd}-b^{kd} & a^{kn}-b^{kn}-b^{kn} \\ a^{kd}-b^{kd}-b^{kd} & a^{dd}-b^{dd}-b^{dd} & a^{dn}-b^{dn}-b^{dn} \\ a^{kn}-b^{kn}-b^{kn} & a^{dn}-b^{dn}-b^{dn} & a^{nn}-b^{nn}-b^{nn} \end{bmatrix}$$

The IDA models assume (see equation (24) Section III):

(A.3) $$a^{ij} = b^{ij}, \qquad \text{for all } i \text{ and } j.$$

So, the relevant Hessian in the IDA case is simply:

(A.4) $$H^{IDA} = - \begin{bmatrix} b^{kk} & b^{kd} & b^{kn} \\ b^{kd} & b^{dd} & b^{dn} \\ b^{kn} & b^{dn} & b^{nn} \end{bmatrix} \equiv - S$$

Thus, H^{IDA} is negative definite if S is positive definite. There are various ways of expressing the necessary and sufficient conditions for the real symmetric matrix S to be positive definite. The most convenient in the present context states that S is positive definite if and only if all its principal minors are positive. Notice that since the principal submatrices of S can be rearranged in different ways, starting with any diagonal entry s^{ii} as the first submatrix, it is implied as a necessary, although not sufficient condition for S to be positive definite, that every diagonal entry s^{ii} be positive. Thus, it is necessary for the firm's optimization problem to have a well defined maximum in the IDA tradition that:

$$\text{(A.5)} \qquad b^{kk} > 0, \quad b^{dd} > 0, \quad b^{nn} > 0.$$

The remaining necessary and sufficient conditions are obtained from the second and third principal minors, which must be positive:

$$\text{(A.6)} \qquad b^{kk}b^{dd} - (b^{kd})^2 > 0$$

$$\text{(A.7)} \qquad b^{kk}[b^{dd}b^{nn} - (b^{dn})^2] - b^{kd}[b^{kd}b^{nn} - b^{kn}b^{dn}] + b^{kn}[b^{kd}b^{dn} - b^{kn}b^{dd}] > 0.$$

Equations (A.6) and (A.7) can be rewritten as follows:

$$\text{(A.6')} \qquad b^{kk}b^{dd} > (b^{kd})^2$$

$$\text{(A.7')} \qquad b^{nn}[b^{kk}b^{dd} - (b^{kd})^2] + 2b^{kd}b^{kn}b^{dn} > b^{dd}(b^{kn})^2 + b^{kk}(b^{dn})^2$$

From (A.6') it is recognized that b^{kd} can be either positive or negative, as long as its absolute value does not violate the inequality. Similarly, it is noticed that the right hand side of the inequality in (B.16') is a positive number, as well as the first term on the left hand side [from (B.14) and (B.15')]. Thus, it is recognized that the product $b^{kd}b^{kn}b^{dn}$ can be either positive or negative, as long as its absolute value does not violate the inequality.

In sum, for the restricted objective function of the firm in the IDA models to be globally concave, it is necessary that the parameters (b^{ii}) must be all positive, whereas the parameters $(b^{ij},\ i\neq j)$ can be either positive or negative, as long as they satisfy the inequalities (A.6') and (A.7').

PAT type models.

Using the notation of Section II, the Hessian is written in this case:

(A.8)

$$H = \begin{bmatrix} a^{kk}-b^{kk}-b^{kk} & a^{kd}-b^{kd}-b^{kd} & a^{kn}-b^{kn}-b^{kn} \\ a^{kd}-b^{kd}-b^{kd} & a^{dd}-b^{dd}-b^{dd} & a^{dn}-b^{dn}-b^{dn} \\ a^{kn}-b^{kn}-b^{kn} & a^{dn}-b^{dn}-b^{dn} & a^{nn}-b^{nn}-b^{nn} \end{bmatrix}$$

The PAT models assume [see equation (32), Section III]:

(A.9) $a^{ij} = 0,$ for all i and j.

