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Investment and Financial Asset Accumulation

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This paper uses firm-level panel data to investigate the proposition that reliquification is an important phase of the business cycle. It occurs late during recessions and is characterized by prolonged reductions in real investment, caused by firms needing to accumulate assets in order to improve their financial health. The paper concludes that a buildup of assets precedes an increase in investment. This effect is more important for firms without access to organized bond markets and during recession years. *Journal of Economic Literature* Classification Numbers: E27, E44.

I. INTRODUCTION

If a firm is considering building a new plant, will its access to external funds have an impact on when it decides to invest? This notion that the financial situation of the firm affects its real investment spending has become prominent in the empirical and theoretical investment literatures. The interaction between investment and finance is important for understanding the capital accumulation process, both on the level of the individual firm and in the aggregate. Also, if financing does indeed affect the investment of an important fraction of the firms in the economy, shocks to capital markets may help to induce cyclical fluctuations in national output. An understanding of this interaction may influence the design of policies to smooth business cycles.

Most of the recent empirical work in this area supports the contention that firms' ability to obtain external funding influences their investment

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activity. However, these studies have focused on only one aspect of the question. For the most part, they adopt the static approach of identifying firms that may be unable to obtain external finance, and then comparing their investment behavior. One set of papers examines the sensitivity of investment to cash flow, finding evidence that financially constrained firms are more sensitive to current cash flows than unconstrained firms. Another set examines the behavior of firms' investment Euler equations and concludes that this relationship holds in the absence of financial constraints but not in their presence.[1] Both research strategies ignore the time-series interaction between a firm's investment expenditures and its balance sheet position or debt capacity. An alternative perspective focuses on whether the firm has an incentive to build its debt capacity before undertaking an investment project, and whether such financial retrenching induces delays in investment expenditure. This paper provides empirical evidence supporting this hypothesis.

Such firm behavior has been described as "reliquification" by Eckstein and Sinai (1986). They view the process as a phase of the business cycle that occurs during recessions and early during recoveries, providing evidence that financial factors play a role in business cycles. The importance of reliquification stems from its impact on the persistence of cyclical fluctuations; that is, it prolongs the reductions in real investment expenditures that occur during downturns. Bernanke (1983) implies that this sort of behavior may have been key in prolonging the Great Depression, inasmuch as the weakened financial positions of many businesses curtailed their spending. Finally, this idea has numerous antecedents. Perhaps most notable is Gurley and Shaw (1955), who stress the idea that economic growth relies on the availability of finance.

Recent theoretical work also finds that the links between finance and investment may be important.[2] The underlying theme of these more recent papers is that informational asymmetries may result in financial market inefficiencies that spill into the real economy. More specifically, the usual result in models of one-period contracting is that a paucity of financial assets will increase the agency costs of external finance and therefore increase the opportunity cost of investment. Gertler (1988b) constructs a multiperiod financial contracting model in which firms substitute investment today for investment tomorrow in order to accumulate financial assets. This behavior stems from a need for individual entrepreneurs to insure themselves against fluctuations in their wealth, which in turn arises

[1] See Fazzari and Athey (1987), Fazzari *et al.* (1988a,b), and Hoshi *et al.* (1990, 1991) for work on the sensitivity hypothesis. Whited (1992) and Hubbard and Kashyap (1992) focus on the Euler-equation approach.

[2] See Gertler (1988a) for a survey.

from the role that this wealth plays in reducing the agency costs of external finance.

One important assumption of Gertler's is that the investment projects available to the entrepreneur are irreversible, inasmuch as capital depreciates completely in each year. Irreversibility plays a key role in the main result, since if the firm could costlessly turn physical capital back into financial assets, the role of collateral would disappear. In more general terms, the implicit irreversibility of the investment project creates an option value of waiting to invest.[3] As the firm waits, it accumulates liquid assets, which not only preserves its option to invest at a later date, but also reduces the funding costs of any future projects. Since a firm accumulates assets over time, waiting today will decrease the option value of waiting in the future by making external finance less costly, thereby increasing the profitability of any given investment project. The greater the agency costs of external finance, the more pronounced this behavior will be. This means that a firm with a large asset base will face a lower opportunity cost of reversing its investment decision in the future and will be more likely to commit to a project. The assumption of irreversibility is thus crucial for understanding the ways that financial market frictions can affect real activity.

This intuition can be seen from a complementary point of view. A weaker form of irreversibility occurs when the firm must incur lumpy, nondifferentiable, irrecoverable adjustment costs. The effect of such a cost structure on the interaction between finance and investment can be seen as follows. First, absent any restrictions on external finance, a firm would be able to use capital markets to fund the fixed cost. In contrast, if a firm is without access to capital markets, it will be forced to retain earnings before paying the lump-sum start-up cost required to embark on a project. On the other hand, if the firm can only obtain external funding at a premium, and if the cost of funds depends on its financial health, then, as in the case of a completely irreversible project, it will desire to accumulate funds before investing.

To see how this behavior depends on the structure of adjustment costs, consider the case of a liquidity-constrained firm that faces differentiable, convex adjustment costs, such as the quadratic costs featured in the q-theory literature. Convexity of the installation cost function implies that the firm will want to smooth its investment stream in order to minimize these costs. Therefore, a firm with limited access to financial markets will want to funnel any extra cash flow directly into investment expenditure. Waiting to invest and accumulating financial assets will entail more than proportionally higher costs of adjustment in the future. Therefore, if the

[3] This result is standard. See the survey of irreversible investment theory in Pindyck (1991) and the references therein.

effect of financial asset hoarding in reducing the cost of external funds does not dominate the effect of convex costs, little accumulation of financial assets will be observed prior to an investment outlay.

To reconcile these contrasting implications of liquidity constraints, note that different investment projects within a given firm will entail varying degrees of lumpy adjustment costs and irreversibility. Therefore, reported capital expenditure may *both* exhibit sensitivity to cash flow and be preceded by an accumulation of financial assets. To the extent that a firm's investment projects are lumpy, the latter effect should dominate.

The implication of this theory is that lagged indicators of a firm's financial health should predict investment. The indicator used here is the firm's current financial assets less its current financial liabilities—hereafter referred to as working capital. The correlation between lagged working capital and investment should be positive. As explained above, an increase in investment should follow a rise in working capital, while a drop in working capital should precede a drop in investment, since the firm would want to cut its real expenditures in order to reestablish its financial position.

To test these hypotheses, I use a panel of manufacturing firms from the COMPUSTAT industrial file. As a preliminary step, I separate the firms into groups according to their access to capital markets. The criterion used is whether or not the firm has a Moody's bond rating. Presumably, if a firm has undergone the process of having had its bonds rated, it can be considered a known entity, not as likely to be subject to severe informational asymmetries and the ensuing higher costs of external finance.

The investigation consists of two parts. First, I run a series of regressions of investment on lagged q, output, and working capital. I allow the coefficients on these variables to vary over time, estimating parameters for the years 1981 through 1987. This strategy allows me to determine in which years financial factors are most important. The results show that a strengthening of the financial position of the firm tends to precede an increase in investment and that, conversely, a drop in financial health precipitates a drop in investment. These effects are most pronounced for firms without bond ratings, especially during the first part of the recovery from the recession of the early 1980s.

Second, I attempt to couch these results in the context of the existing literature on financial constraints. In particular, I nest in a single regression the hypotheses of reliquification and excess sensitivity of investment to cash flow. I find both effects to be important, especially for firms without bond ratings. However, even accounting for the impact of current cash flow on investment, the reliquification effect appears to remain strong during the recovery from the 1981–1982 recession.

