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## **Economic Activity and the Short-Term Credit Markets: An Analysis of Prices and Quantities**

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## **Economic Activity and the Short-Term Credit Markets:**

### **An Analysis of Prices and Quantities\***

#### ***Abstract***

Distinguishing between demand and supply phenomena in the credit markets — for example, determining whether the sharp slowdown in credit extensions in the United States during the most recent business recession was due to lack of borrowers seeking loans or to lack of willing lenders — requires a conceptual and empirical framework that combines information on both credit market prices and quantities.

This paper develops a simple model of the short-term credit markets that can serve as a vehicle for discussing demand and supply behavior in an analytically distinguishable way. In the model, nonfinancial businesses, banks and open-market investors interact in the markets for bank loans, commercial paper and Treasury bills. A novel feature of the model is the inclusion of a non-price element to the cost of firms' borrowing via either loans or commercial paper. Using this model, the paper examines analytically the consequences for credit market prices and quantities of four different kinds of shocks, including shocks originating from monetary policy, from changes in banks' capital position or capital requirements, from the risk of business debt default, and from business cash flows.

Empirical work presented in the paper, including descriptive evidence from vector autoregression systems as well as direct estimation of four of the model's central borrowing and lending relationships, provides evidence supporting a role for each of these different kinds of shocks in affecting credit market prices and quantities. In the most recent episode, the evidence points to bank capital shocks, default risk shocks, and cash flow shocks — but, interestingly, not monetary policy shocks — as contributing factors underlying the credit slowdown. By contrast, the evidence does point to tight monetary policy, and especially to an increase in the perceived risk of default on business debts, as key factors accounting for the recession.

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ECONOMIC ACTIVITY AND THE SHORT-TERM CREDIT MARKETS:  
AN ANALYSIS OF PRICES AND QUANTITIES

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The protracted weakness of the U.S. economy that began in 1990 (earlier by some measures) has raised once again some long-standing questions about the relationship between economic activity and the short-term credit markets. To what extent did the unavailability of financing from banks and other traditional short-term lenders either help cause the recession or, once it ended, account for the exceptionally anemic recovery? Did the protracted slowdown in all kinds of lending -- see, for example, Figure 1 -- merely reflect the absence of loan demand from conventionally creditworthy borrowers, or was it also due in part to some "supply" phenomenon that restricted lenders' ability, or willingness, to advance credit? Among familiar possibilities in this regard, how important was the impairment of banks' capital positions due to real estate losses? Or the apparent toughening of attitudes among bank regulators and examiners? Or even something as specific as the Basle agreement mandating an 8% capital ratio on a risk-adjusted basis? And if there was no significant new impediment to lenders' willingness to supply credit, what other aspects of financial market behavior accounted for the extraordinary slowdown in lending activity during this period?

Distinguishing demand influences from supply influences is hardly a new problem in economics. Repeated efforts to do so, applied to countless markets,

have led to two generally agreed upon principles. First, one needs to use both price and quantity data. It is difficult if not impossible to identify a demand or supply shock by observing only prices, or only quantities. Second, identification in this context also requires other information, apart from prices and quantities, that can be independently associated with either demand or supply behavior. There is no reason to think these principles are any less relevant to the short-term credit markets than in other standard contexts.

Credit markets do present special problems, however. Most obviously, the observable price of credit -- the interest rate on a loan -- is typically only one element among many dimensions that together constitute the relevant "price" as seen by both borrowers and lenders. This problem clearly hinders not just the attempt to distinguish supply and demand influences but a much broader class of efforts to analyze credit market behavior empirically.

From the perspective of trying to unravel the roles of supply and demand, however, a more fundamental problem arises from the possibility that credit market phenomena importantly affect economic activity at the aggregate level. Suppose, for example, that the only shock to the economy is a sharp reduction in lenders' willingness to advance credit, and that this negative shock to credit supply induces a decline in aggregate economic activity. Further suppose that the resulting decline in aggregate activity in turn induces potential borrowers to demand less credit (because credit demand is plausibly conditional not just on price but also on the volume of business to be financed). Then both bankers and economists may accurately report that the weakness of lending volume is largely due to the absence of loan demand, even though in a more fundamental sense the only shock that has disturbed the economy was to loan supply. In the presence of noisy measurements, the econometrician in this case could even find that that part of the weakness in credit volume attributable to supply behavior

was not statistically different from zero at standard significance levels, and therefore conclude that weak demand was the only force at work.<sup>1</sup>

Researchers exploring the interrelationships connecting the short-term credit markets and real economic activity have recently advanced two separate lines of analysis, in both cases motivated by observed empirical regularities. Friedman and Kuttner (1992, 1993) have focused on the predictive content, with respect to real output, of relationships among different short-term interest rates, in particular the spread between the commercial paper rate and the Treasury bill rate. Friedman and Kuttner advanced several different hypotheses (not mutually exclusive) to explain why movements of this spread might anticipate movements of real output. Kashyap, Stein and Wilcox (1993) have focused on the analogous predictive content of relationships among the quantities of different short-term credit instruments outstanding, in particular the mix of bank loans and commercial paper. Kashyap et al. developed a model, based on the relative cost of loans versus paper issues, to explain why movements of this mix might anticipate movements of real output.

The motivating hypothesis of this paper is that these two lines of analysis are really just the price and quantity sides, respectively, of the same underlying set of phenomena -- and, further, that for just the same reasons that incorporating both prices and quantities in the analysis is essential to successfully distinguishing demand and supply behavior in other market contexts, here too an expanded analysis encompassing both price and quantity aspects is needed to understand how what happens in the short-term credit markets affects real economic activity and vice versa. In this spirit, the paper's objective is to move beyond the evaluation of the statistical properties of the paper-bill spread, the loan-paper mix, or other similar "indicator" variables, to explore more fundamental questions about the economic and financial behavior underlying

their predictive content.

Section I begins by placing these price and quantity investigations, and the substantive hypotheses to which they give rise, in the context of what has increasingly come to be called the "credit view" of linkages between financial and nonfinancial economic activity. Part of the burden of this discussion is simply to clear the confusion that has resulted from different researchers' meaning different things while using similar (or even identical) terminology. More specifically, this discussion also seeks to distinguish a credit view of how monetary policy affects output from a credit view of financial-nonfinancial linkages more generally.

Section II presents the results of some simple empirical exercises designed not merely to demonstrate the predictive content of the Friedman-Kuttner and Kashyap-Stein-Wilcox variables but to show how their joint interaction is also of interest in this context. An interesting aspect of these results is that, while they do provide support for the paper-bill spread, they show that the predictive content of the loan-paper mix variable emphasized by Kashyap et al. is entirely a reflection of the commercial paper quantity. The volume of loans contains no predictive information with respect to real output, and the loan-paper mix contains none that is not already embodied in the volume of commercial paper. This finding turns out to foreshadow the results of the more detailed analysis presented in Section V below.