So, the relevant Hessian in the PAT models is simply:

(A.10)
$$H^{PAT} = -\begin{bmatrix} b^{kk}+b^{kk} & b^{kd}+b^{kd} & b^{kn}+b^{kn} \\ b^{kd}+b^{kd} & b^{dd}+b^{dd} & b^{dn}+b^{dn} \\ b^{kn}+b^{kn} & b^{dn}+b^{dn} & b^{nn}+b^{nn} \end{bmatrix} \equiv -R$$

As before, for the real symmetric matrix R to be positive definite, all its principal minors must be positive. In this case, one has:

(A.11) $$b^{kk}+b^{kk} > 0, \quad b^{dd}+b^{dd} > 0, \quad b^{nn}+b^{nn} > 0.$$

and also:

(A.12) $$(b^{kk}+b^{kk})(b^{dd}+b^{dd}) > (b^{kd}+b^{kd})^2$$

(A.13) $$(b^{nn}+b^{nn})[(b^{kk}+b^{kk})(b^{dd}+b^{dd}) - (b^{kd}+b^{kd})^2] + 2(b^{kd}+b^{kd})(b^{kn}+b^{kn})(b^{dn}+b^{dn}) > (b^{dd}+b^{dd})(b^{kn}+b^{kn})^2 + (b^{kk}+b^{kk})(b^{dn}+b^{dn})^2$$

In sum, for the restricted objective function of the firm in the PAT models to be globally concave, it is necessary that the parameters $(b^{ii}+b^{ii})$ must be all positive, whereas the parameters $(b^{ij}+b^{ij}, i \neq j)$ can be either positive or negative, as long as they satisfy the inequalities (A.12) and (A.13).

APPENDIX C

DESCRIPTION OF THE DATA-SET AND SAMPLE SELECTION ISSUES

Nature of the micro-data used in the analysis.

The data-set available for the analysis originated from a series of surveys of economic performance and expectations of private firms in Mexico (Encuesta sobre la Actividad Economica Empresarial), conducted annually by the **Oficina de Asesores del C. Presidente de la Republica** during the Lopez Portillo administration (1976-1982). After 1982, the data-base from prior surveys was entrusted to the **Instituto Nacional de Estadistica, Geografia e Informatica**, which continued the surveys on a quarterly basis after some alterations of the original questionnaire. The panel actually used in the following analysis was obtained upon request from the latter institution. The identity of firms was not revealed for reasons of confidentiality.

Each observation in the panel (i.e., an individual firm at a given year) contains data on as many as 150 different quantitative and categorical variables, although the exact number of variables changed over the years. These observations were generated by direct interviews with the firms' top managers with the objective of measuring their appraisals of economic performance, plans and expectations. The surveys are similar in character to those made in Germany and France by the IFO (Institut fur Wirtschaft Forschung) and the INSEE (Institute

Nationale de la Statistique et des Etudes Economiques), respectively.

Of special interest are variables that correspond to the qualitative appraisals or assessments by top management regarding a variety of issues: price-cost margins, level of demand, output, inventories, plant capacity utilization, investment levels and, particularly, financial conditions such as the level of outstanding debt, liquidity and the degree to which the firm perceived constraints on its credit demand in domestic currency in the financial markets. Because of the very nature of these qualitative appraisals, answers to these questions were captured in categorical form. (For example: "How do you appraise the liquidity of the firm, measured by the ratio of current assets to current liabilities?: High, Normal, Low, Very Low."). The qualitative appraisals requested in every annual survey (done in July, actually) referred to the current year, the immediately preceding year and some years into the future. Thus, a spectrum of appraisals regarding several points in time is available from each survey. Moreover, from a series of surveys it is possible to know how individual firms modified over time their expectations and evaluations of performance.

Finally, each observation contains also quantitative data: the Balance Sheet and Income Statement of the last accounting period, employment and wage-bill, and actual and planned expenditures in fixed assets during the last, current and two subsequent years. Top managers were also asked to report the rates of inflation and the foreign exchange rate (pesos/U.S. dollar) that were being used by the firm for its financial programming during the current year and the two following years.