The paper is organized as follows. Section II describes the hypotheses to be tested and the econometric framework, while Section III describes the data and the sample selection procedure. Section IV presents the results. Concluding remarks are in Section V.

II. ECONOMETRIC FRAMEWORK

My tests center around a series of regressions of investment on q, output, and working capital. Working capital is interpreted as a measure of the firm's liquid asset position. As the literature on asymmetric information and borrowing constraints would predict, an accumulation of working capital ought to improve the terms of a borrowing contract. Therefore the reliquification theory suggests that such hoarding ought to precede an investment outlay. Formally, I test this prediction by examining the joint significance of lags of working capital, as well as by inspecting the signs of these coefficients, which ought to be positive.

Including q and output in the regressions serves to isolate the predictive power of the financial variables by controlling for the investment opportunities of the firm. Although the motivation for including working capital in the regression depends in part on the existence of some sort of irreversibility in the investment process, and although q-theory relies on smooth differentiable adjustment costs, models of irreversible investment have also found q to be a determinant of investment. Bertola (1988), for example, presents a model based on irreversibility in which the optimal investment rule depends positively on the expected future marginal product of capital and inversely on the price of capital goods. This rule is conceptually similar to one that specifies investment as a function of q.[4] I include output to capture the accelerator mechanism, which a number of authors have found to be empirically important. Arguments based on the presence of monopolistic competition in the product market also can justify the inclusion of output in the investment equation.[5] Finally, I use lagged values of these two variables to capture the idea of delivery and installation lags in the investment process.

A. *Estimation*

Since the data consist of a panel of individual firms, I use a modification of the methodology described by Holtz-Eakin *et al.* (1988), which adapts standard vector-autoregression techniques to panel data. In particular, it accounts for the typically short time frame of most panels and allows for individual heterogeneity, both in terms of heteroskedasticity and individual fixed effects. The equation estimated takes the following form:

[4] Also see Sargent (1980).

[5] See Blundell *et al.* (1988) and Fazzari *et al.* (1988a,b) for empirical evidence supporting the importance of the accelerator effect. See Schiantarelli and Georgoutous (1987) for theoretical motivation.

$$(I/K)_{it} = \alpha_{0t} + \sum_{l=1}^{m} \delta_{lt} X_{i,t-l} + f_i + u_{it} \qquad (i = 1, \ldots, N;\ t = m+1, \ldots, T). \tag{1}$$

Here, i indexes individual firms, t indexes time, and l indexes lags, where m is the maximum lag length, which is taken to be long enough to ensure that the error term, u_{it}, is white noise. $(I/K)_{it}$ is gross investment, and X_{it} is a vector containing q, output divided by the capital stock, $(Y/K)_{it}$, and working capital divided by the capital stock, $(WC/K)_{it}$. The variable f_i is an unobserved individual effect, and the coefficient α_{0t} can be interpreted as a time dummy. The coefficients $\alpha_{0t}, \delta_{1t}, \ldots, \delta_{mt}$ are allowed to vary over time. The identification of these time-varying parameters is possible because of the ample number of cross-sectional units.

Clearly, the investment, production, and financial decisions of the firm are determined simultaneously. It is therefore appropriate to use instrumental variables in estimating (1). To identify this equation, I use a set of orthogonality conditions that assume that the random component of investment in period t, u_{it}, is uncorrelated with the history of the firm. Such an assumption is justified if u_{it} is an expectational error. In addition, in contrast with the time-series case, the condition for identification must be modified to account for the unobserved individual effect. It is well known that the common practice of eliminating f_i by replacing the variables in the regression with deviations from individual means will produce inconsistent parameter estimates under instrumental variable estimation. Instead, the fixed effect can be eliminated by differencing Eq. (1). This procedure yields

$$\Delta(I/K)_{it} = a_{0t} + \sum_{l=1}^{m+1} d_{lt} X_{i,t-l} + v_{it} \qquad (i = 1, \ldots, N;\ t = m+2, \ldots, T). \tag{2}$$

Here,

$$\begin{aligned} v_{it} &= u_{it} - u_{i,t-1} \\ a_{0t} &= \alpha_{0t} - \alpha_{0,t-1} \\ d_{1t} &= \delta_{1t} \\ d_{lt} &= \delta_{lt} - \delta_{l-1,t-1} \\ &\ \ \vdots \\ d_{m+1,t} &= -\delta_{m,t-1}. \end{aligned} \tag{3}$$

The MA(1) error term of the transformed Eq. (2) will satisfy the following:

$$E[(I/K)_{is}\, v_{it}] = E[X_{is}\, v_{it}] = 0, \qquad s < t - 1. \tag{4}$$

These conditions imply that values of $(I/K)_{it}$ and X_{it} lagged at least two periods are available as instrumental variables to estimate the transformed Eq. (2) for each time period. I also include similarly dated values of cash flow scaled by the capital stock, $(CF/K)_{it}$, in the instrument list. The vector of instrumental variables will change for each time period. The order condition for identification of the parameters of the transformed equation requires at least as many instruments as right-hand side variables—$(4(m + 1) + 1)$. Therefore, since I choose a maximum lag length of 3, I use as instruments each right-hand side variable dated $t - 2$ through $t - 6$, in addition to the time dummies. To identify the underlying parameters of (1), it is necessary to estimate (2) subject to the linear restrictions in (3).

To estimate Eq. (2), I use generalized instrumental variables. More specifically, the procedure consists of first stacking the equations (2) for each time period, then premultiplying the resulting system by the matrix of stacked instrumental variables, and finally applying feasible GLS to the entire transformed system. This type of estimator requires a consistent estimate of the covariance matrix, which can be obtained by a two-step procedure. First, estimate the coefficients of the equation separately for each time period with two-stage least squares, using the correct vectors of instrumental variables for each time period. These preliminary estimates can be used to form a vector of residuals, which can then be used to calculate the covariance matrix. The only restriction on this matrix is the assumption that the error terms for different units are uncorrelated—an assumption made plausible by the inclusion of the time dummies. The procedure allows for arbitrary serial correlation in the residuals.[6]

B. *Testing*

Equation (2) is quite general; and in order to glean information concerning the intertemporal reaction of investment to financial capacity, it is

[6] The estimator of the covariance matrix, Ω/N, is given by

$$(\hat{\Omega}/N)_{rs} = \sum_{i=1}^{N} (\hat{v}_{ir}(\hat{v}_{is} Z'_{ir} Z_{is})/N,$$

for all times r, s, where the $\hat{v}_{it}$ are the above described consistent estimates of the residuals and the Z_{it} are the vectors of instrumental variables. This procedure is valid when $E(\hat{v}_{ir}\hat{v}_{js}) = 0$ for all i, j, r, s such that $i \neq j$; that is, when the error term is assumed to be independent over cross-sectional units.

necessary to impose more structure on the model in the form of linear restrictions. I therefore imbed the test of the joint significance of the coefficients on lagged working capital within a sequence of tests. First, I test to see whether the parameters in (2) are constant over time. Second, I test for the appropriate maximum lag length for each of the regressors, conditional upon the result of the test for parameter stationarity. Finally, I test exclusion restrictions on working capital, conditional upon the outcome of the test for lag length. This procedure permits the isolation of the reason for the rejection of any of the above hypotheses through the construction of a sequence of test statistics that are asymptotically independent. In addition, the test for parameter stationarity can reveal whether the relationship between investment and financial health is stable over time. Similarly, the test for lag length is useful in determining the time that a typical firm might spend building up its financial asset base before embarking on capital expansion. It also permits a parsimonious specification of (2), which helps to reduce collinearity between the explanatory variables.