Section III describes a simple model of the short-term credit markets that can serve as a vehicle for discussing demand and supply behavior in an analytically distinguishable way. The main actors in this model are businesses, banks and open-market investors. As in Kashyap et al.'s model, here all nonfinancial firms are homogeneous. (A companion paper, currently in progress, extends this model to include two separate groups of nonfinancial firms, those

that do and those that do not have the ability to borrow in the open market from nonbank lenders.) A novel feature of this model is the inclusion of a non-price element to the cost of borrowing via either loans or commercial paper. Although each of these non-price costs is in some sense just a reflection of the extent to which reported interest rates fail to measure accurately the true cost of borrowing, the model's non-parallel treatment of how these costs arise in the bank loan and commercial paper markets, respectively, adds to its ability to provide substantive explanations for the predictive content of prices and quantities in these markets.

Section IV employs the model of Section III analytically to examine the consequences of four different kinds of shocks affecting the financial markets, including shocks originating from monetary policy, from changes in banks' capital position or capital requirements, from the risk of business debt default, and from business cash flows. Given the model, each of these different shocks results in a potentially observable set of price and quantity responses in the credit markets. An important distinction, however, is that while monetary policy shocks and bank capital shocks imply that the relationship between these credit market responses and subsequent movements of real economic activity is "causal," default risk shocks and business cash flow shocks do not.

Section V presents the results of empirical exercises that describe, in a richer way than the simple results shown in Section II, interactions within the credit markets and between the credit markets and nonfinancial economic activity. This descriptive evidence is mostly consistent with an interpretation of these interactions based on shocks to monetary policy or to corporate cash flows, and, in some respects, also with an interpretation based on shocks to investors' perceptions of default risk. The evidence is inconclusive on the role played by shocks to banks' capital positions (perhaps because of data

limitations, discussed below). As the initial results from Section II suggest, however, throughout this analysis there is a contrast between results based on variables drawn from the commercial paper market and results based on variables drawn from the bank loan market. In short, the paper market variables generally do exhibit the predicted behavior while the loan market variables often do not. This finding is ground for caution against basing the substantive interpretation of interactions between the credit markets and real economic activity on any description centered narrowly on substitution between bank loans and commercial paper. It also bears implications for the direction of further extensions to this line of research.

Section VI presents the results of efforts to estimate empirically some relationships that correspond more directly to the more structural representations of business, financing, bank lending and household investment behavior in the model of Section III. Despite the use of instrumental-variable estimation procedures, the resulting estimates do not consistently distinguish supply and demand behavior in such a way as to identify satisfactorily the price (interest rate) effects on these relationships -- that is, the relevant slope coefficients. By contrast, these estimates do provide further evidence that shocks to monetary policy, to bank capital positions, to default risk and to corporate cash flows affect these relationships by shifting them along the lines discussed analytically in Section IV.

Section VII focuses more directly on the questions about the most recent few years' experience posed at the outset of this paper. Which (if any) of these four sources of shocks played a major role in accounting for the extraordinarily slow growth of credit during the most recent recession and recovery episode? Here the evidence points to bank capital shocks, default risk shocks and cash flow shocks -- but, interestingly, not monetary policy shocks --

as contributing factors underlying the credit slowdown. By contrast, the evidence does point to tight monetary policy, and especially to an increase in the perceived risk of default on business debts, as key factors accounting for the recession itself. This finding is consistent with the concerns raised by numerous researchers about the sharp increase in business debt burdens during the mid to late 1980s.

Section VIII collects the paper's principal empirical findings.

## I. Credit Markets and Nonfinancial Activity

Just what is meant by the increasingly widespread notion of a "credit view" in macroeconomics? Is it a theory in the axiomatic sense, or a set of positive statements about observable behavior that (at least in principle) can be submitted to empirical verification, or both? Are the relevant magnitudes to observe prices or quantities, and if they are quantities are they stocks or flows? Do the relevant markets clear or not? To put first things first, what is the "credit view" a view of?

The central focus of macroeconomics has traditionally been the determination of aggregate nonfinancial economic activity, including its real dimensions like output, employment, income and spending, as well as the prices (both relative and absolute) placed on those aggregates. A useful way to clarify what the recent proliferation of interest in the "credit view" is all about is to distinguish the financial content -- in the sense of the roles played by whatever financial assets and/or liabilities are present -- of five different lines of economic analysis of the determination of real nonfinancial activity. Among these five approaches, the first two do not constitute a "credit view" but help to frame it nonetheless. (Knowing what something is not often helps in understanding what it is). The remaining three do.

1. Classical models. In classical models of the kind associated with Walras, or more recently with Arrow and Debreu, financial markets and what takes place in them have no bearing on the determination of real outcomes. Whether financial markets even exist is irrelevant to real output, labor input, the division of output between consumption and investment, and so on. If the economy has a financial side, the only aspect of it with any relevance to nonfinancial activity is whatever is used as "money" (in the primary sense of a medium of exchange), the nominal quantity of which determines the absolute price

level but not relative prices and certainly not any real quantity.

2. Neoclassical models. In neoclassical models, including Keynesian variants (and those of most self-styled neo-Keynesians and post-Keynesians) as well as monetarist versions, financial phenomena do affect real outcomes. The vehicle that allows them to do so -- that is, the impediment to the establishment of whatever outcomes would prevail in a strictly Walrasian model -- is typically the rigidity of some absolute price (perhaps all absolute prices) or of the relationship between some two absolute prices. Once absolute prices are imperfectly flexible, variation in the nominal quantity of any asset or liability immediately implies variation in the corresponding real quantity, and in the general equilibrium of all markets both financial and nonfinancial other real outcomes may then differ as well. Hence the contrast to classical models. Neoclassical models have often captured familiar intuitions based on empirical relationships. At the theoretical level, the primary challenge confronting such models has been to establish a satisfactory choice-theoretic foundation for the imperfect flexibility that distinguishes them from their classical counterparts. (Alternative approaches to achieving this result include models with "cash in advance" constraints on purchases, or even a role for money in directly affecting consumers' utility.)

What most neoclassical models carry over directly from classical models, however, is the exclusive focus on "money" as the only financial quantity to merit attention. The nominal quantity that varies, and that immediately implies a varying real quantity when prices are imperfectly flexible, is money. Some representation of the demand for money (even if only in the solved-out "quantity equation" form) is therefore characteristic of all such models. All other assets are implicitly assumed to be imperfectly substitutable for money but perfectly substitutable for one another, and the demand for them collectively is

implicitly modeled by the description of money demand together with whatever determines total wealth holding. As for liabilities, neither households nor firms typically have any in such models. If they do, their liabilities are perfect substitutes for their non-money assets and hence are also irrelevant to the determination of real outcomes. In "representative agent" models there can be no such liabilities even if markets for them exist, since there is no reason for two identical agents to enter into an arrangement whereby one borrows from or lends to the other.

Models that are neoclassical in this sense can also include a multiplicity of imperfectly substitutable non-money assets, although this elaboration is much less typical. For example, in the model in Tobin (1961) and also in Tobin's (1969) "Model II," imperfect substitutability between real capital and government-issued bonds is central to the analysis. Even so, such models do not present a "credit view" in the sense intended here because they do not include liabilities issued by "inside" agents like firms or households.