[Full documentation on the survey methodology is included in: Oficina de Asesores del C. Presidente de la Republica, Encuesta sobre la Actividad Economica Empresarial: Anexo Metodologico, Mexico, 1982].

Sample selection.

The original statistical design of the surveys was carefully tailored to obtain in each year adequate representation of the universe of private firms in the Mexican economy, as explained in the Methodological Appendix published by the Oficina de Asesores in 1982. The "universe" was defined as the set of all firms listed in the Registro Federal de Causantes (corresponding to the IRS in the U.S.) whose taxable income was above one million pesos. Due to accounting reporting differences, firms in several sectors (agriculture, livestock raising, fishing, construction, commerce, banking and services), were not included in the "universe". In the statistical design adopted in each year, firms whose taxable income was above 100 million pesos were sampled with probability one (i.e., censored), whereas firms under that amount were sampled with probability proportional to their size, with pre-sampling by cities. The exact number and identity of firms in each survey varied from year to year, the typical sample size being around 2,000 firms.

As the data requested from the Instituto Nacional de Estadistica required observations on the same cross-section of firms over a number of consecutive years (i.e., a panel), the number of firms in the data-base fulfilling the antecedent condition was considerably smaller (in the order of 400). Upon careful inspection of the continuity of the required accounting data, it was later decided to limit the analysis to the surveys carried on in 1980, 1981 and 1982, which provide financial information from accounting statements corresponding to 1979, 1980 and 1981, respectively. The firms with data available on all the required variables (after the elimination of observations with unexplainable inconsistencies in the accounting statements) constitute the sample for the following analysis, 141 firms in all. The composition of this sample by firm size, industry and ownership type is presented in Table III.1.

The sample of 141 firms was sub-divided for the present analysis into four size-groups, based on the book value of Total Assets in the 1979 Balance Sheet. These groups will be referred to by S (smaller firms, 0-100 million), M (medium-sized firms, 100-250 million), L (large firms, 250-400 million) and G (giant firms, over 400 million). For the reasons explained in the preceding paragraphs, this sample includes a disproportionate high number of the larger firms in the "universe" of Mexican private firms. Thus, the labels "small" and "medium" should not be misleading: even those firms are relatively large by Mexican standards.

Definition of variables for the analysis.

K_t, D_t and N_t (for t=1979, 1980, 1981) were obtained from the book values of "Net Fixed Assets", "Total Long-term Debt" and "Shareholders Equity" from the firms' Balance Sheets reported in the surveys of 1980, 1981 and 1982, respectively. All these variables were divided by the book value of "Total Assets" in 1979 to standardize the observations and reduce heteroscedasticity problems.

Three dichotomous indicators (KT_{80}, DT_{80} and NT_{80}) were defined, corresponding to the "timing variables" (Z^k_{80}, Z^d_{80} and Z^n_{80}, respectively), as follows. In each survey, the firms' top managers were asked to give their qualitative opinion regarding their investment in fixed assets for several years. In July-1980 they were asked to answer:

$$AIL80 = \begin{cases} 6, & \text{if investment in 1980 is "very high",} \\ 5, & \text{if "high",} \\ 4, & \text{if "intermediate",} \\ 3, & \text{if "low",} \\ 2, & \text{if "very low",} \\ 1, & \text{if "zero investment".} \end{cases}$$

An analogous indicator, EIL81, captured also the July-1980 appraisals regarding planned investment for 1981. Thus, KT_{80} was defined as follows: (See Figure III.1)

$$KT_{80} = 1, \text{ if } EIL81 < AIL80,$$
$$0, \text{ otherwise.}$$

One would expect $KT_{80} = 1$ whenever the reporting firm is undertaking larger investments in 1980 than in 1981, a behavior closely related to the "timing" notion looked for.

Since retained earnings constitute a very important source of equity financing among Mexican firms, the July-1980 categorical appraisals regarding profit margins on sales for 1980 and 1981 (namely, RPY801 and EPY81) were the basis to construct NT_{80}, as follows: $NT_{80} = 1$ if $EPY81 \leq RPY801$.