The validity of this sequence of tests relies on the orthogonality conditions used to identify the model, which in turn presumes that the error term in Eq. (1) is serially uncorrelated or, equivalently, that the MA(1) error in Eq. (2) has no autocorrelation of order greater than one. I test for second-degree autocorrelation in (2) using the heteroskedasticity-consistent estimator proposed by Arellano and Bond (1988), which uses the residuals from the differenced reduced-form equation (2).[7] This test also helps to isolate the reason for any possible rejections of the overidentifying restrictions of the model.

Testing for parameter stationarity, lag length, and exclusion restrictions all require estimating Eq. (2) subject to the relevant linear restrictions and then comparing the resulting sum of squared errors with that from the unconstrained model. More specifically, let J represent the sum of squared errors from the unconstrained model. It will have a χ^2 distribution with degrees of freedom equal to the number of instrumental variables minus the number of parameters. The sum of squared errors from the restricted model, J_R, will also be distributed as a χ^2. The appropriate

[7] The estimator takes the form

$$\hat{r}_s = \sum_{i=1}^{N} \hat{v}'_{i(-s)}\hat{v}_i\hat{v}'_i\hat{v}_{i(-s)} - 2\hat{v}'_{(-s)}W(W'Z\hat{\Omega}^{-1}Z'W)^{-1}W'Z\hat{\Omega}^{-1}\left(\sum_{i=1}^{N} Z'_i\hat{v}_i\hat{v}'_i\hat{v}_{i(-s)}\right)$$
$$+ \hat{v}'_{(-s)}W(W'Z\hat{\Omega}^{-1}Z'W)^{-1}W'\hat{v}_{(-s)},$$

where W is the matrix of explanatory variables in the regression. Under the null hypothesis of no autocorrelation of order s, $\hat{r}_s$ will be asymptotically distributed $N(0, 1)$.

statistic to test for the validity of the restrictions, L, will then be the difference $J_R - J$. It will have degrees of freedom equal to the number of parameters in the unrestricted model minus the number of parameters in the restricted model.[8]

III. SAMPLE SELECTION AND DATA

The data are from the manufacturing firms (SIC codes 2000–3999) in the combined annual and over-the-counter 1988 COMPUSTAT industrial files. The total number of such firms is 1064. Firms with missing or inconsistent data or involved in a merger that accounted for greater than 15% of book value assets are deleted. The sample thus obtained runs from 1973 to 1987 and contains 317 firms—299 that are listed on either the NYSE or the AMEX and 18 OTC firms.

The primary data requirements for estimation and testing are the firm-specific time series on gross investment, working capital, cash flow, q, and output. To control for potential heteroskedasticity problems, I scale working capital, cash flow, investment, and output by the beginning-of-period capital stock. A detailed description of these variables is in the Appendix.

In order to discern whether access to capital markets affects the time-series interaction between finance and investment, I divide the sample according to whether the firm has a Moody's bond rating at the outset of the sample period. I use the presample existence of a bond rating in order to avoid violating the orthogonality conditions used to identify the model. A one to three letter bond rating gives a potential investor an idea of the risk of her investment, and it shows that the firm has undergone scrutiny regarding its financial health and future growth opportunities. In addition, as demonstrated by Diamond (1991) in a multiperiod contracting model with moral hazard, firms must generally undergo the monitoring of a financial intermediary before being able to place debt directly. The bond rating can thus be seen as a summary statistic of all of this information, and any firm having one will be unlikely to face the same informational asymmetries as an unrated firm.[9] The two samples, hereafter referred to as the bond and bank samples, contain 153 and 164 firms, respectively.

[8] This type of test is analogous to a standard likelihood ratio specification test. See Newey and West (1988).

[9] The question arises if a firm issuing junk bonds can be grouped together with a firm issuing investment-grade bonds. To see if my original classification scheme is valid, I alternatively split the sample according to whether the firm was issuing investment-grade bonds in the year before the first year of the sample period. The qualitative content of the empirical results does not change significantly.

TABLE I
SUMMARY STATISTICS: SAMPLE OF MANUFACTURING FIRMS, 1974–1987[a]

	Group of observations		
	Bond sample	Bank sample	Full sample
Number of firms	153	164	317
Capital stock			
Mean	2157.05	334.95	1214.39
Median	562.22	40.20	109.61
Market value of total assets			
Mean	3503.65	463.44	1930.80
Median	1150.61	96.15	291.53
Investment			
Mean	0.195	0.183	0.189
Median	0.176	0.166	0.171
Working capital			
Mean	0.811	1.202	1.014
Median	0.598	0.942	0.778
Cash flow			
Mean	0.309	0.338	0.324
Median	0.270	0.295	0.283
Output			
Mean	3.525	4.183	3.866
Median	3.158	3.525	3.521
Tobin's q			
Mean	1.953	2.279	2.122
Median	1.294	1.467	1.376

[a] Calculations are based on a sample of firms from the COMPUSTAT data base. Capital stock and market value figures are in millions of 1982 dollars. The figures for investment, working capital, cash flow, and output are represented as fractions of the capital stock.

In 1974 the full sample accounted for 12% of total investment in the economy, the bond sample for 10%, and the bank sample for 2%. These percentages diminish as the sample period progresses until 1987 when the full sample accounts for 9%. The bank sample's share falls to 1%, while the bond sample's share diminishes to 8%. It is also noteworthy that only about 20% of the publicly owned firms in the economy have bond ratings. Since this sample is split almost evenly between the two types of firms, it includes a large number of the firms participating in the corporate bond market. This characteristic, together with the small fraction of total investment represented, suggests that the sample captures primarily the largest firms in the economy. Therefore, if any behavior resembling reliquification appears to be important in the sample, it may be even more prominent in the rest of the economy.

Table I provides summary statistics for the firms in the two samples.

The median firm in the bank sample has both a capital stock and a market value of total assets less than a tenth of those of the median firm in the bond sample. The bank sample has a higher mean ratio of output to capital stock, but lower mean values of q, the ratio of investment to capital stock, and the ratio of cash flow to capital stock. None of these differences is statistically significant. However, the ratio of working capital to capital stock is significantly higher in the bank sample, the mean being 0.811 for the bond sample and 1.202 for the bank sample. This difference may stem from these smaller firms being less diversified in their financial asset holdings. Such a tendency would leave a greater portion of their financial assets as short-term holdings, which are counted as working capital. These numbers also may reflect the greater tendency of these smaller firms to hoard precautionary liquidity in order to be able to invest.

IV. RESULTS

The empirical investigation consists first of testing for the significance of working capital in the above described regressions and of comparing the results across the two subsamples. I then consider several interpretations of these results. Finally, I compare the results with those from the existing literature on the role of cash flow in explaining the investment of liquidity-constrained firms.

Before examining the results in detail, two preliminary findings are noteworthy. First, the hypothesis of parameter stationarity is strongly rejected for each of the samples and for all of the specifications considered below. Since parameter stationarity is rejected in every case, I perform the test for maximum lag length under the assumption that the coefficients of the explanatory variables may vary over time. The results of these tests indicate that the most parsimonious specification of (2) includes two lags of q, one lag of output, and two lags of working capital. This lag structure is also valid when current liquidity variables enter the model.