3. Credit models: the general case. What distinguishes the "credit view" from conventional neoclassical models is the recognition that households and/or firms do have liabilities, together with the presumption that these liabilities play a role in the determination of nonfinancial economic activity that is at least conceptually on a par with that reserved for money in neoclassical models. For private economic agents' liabilities to matter in this way, it must be true that not all non-money assets are perfectly substitutable one for another. Private agents therefore have balance sheets, in the nontrivial sense that there are distinguishable assets and liabilities, and that any agent's liability must be some other agent's asset.<sup>2</sup> It must also therefore be the case that not all private agents are identical.

The nontrivial existence of balance sheets for households and/or firms

introduces two forms of financial variables that can then be posited to play a role in the determination of nonfinancial economic activity: stocks and flows. Different expositions of the "credit view" have emphasized either or both, and much unnecessary confusion has resulted from the typical failure to recognize that, whatever may appear important empirically, the conceptual basis for a role of one typically implies a role for the other as well. The most immediately transparent "credit view" models focus on flows, distinguishing the opportunity cost of funds generated internally by firms, or earned by households, from the (presumably greater) explicit cost of external debt financing.<sup>3</sup> Balance sheet stocks enter the analysis naturally as a straightforward extension of this difference. If the opportunity cost of certain assets held is like that of internally generated funds but less than the cost of external debt financing, real spending or production decisions may depend not just on cash flows but also on the stock of such assets held.<sup>4</sup> Further, if the marginal cost of debt financing is not fixed but instead depends (presumably positively) on the quantity of debt already owed, relative to the borrower's ability to pay as measured by either income or assets, then stocks of liabilities and perhaps of other assets too can also affect real outcomes.

Like neoclassical models in a different context, models embracing the "credit view" capture a variety of familiar intuitions based on empirical relationships. And just as neoclassical models face the challenge of establishing satisfactory choice-theoretic foundations for the price rigidities or incomplete markets that render the real outcomes that they imply different from the corresponding Walrasian equilibria, so too the credit view faces the challenge of establishing such foundations for the differential cost of internal and external funds, or a rising marginal cost of debt finance -- or, to frame the matter in more fundamental terms, whatever makes one non-money asset

imperfectly substitutable for another and hence makes liabilities not trivially identical to assets. The main lines of analysis introduced to address these questions in recent years have exploited advances in the theory of imperfect information, of relationships between principals and their agents, and of the incentives and constraints embodied in contracts.<sup>5</sup>

4. Credit models of monetary policy. In the abstract, the notions that non-money assets are not all perfect substitutes, that liabilities exist and are distinct, and that balance sheets stocks and/or flows matter for the determination of nonfinancial economic activity -- that is, the central core of the "credit view" -- need imply little or nothing about how monetary policy works. Shocks emanating from the central bank's monopoly over the supply of bank reserves presumably represent only one of the many kinds of shocks to which an economy is subject. Even in a model in which other shocks influence nonfinancial activity through a process involving private-sector liabilities and balance sheets, as a practical matter monetary policy shocks could still have their effect largely via the equilibration of the demand for and supply of money as spelled out in neoclassical models.

In fact, however, many researchers advancing "credit view" models have done so as an explicit alternative to the neoclassical account of the monetary policy process.<sup>6</sup> What immediately makes the credit view at least potentially relevant to monetary policy is that banks (and other depository intermediaries) have balance sheets too. Given the banking system's capital position, or net worth, anything that affects the total amount of bank liabilities correspondingly affects the total amount of bank assets. Monetary policy may therefore affect nonfinancial economic activity by influencing banks' ability to create deposits, or by influencing their ability to extend credit, or in both ways. The force of the deposit mechanism presumably hinges at least in part on whether bank

liabilities, seen as assets in households' and firms' portfolios, are substitutable for non-money assets. The force of the credit mechanism depends at least in part on whether households and firms see non-bank financing as substitutable for bank loans.

Which of these two accounts of the monetary policy process more nearly corresponds to the prevailing empirical relationships in any given economy at any given time is clearly an important question, with immediate implications for monetary policymaking. (For example, would the central bank do better to choose an intermediate target based on bank liabilities or bank assets? Or would it do even better to use, even if only as an information variable, a broader measure encompassing nonbank liabilities or assets?) But even if the answer is that the deposit process is empirically more important, or perhaps even self-sufficient, in the specific context of how monetary policy works, "credit view" models in the more general sense described above may still be useful and even important in describing influences on nonfinancial economic activity apart from monetary policy.

5. Credit rationing models. The brief sketch of "credit view" models offered above, be they of the more general kind or specific to monetary policy, says nothing about markets' not clearing. By contrast, in some models of how credit market phenomena affect nonfinancial economic activity the center of attention is precisely on circumstances in which would-be borrowers cannot obtain financing at all, and therefore face what amounts to a quantity constraint on their ability to spend for purposes of consumption, investment or production. In many such models, the presence and/or intensity of this kind of market failure varies over time, and the motivating argument at an empirical level is that "credit crunches" of limited duration and irregular occurrence account for a significant part of the observed fluctuation of real output and

spending.<sup>7</sup>

Framed in the context of modern theories of imperfect information, principal-agent relationships and contract theory, which have provided the choice-theoretic foundations for recent "credit view" models, market failures of the kind emphasized in such "credit crunch" stories are simply an extension of the same behavioral elements that make non-money assets not all perfect substitutes, and private-sector liabilities distinct, in the first place. It is now well known that adverse selection, moral hazard and other phenomena that arise when information is asymmetric and when agents act on behalf of principals can produce market situations in which potential lenders will not finance would-be borrowers at any interest rate, so that the credit market does not clear even in the strict sense of the term.<sup>8</sup> It is also straight forward to posit reasons, many of them connected to just the balance sheet stocks and flows that are at center stage in "credit view" models, why the forces that prevent credit markets from clearing may vary in intensity over time. Hence models of credit rationing, or occasional "crunches," need be no less consistent with economic first principles than, say, neoclassical models in which money matters because of price rigidities.

The fact that "credit view" models can encompass market non-clearing does not mean that they necessarily do so, however, and on this point too substantial confusion exists. Credit view models may involve ongoing rationing and/or occasional crunches, or they may not. If they do, the credit crunches that occur may or may not be empirically important in explaining fluctuations in real activity. Credit view models in which the markets for all assets and liabilities always clear represent no less an alternative to the money-centered neoclassical model than do models of explicit financial market failure.