Appraisals regarding debt levels were requested just for the current year in each survey. Thus, DT_{80} was defined as follows: $DT_{80}=1$ if total debt (in 1980) is "zero", "low" or "normal"; or, $DT_{80}=0$ if total debt (in 1980) is "high" or "very high". Another useful dichotomous indicator was also defined: $CC_{80}=1$ if the firm "had an unsatisfied demand for domestic credit in 1980", or $CC_{80}=0$ if it did not.

Finally, the instrumental variables were defined as follows: anticipated fixed assets expenditures for 1981 (reported in July-1980), divided by Total Assets in 1979; ratio of profits (also of taxes and interest payments) to sales from the 1979 Income Statements; share of short-term debt in total debt in the 1979 Balance Sheet; proportion of circulating assets minus short-term debt to total assets from the 1979 Balance Sheet; and, lastly, growth of sales from the 1979 and 1980 Income Statements.

Footnotes

/1/ The derivation of the model is presented in greater detail in Chapter II of the author's doctoral dissertation.

/2/ The issue of the proper objective function of the firm has been settled among financial economists in favor of market value maximization. Although I do not address the issue explicitly, I implicitly assume that a "market value function" of the firm can be defined over the outstanding levels of its various assets and liabilities. Obviously, this "market value function" implicitly nests a "production function", a "cash-flow function" and an "expectation-cum-discounting time agregation function" which depend in different ways on the firm's assets and liabilities. Of course, if "production" depends not only on the level of the stock of fixed assets, for example, but also on its rate of growth as assumed by the adjustment-costs literature in economics, then the "market value function" would also have the growth of fixed assets among its arguments. I do not characterize the "market value function" beyond assuming that it exhibits a well defined maximun and is twice-continuously differentiable in all its arguments.

/3/ The theoretical determination of the terminal conditions for a decision horizon is very much open to debate. In infinite horizon models, the assumption of a transversality condition is usually made. In finite horizon models, no clear-cut argument can be unambiguously postulated. Therefore, no attempt is made here to resolve this issue and the existence of an exogenously determined vector of terminal conditions will be merely assumed.

/4/ This point is carefully discussed in the author's doctoral dissertation, pages 128 to 130.

/5/ In words, these TCE restrictions imply that the ratio of the coefficient of D_{79} in the K-equation to the coefficient of K_{79} in the D-equation, must be equal to the ratio of the coefficient of D^{+}_{81} in the K-equation to the coefficient of K^{+}_{81} in the D-equation, etc.

/6/ Indeed, disregarding the restrictions associated with the "timing variables" (because when dichotomous indicators are used instead of the correct variables those restrictions are meaningless as explained in Villarreal (1986), pages 215-218), one may distinguish:

(TCE,1) $\frac{p11}{p21} = \frac{p14}{p23}$, $\frac{p12}{p31} = \frac{p15}{p33}$, $\frac{p22}{p32} = \frac{p25}{p34}$;

(TCE,2) $\frac{p11}{921} = \frac{p17}{p26}$, $\frac{p12}{p31} = \frac{p18}{p36}$, $\frac{p22}{p32} = \frac{p28}{p37}$.

and similarly:

(IDA,1) p13 = 1, p24 = 1, p35 = 1

(IDA,2) p11 = -p14, p12 = -p15, p21 = -p23,

p22 = -p25, p31 = -p33, p32 = -p34.

and

(PAT,1) p11 = -(p14+p17), p12 = -(p15+p18), p21 = -(p23+p26)

p22 = -(p25+p28), p31 = -(p33+p36), p32 = -(p34+p38)

(PAT,2) p13+p16 = 1, p24+p28 =1, p35+p38 = 1, such that, as it can be easily verified, IDA,2 imply TCE,1; PAT,1 together with TCE,1 imply TCE,2; and, lastly, PAT,1 together with TCE,2 imply TCE,1.

/7/ See footnote /6/.

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