Tables II–IV report the results of the regressions of investment on q, output, and working capital for the full sample and for each of the subsamples. Here, since the coefficients of the explanatory variables vary over time, they are reported by year. The J statistic reported is for the overidentifying restrictions of the model, and the L statistic is for the test of the exclusion restrictions on the financial variables. The degrees of freedom of each of these statistics is denoted by a subscript. The R^2 reported is from the second-stage regression. I also present the test statistics for first through third degree serial correlation. Since each of them is distributed asymptotically as an $N(0,1)$, I do not report significance levels and

TABLE II
INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: FULL SAMPLE[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0719	0.0419	0.0168	0.0878	0.1024	0.0185	0.0211
	(0.0069)	(0.0072)	(0.0030)	(0.0495)	(0.0506)	(0.0071)	(0.0062)
Q_{t-2}	0.1266	0.0124	0.1190	0.0254	0.0789	0.0114	0.0209
	(0.0528)	(0.0076)	(0.0371)	(0.0098)	(0.0352)	(0.0062)	(0.0063)
$(Y/K)_{t-1}$	0.0782	0.0205	0.0162	0.0799	−0.0853	0.0947	0.0789
	(0.0284)	(0.0052)	(0.0285)	(0.0354)	(0.0618)	(0.0622)	(0.0428)
$(WC/K)_{t-1}$	0.0951	−0.3799	−0.0211	0.2227	0.0713	−0.3135	0.0562
	(0.0055)	(0.2980)	(0.0189)	(0.1787)	(0.0178)	(0.2417)	(0.0151)
$(WC/K)_{t-2}$	0.2005	0.3314	0.2628	−0.0833	0.0722	0.2889	0.0818
	(0.0873)	(0.2367)	(0.0917)	(0.0772)	(0.0131)	(0.1987)	(0.0318)
J_{133}				153.293			
(Test of overidentifying restrictions)				(0.110)			
L_{14}				31.195			
(Test of exclusion restrictions on WC)				(0.0052)			
R^2				0.515			
$\hat{r}_1$				−2.104			
$\hat{r}_2$				−0.740			
$\hat{r}_3$				0.767			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 317 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987.

only note here that the hypothesis of no serial correlation will be rejected at the 10% level if the absolute value of the test statistic is greater that 1.658.

It is important to note that the hypothesis of serial correlation greater than order one in the MA(1) residuals of (2) is strongly rejected for each sample and for each specification of the model. In addition, for none of the models can the overidentifying restrictions be rejected. These findings add credence to the following results, since they indicate that they are not likely due to model misspecification.

Three important patterns concerning the role of asset accumulation emerge from examining the results of these regressions. First, the test of the exclusion restrictions on working capital are strongly rejected for the full sample and for the bank sample, whereas they cannot be rejected for the bond sample. Second, the coefficients on working capital are for the most part positive and significant for both the full and the bank samples. Here, the results are stronger for the bank sample; not only are more of the coefficients significant, but they are all positive and are larger than

TABLE III
INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: BANK SAMPLE[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0260	0.0733	0.0117	0.1006	0.0759	0.0329	0.0313
	(0.0078)	(0.0053)	(0.0032)	(0.0408)	(0.0047)	(0.0025)	(0.0033)
Q_{t-2}	0.0097	0.0788	0.0599	0.0469	0.0033	0.0081	0.0139
	(0.0045)	(0.0046)	(0.0038)	(0.0017)	(0.0035)	(0.0018)	(0.0027)
$(Y/K)_{t-1}$	0.0145	0.0238	0.0316	0.0478	0.0006	0.0236	0.0159
	(0.0124)	(0.0031)	(0.0030)	(0.0041)	(0.0041)	(0.0044)	(0.0026)
$(WC/K)_{t-1}$	0.0466	0.0881	0.3379	0.2220	0.0501	0.1411	0.0993
	(0.0085)	(0.0215)	(0.0209)	(0.0509)	(0.0221)	(0.2601)	(0.0578)
$(WC/K)_{t-2}$	0.2252	0.1571	0.3345	0.1886	0.1833	0.0529	0.0891
	(0.0410)	(0.0212)	(0.1208)	(0.0231)	(0.0179)	(0.0156)	(0.0447)
J_{133}				149.235			
(Test of overidentifying restrictions)				(0.159)			
L_{14}				51.229			
(Test of exclusion restrictions on WC)				(3.795×10^{-6})			
R^2				0.5407			
$\hat{r}_1$				−3.093			
$\hat{r}_2$				0.303			
$\hat{r}_3$				−0.802			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 164 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987. This subsample consists of firms that do not have bond ratings from Moody's before the sample period begins.

those for the full sample. In contrast, the coefficients on working capital for the bond sample are of varying sign, and only two are positive and significant at the 5% level, while one is negative and significant. Third, the pattern of coefficients on lagged working capital is much more stable from year to year for the bank sample than for either the full sample or the bond sample. This result suggests that the model including working capital may be a specification most appropriate for the firms without bond ratings. In addition, most of the coefficients on q and output appear to be significant, positive, and fairly stable for all three samples. This pattern conforms to the results found by most investment studies.

One result stands out in these three tables: the coefficients on working capital for the bank sample in Table III are significantly larger in the years 1983 and 1984—the first years of the economic recovery. This pattern corroborates Eckstein and Sinai's (1986) idea that reliquification should occur at the end of a recession when firms are in poor financial health. However, one possible explanation for this result is that firms may retain

TABLE IV
INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: BOND SAMPLE[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0222	0.1630	0.1033	0.0509	0.0278	0.0130	0.0349
	(0.0047)	(0.0439)	(0.0046)	(0.0033)	(0.0049)	(0.0066)	(0.0038)
Q_{t-2}	0.0346	0.0954	0.0159	0.0147	0.0516	0.0187	0.0035
	(0.0041)	(0.0409)	(0.0092)	(0.0183)	(0.0064)	(0.0063)	(0.0023)
$(Y/K)_{t-1}$	0.0167	0.0591	0.0068	0.0842	0.0134	0.0351	0.0482
	(0.0019)	(0.0035)	(0.0030)	(0.0043)	(0.0087)	(0.0040)	(0.0029)
$(WC/K)_{t-1}$	0.0245	−0.0440	0.0293	0.0488	0.0310	−0.0632	0.0470
	(0.0129)	(0.0381)	(0.0231)	(0.0310)	(0.0256)	(0.0382)	(0.0617)
$(WC/K)_{t-2}$	−0.0678	−0.0480	−0.0877	−0.0641	−0.2566	0.0562	−0.0785
	(0.0419)	(0.0395)	(0.0672)	(0.0412)	(0.2285)	(0.0213)	(0.0713)
J_{133}				153.240			
(Test of overidentifying restrictions)				(0.111)			
L_{14}				20.441			
(Test of exclusion restrictions on WC)				(0.117)			
R^2				0.521			
$\hat{r}_1$				1.837			
$\hat{r}_2$				0.179			
$\hat{r}_3$				0.554			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 153 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987. This subsample consists of firms that have bond ratings from Moody's before the sample period begins.

working capital as an option to invest as they wait for information about their projects. During a recovery, they learn that projects have high value and invest—behavior that would also produce positive coefficients on lagged working capital during these years. Nonetheless, such a clear pattern of coefficients does not appear for either the full sample or the bond sample. This difference suggests that financial considerations are indeed driving the result for the bank sample.