What this paper is about. The line of research developed in this paper

falls squarely in categories #3 and #4 as described above. The model presented in Section III incorporates not only non-money assets that are not perfect substitutes for one another but also private-sector (for simplicity, here just firms') liabilities that are not trivially identical to assets, and in general balance sheet stocks and/or flows affect real spending. The analysis explicitly considers monetary policy shocks, and as it does so these "credit view" elements are potentially at work alongside the equilibration of the deposit market taken over from the standard neoclassical model. The analysis considers other shocks too, however: to firms' cash flows, to the perceived riskiness of firms' liabilities, to banks' preferences for loans versus securities on the asset side of their balance sheets, and so on. Hence the model presented below potentially offers a "credit view" not just of monetary policy as in #3 but more generally as in #4 as well. By contrast, there is no provision here for markets not to clear. While the spirit motivating this line of research is certainly consistent with the existence and even importance of "credit crunches" as in #5, therefore, such phenomena do not occur in the formal model presented in Section III and they play no explicit role in the analysis of this paper.

## II. Some Illustrative Empirical Relationships

Before embarking on this analysis, is there evidence to suggest that either price or quantity variables that are consistent with a "credit view," but that would play no role in the standard money-centered neoclassical model, are systematically related to real economic activity? Table 1 presents F-statistics for the null hypothesis that all coefficients  $\theta_i$  are zero in regressions of the form

$$(1) \quad \Delta X_t = \alpha + \sum_{i=1}^6 \beta_i \Delta X_{t-i} + \sum_{i=1}^6 \gamma_i \Delta P_{t-i} \\ + \sum_{i=1}^6 \delta_i \Delta r_{t-i} + \sum_{i=1}^6 \theta_i \Delta Z_{t-i} + \phi t + u_t$$

where X and P are the natural logarithms of industrial production and the producer price index, respectively; r is the commercial paper rate; Z is, in turn, each of a series of other financial variables as listed in the table; u is a disturbance term; and  $\alpha_i$ ,  $\beta_i$ ,  $\gamma_i$ ,  $\delta_i$ ,  $\theta_i$  and  $\phi$  are all coefficients to be estimated. Data are monthly. The table presents results separately for the full 1960:1-1992:12 sample and for two sub-samples: 1960:1-1979:9 (that is, before the Federal Reserve System's adoption of new monetary policy operating procedures in October 1979) and 1973:6-1992:12 (that is, since the availability of monthly data on bank loans, a key element in the line of research developed by Kashyap et al).<sup>9</sup>

These results readily show the empirical appeal underlying the research of Friedman and Kuttner (1992, 1993) and, in a less direct way, that of Kashyap, Stein and Wilcox (1993). In contrast to the standard money and credit aggregates, the paper-bill spread variable emphasized by Friedman and Kuttner

exhibits a highly significant relationship to subsequent movements in real economic activity, even in the presence of the interest rate variable, regardless of which sample period is under study.<sup>10</sup> So does the quantity of commercial paper, which is a key element in Kashyap et al.'s analysis. Although the quantity of bank loans is itself not significant over the sample for which monthly data are available for this variable, the loan-paper "mix" ratio emphasized by Kashyap et al. is (weakly) so.

Focusing in more detail on just the 1973-92 sample, Table 2 extends these results to show the relevance, for the determination of real output, of price-quantity interactions in the short-term credit markets. The table shows the F-statistics from regressions that are identical to (1) except that they include both the paper-bill spread and, in turn, each of the other financial variables listed in Table 1 (along with output, prices, the interest rate and a linear trend, all as before). The most immediately visible result shown in Table 2 is that the predictive content of the spread remains highly significant, no matter which of the other variables is included along with it. The volume of commercial paper issued by nonfinancial firms also retains its strong significance in the presence of the spread (although the significance of the loan-paper mix disappears). Especially when the quantity under study is the volume of commercial paper, therefore, these results suggest that the price and quantity dimensions of the short-term credit markets do not just convey identical information in alternative forms. From the perspective of predictive content with respect to real output, looking at credit prices does not make looking at credit quantities irrelevant, nor vice versa.

The finding in Tables 1 and 2 of greater predictive power in the volume of commercial paper issuance than in the loan-paper mix ratio, and of none at all in the volume of bank loans, warrants some further preliminary analysis to learn

just what aspects of short-term credit quantities are most relevant to the determination of real output. Given Kashyap et al.'s definition of the mix as  $m = bl/(cp+bl)$  where  $bl$  and  $cp$  are the outstanding volumes of bank loans and commercial paper, respectively, it is straightforward to decompose the change in the mix (the form that, because of considerations of stationarity, appears in the regressions reviewed above) as

$$(2) \quad \Delta m_t \approx m_{t-1}(1-m_{t-1})\Delta bl_t/bl_{t-1} - m_{t-1}(1-m_{t-1})\Delta cp_t/cp_{t-1}$$

where the discrete-time approximation approaches exactness in continuous time. If the mix is the appropriate measure of short-term credit quantities to use for purposes of information about subsequent output fluctuations, then  $\Delta bl$  and  $\Delta cp$ , entered in place of  $\Delta m$  in regressions for real output, will appear with coefficients equal in magnitude but opposite in sign.

The upper panel of Table 3 shows that this is not the case empirically. In a regression of real output on separate distributed lags of both commercial paper and bank loans (along with output itself and the price index) for the same 1973-92 sample used above, the summed coefficients on commercial paper are negative as predicted, but so are those on bank loans -- although, as is to be anticipated from Tables 1 and 2, neither the t-statistic for the sum nor the F-statistic for all the coefficients together is statistically significant in the case of bank loans. By contrast, a simple reparameterization of this same regression, reported immediately below in the same panel of the table, shows that when the loan quantity is omitted and the mix variable entered in its place, neither it nor the paper quantity is significant. In other words, the mix variable and the paper quantity contain the same predictive information about subsequent fluctuations of real output.<sup>11</sup> Once again, the coefficients on

the commercial paper quantity are negative.

Since the regressions underlying Table 1 and 2 already include both the paper-bill spread and the commercial paper rate, and the spread does exhibit highly significant predictive context with respect to output in the presence of the paper rate, a similar analysis focused on the spread variable should clearly bear different implications. As the lower panel of Table 3 shows, the paper rate and the bill rate are each individually significant at the .01 level when the two are entered together in a regression for real output. Reparameterizing this same regression to include the paper-bill spread in place of the bill rate makes the contrast to the corresponding result with the mix and the commercial paper quantity all the more apparent. The spread is significant at the .01 level in the presence of the paper rate, and vice versa at the .05 level. Moreover, in a separate regression the data also reject at the .01 level the further restriction that the coefficients on the spread just cancel the corresponding coefficients on the paper rate so that the relevant predictive content is actually contained in the bill rate alone.<sup>12</sup>

In sum, the U.S. empirical evidence exhibits four main features that together suggest useful avenues for research on the relationship between real output and the short-term credit markets. First, both prices and quantities in the short-term credit markets contain statistically significant information about subsequent fluctuations in real output. Second, the information about real output contained in these respective price and quantity variables is not identical. Third, much of the relevant information from price variables in this context is contained in relative prices, like the spread between the commercial paper rate and the Treasury bill rate. Fourth, the relevant information from short-term credit market quantities is contained mostly in the volume of commercial paper issuance; specifically, neither the volume of bank loans, nor

the relationship between loan volume and paper volume (except in so far as it merely reflects paper volume alone), appears to matter much for the determination of real output.