This contrast between the two subsamples is the strongest evidence in favor of the role of financial market imperfections in affecting the timing of investment, since the hypothesis of frictionless financial markets would imply no differences between the two sets of results. For example, another interpretation of the theory also implies that *all* firms have an incentive to reliquify. Thus, if a positive shock hits the firm's profits, it may accumulate financial assets before expanding its capital stock simply because of large fixed adjustment costs or ordering lags. This motive for reliquification need not vary across firms of different financial health. Once again, the marked difference in the results for the two subsamples points to a direct role for costly external finance in prolonging investment delays.

Nonetheless, it may be simply the difference in firm size between the two groups of firms that accounts for the difference in the results. If investment projects are indeed lumpy and all of a given size, then this lumpiness may be more important for small firms, which would then have more of an incentive to reliquify, absent imperfections in financial markets. However, as pointed out in the older putty-clay literature on investment, firms have a great deal of ex ante flexibility in choosing an investment project. Therefore, even though small firms may not be able completely to overcome fixed start-up costs, they have some freedom to mitigate these costs by choosing smaller scale investment projects. Since investment projects are not necessarily of a given size, the difference in firm size alone cannot explain these results.

In order to verify that the classification scheme does not simply pick up a size effect, I use an alternative split of the sample, where the dividing line is the median level of the capital stock reported in Table I. As shown in Tables V and VI, the exclusion restrictions on working capital are rejected for both the large and the small firms, indicating that each group contains some constrained firms. However, the coefficients on working capital are in general larger for the small firms. Other studies have confirmed this result. Gilchrist (1990) finds that size differences alone do not account for the sensitivity of investment to cash flow in reduced-form regressions. He and Whited (1992) also note that the success or failure of Euler-equation tests for capital market imperfections does not depend on firm size.

Yet another interpretation of the results can be found in Fazzari and Petersen (1990), who take working capital as an input into the production function. They view firms as using working capital to smooth investment in the face of financial constraints. Such behavior is analogous to the use of inventories to smooth production. As an extreme example, consider a firm without access to financial markets. Since a standard uses of funds identity implies that the firm's two main uses of its cash flow are investment in fixed and working capital, an increase in working capital must be accompanied by a decrease in investment, if the elasticity of substitution between the two inputs is not zero. In this setting, the change in current working capital will appear in an investment regression with a negative coefficient. However, in addition, a standard omitted variables argument indicates that if the level of working capital is sufficiently negatively correlated over time, such smoothing behavior also may cause the lagged level of working capital to appear with a positive coefficient, even in the

TABLE V
INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: LARGE FIRMS[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0562	0.0157	0.0647	0.1241	0.0164	0.0285	0.0407
	(0.0114)	(0.0043)	(0.0072)	(0.0247)	(0.0044)	(0.0020)	(0.0169)
Q_{t-2}	0.0076	0.0134	0.0525	0.0478	0.0664	0.0121	0.0137
	(0.0124)	(0.0047)	(0.0061)	(0.0094)	(0.0217)	(0.0034)	(0.0072)
$(Y/K)_{t-1}$	0.0544	0.0110	0.0347	0.0069	0.0570	0.0643	0.0122
	(0.0059)	(0.0038)	(0.0095)	(0.0054)	(0.0061)	(0.0074)	(0.0066)
$(WC/K)_{t-1}$	0.0945	0.0476	−0.0215	0.1124	0.0155	0.0234	0.0694
	(0.0343)	(0.0670)	(0.0754)	(0.0214)	(0.0063)	(0.0048)	(0.0109)
$(WC/K)_{t-2}$	−0.1154	−0.2015	0.0845	0.0134	0.0385	0.0495	0.0288
	(0.0644)	(0.2219)	(0.0421)	(0.0064)	(0.0197)	(0.0111)	(0.0084)
J_{133}				148.952			
(Test of overidentifying restrictions)				(0.163)			
L_{14}				28.194			
(Test of exclusion restrictions on WC)				(0.0134)			
R^2				0.497			
$\hat{r}_1$				−2.843			
$\hat{r}_2$				−0.041			
$\hat{r}_3$				0.279			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 158 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987.

absence of large fixed adjustment costs, irreversibilities, or the asset accumulation that they may bring about.

In order to distinguish the reliquification from the investment smoothing hypothesis, I run a set of regressions that include the current change in working capital, as well as lagged levels of working capital. As seen in Tables VII–IX, I find that the coefficient on the current change in working capital is significant and negative for most years for each of the three samples, thus confirming Fazzari and Petersen's results. However, the coefficients on the lagged levels of working capital remain significant for the full and the bank samples and remain uniformly positive for the bank sample. This invariance indicates a separate role for financial asset accumulation in reducing the cost of external finance.[10]

Tables X–XII present the regressions that include current cash flow.

[10] My definition of working capital excludes inventories, payables, and receivables, while Fazzari and Petersen's does not.

TABLE VI
INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: SMALL FIRMS[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0548	0.0179	0.0244	0.0846	0.0553	0.0205	0.0311
	(0.0043)	(0.0035)	(0.0079)	(0.0212)	(0.0096)	(0.0065)	(0.0041)
Q_{t-2}	0.0327	0.1004	0.0115	0.0364	0.0513	0.0280	0.0154
	(0.0107)	(0.0393)	(0.0079)	(0.0081)	(0.0083)	(0.0098)	(0.0045)
$(Y/K)_{t-1}$	0.0152	0.0190	0.0433	0.0192	0.0462	0.0356	0.0177
	(0.0354)	(0.0057)	(0.0183)	(0.0062)	(0.0041)	(0.0209)	(0.0049)
$(WC/K)_{t-1}$	−0.0920	0.0557	0.2416	0.1884	0.1016	0.0472	0.0214
	(0.1547)	(0.0352)	(0.0442)	(0.0617)	(0.0301)	(0.0102)	(0.0195)
$(WC/K)_{t-2}$	0.1554	0.2087	0.3005	0.0873	−0.2101	0.0743	0.0388
	(0.0840)	(0.0642)	(0.0995)	(0.0374)	(0.1657)	(0.0274)	(0.0067)
J_{133}				150.271			
(Test of overidentifying restrictions)				(0.145)			
L_{14}				44.072			
(Test of exclusion restrictions on WC)				(5.764×10^{-5})			
R^2				0.504			
$\hat{r}_1$				0.227			
$\hat{r}_2$				−0.004			
$\hat{r}_3$				0.058			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 158 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987.

Here, the exclusion restrictions on cash flow are strongly rejected for each of the three samples. Cash flow may be significant in the bond sample because it may be proxying either for an accelerator effect or for information about future profits not captured by average q. Nonetheless, the magnitudes of the coefficients on cash flow are significantly larger for the bank sample than for either the full sample or the bond sample. This finding in essence corroborates the result in Fazzari *et al.* (1988a,b) that current liquidity should matter for the investment of firms that may have difficulty obtaining external finance. In addition, for the bank sample and the full sample the effect of cash flow appears to be strongest in the years 1982 and 1983, which confirms the idea that liquidity constraints should have the greatest impact in bad times. Finally, the flavor of the results on working capital remains the same, except that for all three samples the magnitudes of the coefficients diminish. Once again, the exclusion restrictions are rejected for the bank and full samples, but not for the bond sample; the bank sample has larger coefficients than the other two sam-

TABLE VII

INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON THE CURRENT CHANGE IN WORKING CAPITAL, AND LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: FULL SAMPLE[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0254	0.0374	0.0877	0.0455	0.0118	0.0244	0.0600
	(0.0064)	(0.0061)	(0.0037)	(0.0055)	(0.0039)	(0.0062)	(0.0069)
Q_{t-2}	0.0144	0.0085	0.0127	0.0132	0.0226	0.0068	0.0668
	(0.0041)	(0.0051)	(0.0054)	(0.0028)	(0.0047)	(0.0058)	(0.0101)
$(Y/K)_{t-1}$	0.0274	0.0887	0.0511	0.0171	0.0142	0.0357	0.0671
	(0.0098)	(0.0097)	(0.0092)	(0.0054)	(0.0067)	(0.0141)	(0.0119)
$(WC/K)_{t-1}$	0.1444	0.0852	0.2554	−0.0025	0.0200	0.0435	0.0784
	(0.0455)	(0.0398)	(0.1014)	(0.0579)	(0.0061)	(0.0138)	(0.0154)
$(WC/K)_{t-2}$	0.1998	0.2654	0.2001	−0.2581	−0.0842	0.0451	0.0684
	(0.0641)	(0.0874)	(0.0905)	(0.1365)	(0.0743)	(0.0285)	(0.0450)
$\Delta(WC/K)_t$	−0.1662	−0.1405	−0.2004	0.0295	−0.1121	−0.1746	−0.1502
	(0.0985)	(0.0120)	(0.0568)	(0.0104)	(0.0559)	(0.0510)	(0.0712)
J_{126}				132.874			
(Test of overidentifying restrictions)				(0.320)			
L_{14}				31.006			
(Test of exclusion restrictions on WC)				(0.0055)			
L_7				18.422			
(Test of overidentifying restrictions)				(0.010)			
R_2				0.598			
$\hat{r}_1$				−3.254			
$\hat{r}_2$				0.782			
$\hat{r}_3$				−0.693			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 317 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987.

ples; and the largest coefficients on working capital for the bank sample appear in 1983 and 1984.

Two interpretations of this last set of results are possible. First, both lagged working capital and cash flow may be noisy indicators of a more ideal measure of liquidity. Second, a single firm may have some investment projects with lumpy adjustment costs and others with convex adjustment costs. As noted in the Introduction, therefore, the total investment expenditure of a liquidity constrained firm will be sensitive to both cash flow and lagged working capital.

V. CONCLUSION

Recent theoretical work has suggested that investment and finance should be interdependent over time. In particular, if a firm is in poor

TABLE VIII
INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON THE CURRENT CHANGE IN WORKING CAPITAL, AND LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: BANK SAMPLE[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0569	0.0767	0.0235	0.0419	0.0289	0.0462	0.1012
	(0.0085)	(0.0096)	(0.0047)	(0.0082)	(0.0090)	(0.0071)	(0.0362)
Q_{t-2}	0.0046	0.0520	0.0723	0.0206	0.0491	0.0951	0.0842
	(0.0051)	(0.0049)	(0.0083)	(0.0082)	(0.0077)	(0.0076)	(0.0604)
$(Y/K)_{t-1}$	0.0522	0.0129	0.0215	0.0278	0.0534	0.0661	0.0426
	(0.0085)	(0.0084)	(0.0047)	(0.0157)	(0.0086)	(0.0351)	(0.0228)
$(WC/K)_{t-1}$	0.2556	0.0982	0.2310	0.2541	0.0567	0.0914	0.2230
	(0.0099)	(0.0062)	(0.0084)	(0.0843)	(0.0211)	(0.0499)	(0.0848)
$(WC/K)_{t-2}$	0.0561	0.1103	0.2014	0.2954	0.1420	0.0202	0.0314
	(0.0884)	(0.0412)	(0.1217)	(0.0521)	(0.0743)	(0.0096)	(0.0141)
$\Delta(WC/K)_t$	−0.2166	−0.0574	−0.1375	0.1283	−0.1381	−0.0097	−0.1047
	(0.0425)	(0.0413)	(0.0080)	(0.0414)	(0.0402)	(0.0407)	(0.0368)
J_{126}				136.008			
(Test of overidentifying restrictions)				(0.256)			
L_{14}				40.547			
(Test of exclusion restrictions on WC)				(2.10×10^{-4})			
L_7				17.229			
(Test of overidentifying restrictions)				(0.016)			
R_2				0.602			
$\hat{r}_1$				2.055			
$\hat{r}_2$				0.123			
$\hat{r}_3$				0.844			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 164 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987. This subsample consists of firms that do not have bond ratings from Moody's before the sample period begins.

financial health, and if it faces some degree of irreversibility or lumpiness in its investment projects, it should postpone investing until it can rebuild its financial asset position. This study has sought to ascertain if reliquification is indeed an important part of the investment process for a panel of U.S. corporations.

Two major conclusions have emerged. First, the tests of the exclusion restrictions on working capital indicate that for the sample as a whole there are important intertemporal linkages between investment and financial asset positions as measured by working capital. Second, these linkages appear stronger for those firms that do not participate in the bond market; that is, those firms that rely on the more information intensive bank loan market. In particular, for the full and especially the bank samples, an improvement in financial health tends to precede investment. This accumulation of financial assets tends to last approximately 2 years

TABLE IX

INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON THE CURRENT CHANGE IN WORKING CAPITAL, AND LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: BOND SAMPLE[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0211	0.0475	0.0684	0.0444	0.0192	0.0346	0.0816
	(0.0042)	(0.0043)	(0.0016)	(0.0086)	(0.0134)	(0.0096)	(0.0081)
Q_{t-2}	0.0559	0.0127	0.0531	0.0439	0.0268	0.0251	0.0412
	(0.0140)	(0.0132)	(0.0085)	(0.0067)	(0.0058)	(0.0240)	(0.0093)
$(Y/K)_{t-1}$	0.0146	0.0734	0.0577	0.0569	0.0120	0.0645	0.0288
	(0.0089)	(0.0088)	(0.0090)	(0.0145)	(0.0083)	(0.0096)	(0.0184)
$(WC/K)_{t-1}$	0.1102	−0.1430	0.0574	0.0263	0.0499	−0.0460	0.0209
	(0.0470)	(0.0836)	(0.0688)	(0.0291)	(0.0361)	(0.0775)	(0.0162)
$(WC/K)_{t-2}$	−0.0214	0.1631	0.1711	−0.0216	0.0344	0.0617	0.0152
	(0.0276)	(0.0926)	(0.0844)	(0.0136)	(0.0266)	(0.0418)	(0.0082)
$\Delta(WC/K)_t$	−0.1146	−0.1794	−0.1651	−0.2018	−0.0063	−0.0253	0.0330
	(0.0621)	(0.0639)	(0.1457)	(0.0811)	(0.0241)	(0.0203)	(0.0105)
J_{126}				139.330			
(Test of overidentifying restrictions)				(0.197)			
L_{14}				17.951			
(Test of exclusion restrictions on WC)				(0.209)			
L_7				20.114			
(Test of overidentifying restrictions)				(0.0053)			
R_2				0.584			
$\hat{r}_1$				1.966			
$\hat{r}_2$				1.002			
$\hat{r}_3$				0.025			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 153 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987. This subsample consists of firms that have bond ratings from Moody's before the sample period begins.

preceding the investment outlay. The bond sample, as predicted, shows no such pattern.

These results add to the mounting evidence concerning the dependence of some firms' investment on liquidity variables. They expand this idea in three directions. First, firms are separated by their presample access to bond markets instead of, as in Fazzari *et al.* (1988a,b), by their dividend policy, which is certainly simultaneously determined with their investment decisions. This method of classification also is more valid in the sense that it assumes that firms are constrained more on the margin of debt finance than on that of external equity finance, which is the basis for separating firms on the basis of their payout ratios. Since debt is well documented to account for a much larger share of external finance, then, in a loose sense, credit restrictions have greater potential to affect corporate decisions than do costly new share issues.