### III. A Model of Credit Markets and Their Interaction With Real Output

What set of circumstances describing the short-term credit markets might systematically give rise to interactions with real output of this form?

A minimal description of the credit markets for this purpose must bring together the behavior of three distinct kinds of private-sector agents -- banks, open-market investors, and homogeneous nonfinancial firms -- interacting in three different markets -- those for Treasury bills, bank loans, and commercial paper. In addition, as in neoclassical models, the analysis must include a market for whatever constitutes money. This section sketches the outlines of such a model.<sup>13</sup>

Nonfinancial Firms. The place to begin is with the behavior of nonfinancial firms, here taken to be homogeneous. The  $i$ -th firm's balance sheet constraint, implicitly defining its stockholders' equity as the difference between its assets and its liabilities, is

$$(3) \quad PE^i + B^i = L^i + P^i + E^i$$

where  $PE$  represents the firm's stock of physical capital,  $B$  its holdings of Treasury bills,  $L$  its debt owed to banks,  $P$  its commercial paper outstanding, and  $E$  its net worth.<sup>14</sup> The corresponding financing constraint, equating total uses of funds for investment with total sources of funds, is

$$(4) \quad I^i + \Delta B^i = NR^i + \Delta L^i + \Delta P^i$$

where  $I$  represents investment outlays and  $NR$  net revenues from operations not paid out in interest or dividends.<sup>15</sup> Under standard conditions admitting aggregation, the financing constraint for all firms together is<sup>16</sup>

$$(5) \quad I + \Delta B^F = NR + \Delta L^F + \Delta P^F.$$

A central presumption of the "credit view" is that conditions in the financial markets play a causal role in determining firms' nonfinancial investment and net revenues. But regardless of whether that is so or those aspects of firms' nonfinancial behavior are predetermined with respect to their financial choices, (5) shows that the gap between  $I$  and  $NR$  must be financed by some combination of loans, paper issuance, and sales of bills previously held. Over a time horizon such that firms' nonfinancial investment and net revenues are predetermined with respect to contemporaneous conditions in the financial markets, their financing choice for given financing gap  $I-NR$  reflects in the first instance standard principles of risk-averse portfolio selection, supplemented here by the non-price (that is, other than the observed interest rate) costs of obtaining external funds,

$$(6) \quad \Delta L^F = f_1(I-NR, r_L, \theta_L, r_P, \theta_P, r_B)$$

+   -   -   +   +   +

$$\Delta P^F = f_2(I-NR, r_L, \theta_L, r_P, \theta_P, r_B)$$

+   +   +   -   -   +

$$\Delta B^F = f_3(I-NR, r_L, \theta_L, r_P, \theta_P, r_B)$$

-   -   -   -   -   +

where the  $r_i$  are the interest rates in the three short-term markets and the  $\theta_i$  are the corresponding non-price cost elements (assumed to be zero in the bill market). Given (5), the usual cross-equation restrictions apply, so that (6) contains only two independent relationships.

Nothing in (6) as written reflects either a greater cost of external financing compared to internal funds or the possibility of a rising marginal cost of external financing as firms have more debt outstanding -- two standard propositions associated with "credit view" models as indicated in Section I. Differential costs of internal and external funds are largely a matter of whether the flow of net revenues from operations, NR, enters the investment function (as it does below). If the cost of debt is rising at the margin, however, then both the investment function and (6) may also include the outstanding stocks of loans and paper, and the stock of nonfinancial capital, from the balance sheet.<sup>17</sup> In addition, since no firm's holdings of Treasury bills can be negative, in general the stock of bills will also enter these expressions even though the return to bills (as seen by any firm) is of course fixed no matter how many bills are held.<sup>18</sup> As is well known, once either the investment function or the equations describing firms' financial decisions do include balance sheet stocks, of either assets or liabilities, the resulting model then provides a vehicle for describing stock-flow dynamics as is familiar in a variety of theoretical and empirical contexts.

Banks. The firms that behave in this manner interact with two separate classes of lenders. Banks issue deposits, including ordinary transactions accounts as well as deposit certificates (which are negotiable but uninsured), and against these deposits they hold Treasury bills and commercial loans. In addition, by law each bank must meet two constraints. First, part of its assets, equal to or greater than some stated fraction of its outstanding deposits, must consist of zero-interest reserves held at the central bank. Second, the bank must support a part of its assets, equal to or greater than a (different) stated fraction, with capital rather than deposit liabilities. Because these two restrictions are inequalities, they are not necessarily

binding at the margin.

The  $i$ -th bank's balance sheet constraint is

$$(7) \quad B^i + L^i + R^i = D^i + CD^i + K^i$$

where  $R$  represents reserves,  $D$  transactions deposits,  $CD$  certificates of deposit, and  $K$  the bank's capital position. The bank's reserve and capital requirements are, respectively,

$$(8a) \quad R^i \geq D^i \cdot k_1 + CD^i \cdot k_2$$

$$(8b) \quad K^i \geq L^i \cdot k_3 + B^i \cdot k_4$$

where the  $k_j$ ,  $0 \leq k_j < 1$ , are fractions set by the relevant regulatory authorities. A key feature of these requirements as they currently apply in the United States is that  $k_2 = k_4 = 0$ . That is, transactions deposits are reservable but certificates are not, and banks need capital against their loans but not their securities.

If the model is taken literally as a simple one-period model, with  $R$  and  $K$  fixed for the period, the inequalities in (8) are straightforward constraints binding banks' choice of assets  $B$  and  $L$  and liabilities  $D$  and  $CD$ .<sup>19</sup> Because banks can readily exchange reserves among one another (in effect, most bank transactions are settled by transferring reserves), what is given in effect is not each bank's individual  $R^i$  but the aggregate  $R$  supplied by the central bank. By contrast, for purposes of the capital requirement each bank's individual  $K^i$  is what matters, and so the distribution of  $K^i$  among individual banks within the aggregate  $K$  is relevant as well.<sup>20</sup>