TABLE X
INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON THE CURRENT CASH FLOW, AND LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: FULL SAMPLE[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0152	0.0353	0.0251	0.0755	0.0467	0.0518	0.0316
	(0.0041)	(0.0053)	(0.0037)	(0.0094)	(0.0069)	(0.0292)	(0.0068)
Q_{t-2}	0.0049	0.0616	0.0300	0.0209	0.0134	0.0130	0.0157
	(0.0040)	(0.0049)	(0.0054)	(0.0245)	(0.0039)	(0.0084)	(0.0064)
$(Y/K)_{t-1}$	0.0227	0.0322	0.0227	0.0762	0.0146	0.0166	0.0146
	(0.0118)	(0.0072)	(0.0033)	(0.0041)	(0.0056)	(0.0064)	(0.0026)
$(WC/K)_{t-1}$	0.1187	0.0132	−0.2215	0.1264	−0.0845	0.0212	−0.2847
	(0.0404)	(0.0108)	(0.0547)	(0.0505)	(0.0687)	(0.4587)	(0.1833)
$(WC/K)_{t-2}$	0.1957	0.2661	0.3544	0.0533	−0.0664	0.1408	0.0659
	(0.0655)	(0.0998)	(0.0981)	(0.0306)	(0.0317)	(0.1491)	(0.0315)
$(CF/K)_t$	0.1573	0.3699	0.4069	0.1521	0.3917	0.1626	0.1576
	(0.0330)	(0.0731)	(0.0752)	(0.0749)	(0.1840)	(0.0280)	(0.0256)
J_{126}				135.622			
(Test of overidentifying restrictions)				(0.263)			
L_{14}				29.305			
(Test of exclusion restrictions on WC)				(0.0095)			
L_7				29.221			
(Test of overidentifying restrictions)				(1.32×10^{-4})			
R_2				0.587			
$\hat{r}_1$				2.332			
$\hat{r}_2$				−0.256			
$\hat{r}_3$				0.759			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 317 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987.

Second, this analysis complements previous work by focusing on how past financial health affects investment rather than on contemporaneous relationships. As explained above, it is the structure of adjustment costs that determines which effect will dominate. The evidence here points to the importance of both effects in the investment process. Also, using working capital to detect financial constraints avoids the criticism of earlier work that current cash flow may pick up expectations of future profits not captured by average q. Finally, the regression technique employed here provides insight into how macroeconomic conditions may affect the linkages between financial market imperfections and real expenditures. This relationship appears to be stronger during the economic recovery from the recession of 1981 and 1982 than in other years of the 1980s.

As a final note, the suggestive nature of the results for the sample of firms investigated here begs the question of whether these effects are

TABLE XI

INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON THE CURRENT CASH FLOW, AND LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: BANK SAMPLE[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0160	0.0440	0.0110	0.1754	0.0582	0.0115	0.0465
	(0.0047)	(0.0043)	(0.0042)	(0.0543)	(0.0075)	(0.0042)	(0.0039)
Q_{t-2}	0.0373	0.0652	0.0922	0.0210	0.0569	0.0750	0.0120
	(0.0094)	(0.0096)	(0.0461)	(0.0258)	(0.0096)	(0.0294)	(0.0204)
$(Y/K)_{t-1}$	0.0124	0.0454	0.0103	0.0304	0.0515	0.0657	0.0652
	(0.0062)	(0.0097)	(0.0037)	(0.0062)	(0.0099)	(0.0316)	(0.0320)
$(WC/K)_{t-1}$	0.1054	0.0640	0.3055	0.1477	0.0123	0.1441	0.0380
	(0.0488)	(0.0139)	(0.0911)	(0.0514)	(0.0047)	(0.0573)	(0.0100)
$(WC/K)_{t-2}$	0.0984	0.1402	0.2981	0.1099	0.0995	0.0112	0.0264
	(0.0170)	(0.0395)	(0.0840)	(0.0215)	(0.0185)	(0.0197)	(0.0171)
$(CF/K)_t$	0.6040	0.6596	0.7494	0.2321	0.3747	0.4710	0.1614
	(0.0824)	(0.0541)	(0.0693)	(0.0423)	(0.0894)	(0.0731)	(0.0434)
J_{126}				135.222			
(Test of overidentifying restrictions)				(0.271)			
L_{14}				42.330			
(Test of exclusion restrictions on WC)				(1.10×10^{-4})			
L_7				54.008			
(Test of overidentifying restrictions)				$(3.89 \times 10^{-9}$			
R_2				0.577			
$\hat{r}_1$				2.156			
$\hat{r}_2$				−0.420			
$\hat{r}_3$				0.018			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 164 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987. This subsample consists of firms that do not have bond ratings from Moody's before the sample period begins.

important in the economy as a whole. Friedman (1982) finds a steady relationship between a number of different measures of aggregate debt and national income. Further research is necessary, however, to look more carefully at the different components of national income, and to understand the dynamic interaction between finance and real activity in the aggregate.

APPENDIX

Descriptions of the Constructed Variables

The data appendix is organized as follows. First I describe the actual variables used in the regressions, where I have dropped the i subscripts

TABLE XII
INSTRUMENTAL VARIABLE REGRESSIONS OF INVESTMENT ON THE CURRENT CASH FLOW, AND LAGGED Q, OUTPUT, AND WORKING CAPITAL[a]: BOND SAMPLE[b]

	Year						
	1981	1982	1983	1984	1985	1986	1987
Q_{t-1}	0.0396	0.0306	0.1253	0.0229	0.0377	0.0568	0.0774
	(0.0043)	(0.0097)	(0.0225)	(0.0087)	(0.0088)	(0.0052)	(0.0027)
Q_{t-2}	0.0596	0.0309	0.0103	0.0132	0.0736	0.0552	0.0918
	(0.0455)	(0.0085)	(0.0058)	(0.0382)	(0.0074)	(0.0096)	(0.0307)
$(Y/K)_{t-1}$	0.0460	0.0113	0.0613	0.0446	0.0286	0.0632	0.0712
	(0.0167)	(0.0024)	(0.0038)	(0.0069)	(0.0086)	(0.0139)	(0.0098)
$(WC/K)_{t-1}$	−0.0258	−0.1109	0.1222	0.0025	−0.0379	0.0774	0.0588
	(0.0940)	(0.0535)	(0.0855)	(0.0013)	(0.0415)	(0.0619)	(0.1674)
$(WC/K)_{t-2}$	0.0547	0.0214	−0.0177	0.0874	−0.0574	0.0552	0.0185
	(0.0301)	(0.0201)	(0.0124)	(0.0490)	(0.0672)	(0.0300)	(0.0098)
$(CF/K)_t$	0.2249	0.2286	0.2390	0.0432	0.2959	0.1318	0.2047
	(0.0392)	(0.1450)	(0.0976)	(0.0551)	(0.0935)	(0.0383)	(0.0541)
J_{126}				137.901			
(Test of overidentifying restrictions)				(0.221)			
L_{14}				18.219			
(Test of exclusion restrictions on WC)				(0.197)			
L_7				21.914			
(Test of overidentifying restrictions)				(0.0026)			
R_2				0.549			
$\hat{r}_1$				4.749			
$\hat{r}_2$				0.545			
$\hat{r}_3$				0.394			

[a] The J and L statistics have χ^2 distributions. Their degrees of freedom are indicated by subscripts, and their P-values are in parentheses. The parameter standard errors are in parentheses below the parameter estimates. The R^2 is from the second-stage regression. The $\hat{r}_i$ statistics are tests for autocorrelation in the residuals of degree i. They have standard normal distributions.

[b] The sample consists of 153 U.S. manufacturing firms from the COMPUSTAT data base from 1974 to 1987. This subsample consists of firms that have bond ratings from Moody's before the sample period begins.

for convenience. All of these variables, except for Q_t, are scaled by the replacement value of the capital stock, K_t. I then set out the details of the underlying variables used to construct the regression variables.

Regression Variables

Investment. I_t is reported spending on plant, property, and equipment.

Output. Y_t is sales plus the change in finished goods inventories. The change in finished goods inventories is taken directly from the COMPUSTAT tape, when available. If the number is not reported, I calculate it as 0.23 times the value of total inventories; 0.23 is the average ratio of finished goods inventories to total inventories among the 46% of the firms in the sample that report these data.

Tobin's q.

$$Q_t = \frac{D_t + E_t - INV_t}{K_t}. \tag{A.1}$$

Here, $D_t + E_t - INV_t$ is the market value of the capital stock. I have subtracted the replacement value of inventories from the sum of the market values of debt and equity since inventories are included in the market value of the firm but do not contribute to the market value of the capital stock itself.

Cash Flow. CF_t is income plus depreciation.

Working Capital. WC_t is current assets minus current liabilities. Current assets include cash on hand and short-term asset holdings. It excludes inventories and receivables. Current liabilities include short-term debt and the current portion of long-term debt. It excludes payables.

Underlying Calculations

Replacement Value of the Capital Stock. In order to convert the book value of the gross capital stock into its replacement value, I use the perpetual inventory method described in Salinger and Summers (1983). First, I set the replacement value of the capital stock equal to the book value of gross plant, property, and equipment for the first year the firm appears on the COMPUSTAT tape. For 67% of the firms, this starting date occurs before 1962, when low inflation would not have caused much of a gap between the replacement value of capital and figures based on historical cost. For new firms that appear on the tape in later years, the book value of the capital stock in the first year is a reasonable approximation for the replacement value. However, for existing firms that appear in later years, this approximation will not be as good. Using the net value of plant, property, and equipment did not alter the empirical results significantly.

Next, I estimate the useful life of capital goods in any year using the formula

$$L_t = \frac{GK_{t-1} + I_t}{DEP_t}. \tag{A.2}$$

Here, L_t is the useful life of capital goods at time t, GK_{t-1} is the reported value of gross property, plant, and equipment at time $t - 1$, and DEP_t is the book value of depreciation allowances at time t. I have dropped the i subscript for convenience. I then take the average over time of L_t and use this average value, L, in the following formula to define the replacement value of the capital stock:

$$K_t = \left(K_{t-1}\left(\frac{P_t^k}{P_{t-1}^k}\right) + I_t\right)(1 - 2/L). \tag{A.3}$$

Here, P_t^k is the deflator for nonresidential investment, taken from the 1988 *Economic Report of the President*. The second term represents the amount of the capital stock that depreciates each year and is based on the assumption that economic depreciation is double declining balance. See Salinger and Summers (1983) for the other assumptions necessary to use this method of calculation.

Market Value of Equity. E_t is calculated as the sum of the market value of preferred stock and the market value of common stock. The latter is calculated simply as the number of common shares outstanding times the end-of-year share price. Preferred stock is treated as paying dividends forever. Its market value is therefore its dividend divided by Moody's medium-grade dividend yield.

Market Value of Debt. I use the method set forth in Bernanke and Campbell (1988) to convert the book value of debt into the market value. Since COMPUSTAT only provides limited information on the different maturities of debt, it is necessary to construct the maturity distribution of long-term debt from historical information on debt issues. The first step consists of using the method of Brainard *et al.* (1980) to construct the maturity distribution of book debt under the assumption that all long-term debt matures in 20 years. First, each individual firm's maturity distribution is set equal to the aggregate for the first year that the firm appears on the tape. Then, if D_{jt} is debt due in j years at time t, LTD_t is the reported value of long-term debt at time t, and DI_t is the amount of debt issued at time t, the maturity distribution is updated as follows:

$$D_{20t} = DI_t = LTD_t - (LTD_{t-1} - D_{1,t-1})$$
$$\text{if } LTD_t - (LTD_{t-1} - D_{1,t-1}) \geq 0 \tag{A.4}$$
$$D_{20t} = DI_t = 0 \qquad \text{if } LTD_t - (LTD_{t-1} - D_{1,t-1}) < 0$$

and

$$D_{jt} = D_{j+1,t-1}, \qquad j = 1, \ldots, 19. \tag{A.5}$$

If $LTD_t - (LTD_{t-1} - D_{1,t-1}) < 0$ debt retirement is distributed proportionately across the maturity distribution; that is, debt due in 1 to 19 years is scaled down by the factor

$$\frac{LTD_t}{LTD_{t-1} - D_{1,t-1}}.$$

The second step consists of replacing the estimated values of debt due in Years 1 through 5 with the actual COMPUSTAT numbers and rescaling the rest of the maturity distribution to be consistent with the total amount of long-term debt:

$$D_{jt}^{a} = D_{jt}^{*}, \qquad j = 1, \ldots, 5$$

$$D_{jt}^{a} = D_{jt}\left(1 + \left(\sum_{j=1}^{5} (D_{jt} - D_{jt}^{*})\right) \div \left(\sum_{j=6}^{20} D_{jt}\right)\right), \qquad j = 6, \ldots, 20. \tag{A.6}$$

Here, D_{jt}^{a} is the adjusted value of debt due in j years and D_{jt}^{*} is the reported value of debt due in j years for j equal to 1 through 5.

The final modification adjusts the value of total book debt to make reported interest expense consistent with that implied by assuming that the firm's interest rate on debt issued at time t is the Baa rate at time t. First, the new value of total book value is scaled as

$$NLTD_t = LTD_t \times IEX_t \div \sum_{j=1}^{20} \mathrm{Baa}_{t+j-20} D_{jt}^{a}, \tag{A.7}$$

where $NLTD_t$ is the scaled value of long-term debt at time t, Baa_t is the interest rate on grade Baa bonds at time t, and IEX_t is the reported amount of interest expense at time t. The new maturity distribution is then set proportional to the old.

Replacement Value of Inventories. For firms using the FIFO method, inventories are valued at current cost; and book value equals replacement value. However, for firms using LIFO, inventories are valued at historical cost. To convert book to replacement value, I first assume that the reported value of LIFO inventories is equal to the replacement value for the first year the firm appears on the tape. Following Salinger and Summers (1983), I assume that inventories are rolled over each year and use the following formulas to calculate their replacement value:

$$INV_t = INV_{t-1}(PPI_t/PPI_{t-1}) + INV_t^{*} - INV_{t-1}^{*} \qquad \text{if } INV_t^{*} \geq INV_{t-1}^{*}$$

$$INV_t = (INV_{t-1} + INV_t^{*} - INV_{t-1}^{*})(PPI_t/PPI_{t-1}) \qquad \text{if } INV_t^{*} < INV_{t-1}^{*}. \tag{A.8}$$

Here, INV_t is the replacement value of LIFO inventories at time t, INV_t^{*} is their reported value, and PPI_t is the two-digit industry-specific producer price index at time t, taken from the 1988 *Economic Report of the President*.

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