In any more dynamic model, however, there is always the possibility that a bank that does not "now" face a binding reserves or capital constraint may do so "later." Expanded loan opportunities may arise, or the bank may experience large deposit outflows (which cause its  $R^i$  to decline), or it may experience defaults on its existing loans (which cause its  $K^i$  to decline), or the regulators may even raise the relevant  $k_j$ . For a given distribution describing the probability of any or all of these kinds of shocks, the probability that the bank's reserves or capital constraint will become binding "later" depends negatively on the amount by which  $R^i$  or  $K^i$  exceeds the requirement "now." Hence there are implicit non-zero shadow prices on reserves and capital, even for banks for which the respective constraints are not binding, and it is plausible to think of both  $R$  and  $K$  as arguments of the equations describing the banks' choice of  $B$ ,  $L$ ,  $D$  and  $CD$ , along with the standard portfolio theoretic arguments, here including the non-interest return to bank loans,  $\theta_L$ .<sup>21</sup> The resulting representation is

$$(9) \quad B^B = b_1(r_B, r_L, \sigma^2, \theta_L, r_D, r_P, R, K) \\ + \quad - \quad + \quad - \quad - \quad - \quad + \quad ?$$

$$L^B = b_2(r_B, r_L, \sigma^2, \theta_L, r_D, r_P, R, K) \\ - \quad + \quad - \quad + \quad - \quad - \quad + \quad +$$

$$D^B = b_3(r_B, r_L, \sigma^2, \theta_L, r_D, r_P, R, K) \\ + \quad + \quad - \quad + \quad - \quad + \quad + \quad +$$

$$CD^B = b_4(r_B, r_L, \sigma^2, \theta_L, r_D, r_P, R, K) \\ + \quad + \quad - \quad + \quad + \quad - \quad ? \quad +$$

where  $\sigma^2$  is the risk of default on loans (Treasury bills are default-free), and  $r_D$  is the rate paid on transactions deposits. Here  $r_P$ , the interest rate on commercial paper, represents the interest rate on certificates of deposit because open-market investors (modeled just below) are assumed to treat banks' certificates and firms' paper as perfect substitutes and therefore to arbitrage the two assets' returns into equality.<sup>22</sup> Given banks' role as takers of transactions deposits, the most plausible interpretation of the equation for  $D^B$  is in governing banks' choice of  $r_D$ . The risk of default  $\sigma^2$ , which reflects not only the risk associated with firms' return on nonfinancial investment but also the relationship among their respective stocks of assets and liabilities as described above, affects banks' willingness to lend negatively, and hence their demand for Treasury bills positively and their supply of deposits negatively.

The equations in (9) determine the composition of the banking system's balance sheet but say nothing explicitly about its scale. Given the reserve and capital requirements, however, the scale of the banking system at any specific time is determined by the amount of reserves supplied by the central bank and the amount of capital that banks have accumulated from past earnings (or equity issues). Given that certificates of deposit are not reservable and Treasury bills carry no capital requirements, it might seem that the banking system would expand indefinitely if  $r_B > r_P$ , but in fact  $r_P > r_B$  and so the preferences with respect to balance sheet composition reflected in (9) also determine banks' scale once  $R$  and  $K$  are given. While  $R$  and  $K$  are both strictly positive influences on the banking system's scale, therefore, the structure of (8) still renders their effects on banks' portfolio composition asymmetric. Specifically, as the undetermined derivatives in (9) indicate, changes in  $R$  have differential effects on banks' choice of liabilities while changes in  $K$  have differential effects on banks' asset choice.

Households. Finally, open-market investors -- what most models identify as households, although that designation misses what is of the essence here -- choose among transactions deposits, Treasury bills, commercial paper and certificates of deposit, all in a manner constrained by their accumulated net saving. In the absence of household borrowing opportunities,<sup>23</sup> the i-th household's balance sheet constraint is just

$$(10) \quad NA^i + D^i + B^i + P^i + CD^i = NW^i$$

where NA represents nonfinancial assets and NW net worth (here identical to total assets). The corresponding constraint equating total uses of funds with total sources is

$$(11) \quad \Delta D^i + \Delta B^i + \Delta P^i + \Delta CD^i = NS$$

where NS represents saving net of accumulation of nonfinancial assets. If (11) admits aggregation,<sup>24</sup> standard principles of portfolio selection under conditions of risk then result in

$$(12) \quad \Delta D^H = h_1(NS, r_D, r_B, r_P, \sigma^2, \theta_P, Y)$$

+ + - - + + +

$$\Delta B^H = h_2(NS, r_D, r_B, r_P, \sigma^2, \theta_P, Y)$$

+ - - - + + -

$$\Delta P^H + \Delta CD^H = h_3(NS, r_D, r_B, r_P, \sigma^2, \theta_P, Y)$$

+ - - + - - -

where the demand for money for purposes of executing transactions -- which is presumably the origin of the distinct demands (and in general, therefore, different interest rates) for transactions deposits and Treasury bills, despite the absence of risk on either asset -- mandates the presence of income  $Y$  in the deposit demand equation (and in general, therefore, in each of the other two asset demands). As before, the applicable restrictions mean that (12) contains only two independent equations.

Non-price Costs of Borrowing. While it is widely known that reported interest rates often do not measure accurately the true cost of borrowing, few models include any concrete attempt to allow for the effects of whatever other costs account for this discrepancy. The inclusion here of  $\theta_L$  and  $\theta_P$  -- and, in particular, the non-parallel treatment of these two non-price cost elements from the perspective of lenders -- strengthens this model's ability to explain observed relationships between price-quantity interactions in the credit markets and real economic activity of the kind documented in Section II. From the perspective of nonfinancial firms, the two non-price costs of borrowing are parallel. Greater  $\theta_L$  depresses  $\Delta L^F$  just as would higher  $r_L$ , while greater  $\theta_P$  depresses  $\Delta P^F$  just as would higher  $r_P$  (and, just below, either greater  $\theta_L$  or greater  $\theta_P$  depresses firms' nonfinancial investment). The non-parallel treatment lies in the effect of these non-price costs on lenders.

As many researchers have emphasized, banks typically have ongoing relationships with their borrowers.<sup>25</sup> In the case of loans, therefore,  $\theta_L$  represents charges -- either explicit (like origination and servicing fees) or implicit (like compensating balances, or the requirement to purchase unrelated services like underwriting or trust operations) -- earned by banks as lenders. Interpreted to be net of any additional direct expenses of originating and servicing a particular loan, the elements of  $\theta_L$  are just additional ways (beyond

interest payments) for the bank to earn a profit from the transaction. Hence greater  $\theta_L$  increases banks' willingness to lend, just as does higher  $r_L$ .

Observers of bank lending relationships typically report that over time these non-interest charges tend to increase or decrease as loan interest rates rise or fall, so that it is reasonable to treat  $\theta_L$  in part as a positive function of  $r_L$ . To the extent that banks move  $r_L$  only sluggishly in response to changes in supply-demand conditions in the loan market, however, even this partial covariation is presumably highly imperfect. Moreover,  $\theta_L$  plausibly varies both with the volume of loans outstanding and with the change in loan outstandings, since some kinds of non-interest charges (for example, compensating balances) are logically related to the ongoing level of financing while others (for example, origination fees) pertain to new financings only.<sup>26</sup>

$$(13) \quad \theta_L = \theta_L(r_L, L, \Delta L).$$

+   +   +

In contrast to banks, open-market investors by definition have no ongoing relationship with the borrowers to whom they lend, and hence cannot capture all, or in some cases any, of the charges  $\theta_p$  that represent non-interest costs to borrowers. Open-market investors must at least partly share these costs, which then accrue as profit to dealers, advertisers, rating agencies and the like.<sup>27</sup> Hence greater  $\theta_p$  depresses not only  $\Delta P^F$ , as is the case for bank loans, but  $\Delta P^H$  also. Since the costs that borrowers must incur for such purposes as establishing dealer relationships or obtaining agency ratings do not accrue to lenders, there is no reason for  $\theta_p$  to covary with  $r_p$ . By contrast, these costs (and the profits made from them) do depend on the volume of business done in the commercial paper market, as the discussion below elaborates, and here too what

matters is presumably both the volume of paper outstanding (and being continually refinanced, since commercial paper is a short-term liability) and the change in that volume:<sup>28</sup>

$$(14) \quad \theta_P = \theta_P (P, \Delta P).$$

+ +

Market Clearing. Given participation in the short-term credit markets by nonfinancial firms, banks and open-market investors as described in (3)-(14), market clearing requires

$$(15) \quad \Delta B^F + \Delta B^B + \Delta B^H = \Delta B^G$$

$$\Delta L^B = \Delta L^F$$

$$\Delta P^H = \Delta P^F$$

$$\Delta D^H = \Delta D^B$$

$$\Delta CD^H = \Delta CD^B$$

$$\Delta R^B = \Delta R^G$$

where  $B^G$  is the outstanding volume of Treasury bills (net of ownership by the central bank and by foreign investors) and  $R^G$  is the outstanding volume of reserves created by the central bank. Figure 2 provides the standard tableau summarizing this set of market clearing conditions together with the balance

sheet restrictions embedded in (6), (9) and (12).

Links to Nonfinancial Activity. The representation of the behavior of firms, banks and open-market investors in (3)-(15) describes these agents' financial behavior only. Relevant aspects of firms' and households' nonfinancial activity -- firms' investment and revenues, households' saving and accumulation of nonfinancial assets -- enter this description but are not determined there. What is missing is the connection between the financial prices and quantities determined in (3)-(15) and nonfinancial outcomes. In most simplified models, of either the neoclassical or the credit variety, the main link between the financial markets and real economic activity is firms' investment behavior.

If the model is not to dictate ex ante any conclusion about whether whatever empirical connection exists between the short-term credit markets and real activity is or is not causal, the representation of investment behavior must include the makings of financial influences on investment as well as independent influences determining investment that needs in turn to be financed. Given the spirit of the description of financial behavior in (3)-(15), the most natural starting place for such a representation focuses on matters of risk and return. In addition, however, a principal object of the model developed here is to admit a potential role for balance sheet stocks and flows, as well as to expand the treatment of the risk and return variables to allow for non-price elements of borrowers' cost of financing.

A skeletal representation of firms' investment that excludes any balance sheet stock variable is

$$(16) \quad I = I(NR, r_{I+}, \bar{r}, \bar{\theta}, \sigma^2)$$

where, apart from purely stochastic fluctuations due, for example, to unintended inventory accumulation, investment responds positively to net revenues from operations, positively to the excess of the expected rate of return on investment  $r_I$  over firms' composite interest cost of additional funds  $\bar{r}$ , negatively to the corresponding composite of non-price elements of firms' cost of external funds  $\bar{\theta}$ , and negatively to the risk  $\sigma^2$  associated with firms' return on investment. The composite interest cost  $\bar{r}$  depends on  $r_L$ ,  $r_P$  and  $r_B$  with weights that reflect the respective importance of  $\Delta L$ ,  $\Delta P$  and  $\Delta B$  that firms choose in their financing of investment at the margin. The composite non-interest cost  $\bar{\theta}$  depends in an analogous way on  $\theta_L$  and  $\theta_P$ . The presence of NR in (16) reflects the standard "credit view" presumption that internal funds are less costly than external financing (again, for reasons of asymmetric information, principal-agent interactions, and contracts).<sup>29</sup> Finally in addition to these arguments of (16), a rising cost of debt at the margin, as discussed above in connection with firms' financing choice (6), would also imply a role for balance sheet stocks  $L^F$  and  $P^F$ , and the nonnegativity constraint on firms' holdings of bills would likewise imply a role for  $B^F$ .

At a formal level, closing the model then simply requires making explicit the standard dependence of aggregate spending (income) on investment, of firms' revenues on spending, and of saving on income (and perhaps on interest rates). Given the two government variables  $R^G$  and  $B^G$ , banks' capital position  $K$ , and all existing balance sheet stocks, the resulting model is then sufficient to determine the market-clearing values of all of the financial quantities, interest rates and non-price financing costs in (3)-(15) as well as nonfinancial investment in (16). What remains undetermined, of course, is the prospective return  $r_I$  and risk  $\sigma^2$  associated with firms' nonfinancial investment. But that is a matter for a different paper.

#### IV. Hypotheses About the Credit Markets and Real Activity

How, then, can the model sketched in Section III account for the observed relationships between the short-term credit markets and real economic activity? And does whatever interaction is involved imply that the predictive content of credit market variables with respect to real activity, as shown in Section II, is causal?

A Causal Hypothesis: Monetary Policy Shocks. One such mechanism, suggested by Kashyap et al. as well as by Friedman and Kuttner, centers on monetary policy and does make the observed relationships causal.<sup>30</sup> Given (9), a tightening of monetary policy in the form of a negative shock to  $R^G$  restricts banks' willingness to make loans, so that the loan interest rate increases and the volume of loans decreases. As firms that do not receive bank loans seek credit elsewhere, specifically in the commercial paper market, both the quantity of paper issued and the associated interest rate increase. With higher interest rates on financing, firms' investment declines. As is familiar, such a negative monetary policy shock also raises interest rates more broadly. Banks may seek to shrink their balance sheets not just by cutting back on loans but also by selling bills, and firms also sell bills from their portfolios (or accumulate less) as a way of obtaining additional investable funds. In the meanwhile, the supply of bills to be held by all private investors together is greater, because the central bank's means of reducing the quantity of reserves is to sell bills to the market. Hence interest rates rise not just in the loan and paper markets but in the bill market too.

With plausible lags in the investment function, this story clearly can account for the empirical regularity emphasized by Kashyap et al., that firms' "mix" between loan and paper financing tends to shift toward paper in advance of a decline in real output. (To recall, however, a caveat flagged in Section II

is that the predictive content with respect to real output is contained entirely in the volume of paper issuance, with essentially none in the behavior of bank loans: more on this below.) By contrast, it is not obvious that anything in this process will cause the paper-bill spread to widen in advance of a decline in real output. The general equilibrium of the credit markets described above implies that a negative shock to  $R^G$  will produce an increase in the bill rate along with the rates on loans and paper, and there is no reason why the paper rate increase should systematically exceed the bill rate increase as tends to occur empirically.<sup>31</sup>

One solution way of accounting for this phenomenon would be to appeal to heterogeneity of firms. If the obligations of borrowers that shift from the bank loan market to the commercial paper market when monetary policy tightens are systematically less attractive to open-market investors than the obligations of borrowers whose paper is already outstanding -- either because these new borrowers are less creditworthy, or because they deal in smaller volume so that their paper is less liquid -- then the resulting rise in risk or loss of liquidity for the representative issuer's paper will lead the market-average commercial paper rate to rise relative to the rate on Treasury bills (or any other instrument for which risk and liquidity remain unchanged). This is essentially the story told verbally by Kashyap et al., although it stands outside the model they present, which assumes homogeneous borrowers. Making such a story explicit would require a model with at least two classes of firms.<sup>32</sup>

A way of accounting for the widening of the paper-bill spread in these circumstances, even when all borrowing firms are homogeneous, is to exploit the fact that investors recognize the differing tax, risk and liquidity features of commercial paper and Treasury bills, and hence treat these instruments as

imperfect substitutes in their portfolios. When assets are imperfectly substitutable, changes in their relative supplies in general affect their relative market-clearing expected returns. Friedman and Kuttner (1993) showed that the relative supplies of commercial paper and Treasury bills do have statistically significant effects, in the direction predicted by standard portfolio analysis, on the paper-bill spread. As long as the increase in the quantity of paper that open-market investors have to hold when monetary policy tightens is relatively greater than the corresponding increase in the quantity of bills to be held, a direct consequence of that tightening is a widening of the paper-bill spread.

Finally, the model of the short-term credit markets developed in Section III can also account for an increase in the paper-bill spread when monetary policy tightens because of the role played by the non-price cost of commercial paper issuance,  $\theta_p$ , and in particular the asymmetry between  $\theta_p$  and the non-price cost of bank loans,  $\theta_L$ . Figure 3 illustrates the basic interaction at work by plotting borrowers' and lenders' behavior in the respective markets for bank loans, commercial paper and Treasury bills. The negative shock to  $R^G$  shifts the  $\Delta L^B$  curve inward as in conventional analyses. With no change in the  $\Delta L^F$  curve, quantity  $\Delta L$  falls and banks raise the measured price of loans  $r_L$  and probably the non-observed price element  $\theta_L$  as well. (Because the equations in the model are simultaneous -- that is, curves plotted in Figure 3 to represent borrowers' and lenders' behavior in each market are conditional on outcomes in the other markets -- any attempt to describe the effects of a specific shock verbally is necessarily imprecise because it is only sequential.)

As firms that otherwise would have borrowed from banks then turn to the commercial paper market, not only does  $r_p$  rise but also  $\theta_p$  increases for either or both of two reasons, both intuitively reflected in (14). First, if firms

that normally borrow at banks do not have pre-existing commercial paper programs, they must incur a cost to establish a relationship with a dealer in this market.<sup>33</sup> The resulting dealer's profit constitutes a cost that must be paid in some proportion by borrowers and lenders. Second, in addition to the cost of establishing and maintaining a dealer relationship, when firms borrow in the open market someone must monitor their performance and prospects on behalf of lenders. As Bernanke (1983) and Bernanke and Gertler (1986) have emphasized, a key role traditionally played by banks is to perform just this monitoring function. When firms that normally borrow at banks move into the open market, the burden placed on market analysts, independent rating agencies and lending institutions themselves becomes greater.

Depending upon how this additional cost is shared between borrowers and lenders, either  $\Delta P^F$  shifts outward by less than would otherwise be the case, or  $\Delta P^H$  shifts inward, or both as illustrated in Figure 3. In addition, with reserves more scarce, banks may increase their eagerness to issue (non-reservable) certificates of deposit, as indicated in (9). The new equilibrium in the paper and CD market may have quantity ( $\Delta P + \Delta CD$ ) either greater (as in Figure 3) or smaller than before the negative monetary policy shock, but the price  $r_p$  is unambiguously greater. Moreover, because  $\theta_p$  represents a cost to borrowers or lenders, or both -- again, in contrast to  $\theta_L$ , which is an element of the price that lenders receive from borrowers -- the increase in  $r_p$  exceeds the increase in other short-term interest rates to which such costs do not pertain. Hence the credit market consequences of a tightening of monetary policy include not only a decline in the loan-paper mix but also a widening of the paper-bill spread, even though the inward shift in any or all of  $\Delta B^F$ ,  $\Delta B^B$  and  $\Delta B^H$ , and the outward shift in  $\Delta B^G$ , increase  $r_B$  as well. And as long as firms' investment is sensitive to the price and/or non-price cost of

financing, real economic activity declines.

Another Causal Hypothesis: Bank Capital Shocks. Much of the discussion of the 1990-92 weakness in lending illustrated in Figure 1, and of the connection between the weakness in lending and the sluggishness of the recovery of real economic activity following the 1990-91 recession trough, has focused not on monetary policy but on arrangements surrounding banks' capital requirements.<sup>34</sup> In brief, the argument has three elements: The Basle accord in effect raised  $k_2$  in (8b) to 8% while maintaining  $k_4 = 0$ .<sup>35</sup> Loan losses, especially in their real estate portfolios, reduced  $K$  at many banks. And more vigorous supervision by the regulators further reduced many banks'  $K$  by classifying as problematic many loans on which borrowers had not yet defaulted.

The effect of an increase in  $k_2$  and/or a reduction in  $K$  is to render the capital requirement binding for some banks at which it was not so already. For yet other banks, following the discussion in Section III, the effect is to narrow the margin by which the requirement is not binding, and hence to increase the shadow cost on capital in a dynamic context. On both counts, banks' willingness to lend is reduced, as indicated in (9), and so  $\Delta L^B$  again shifts inward as in Figure 3. As firms that cannot obtain bank loans seek funds in the paper market,  $\Delta P^F$  again shifts outward as in Figure 3.

The fact that banks' assets differentially affect their required capital while their liabilities differentially affect their required reserves, however, means that the further consequences of a negative shock to bank capital (or an increase in the capital requirement) are not necessarily as described above for the case of a monetary policy shock. Unlike in the wake of a negative monetary policy shock, here banks have no incentive to issue more certificates of deposit, and so firms' greater issuance of commercial paper is now the only reason why  $(\Delta P^F + \Delta CD^B)$  in Figure 3 would shift outward. Also, as (9)

indicates, here there is less reason to expect banks to reduce their holdings of securities, and they may even increase their securities holdings in order to avoid shrinking in overall scale when capital is inadequate. Hence the inward shift of  $(\Delta B^F + \Delta B^B + \Delta B^H)$  in Figure 3 is now mostly, or perhaps entirely, a matter of firms' and households' behavior. Unlike an open market operation that withdraws reserves, a negative shock to banks' capital positions does not involve any outward shift of  $\Delta B^G$ .

As this comparison makes clear, merely looking at the behavior of interest rates and loan volumes -- the standard fare of most discussions of whether great capital requirements and/or banks' loan losses have contributed to the "credit crunch" -- is not sufficient to distinguish a negative bank capital shock from a negative monetary policy shock. In both cases loan volume falls, all interest rates rise, and the paper rate rises by more than the bill rate. And in both cases these happenings in the financial markets play a directly causal role in retarding real economic activity. Only by bringing into the analysis additional specifics of the banks' balance sheet, like CD issuance and securities holdings, is it possible to distinguish these two kinds of shocks.

A Noncausal Hypothesis: Default Risk Shocks. While it is entirely plausible that the predictive content of the loan-paper mix and the paper-bill spread reflects a mechanism by which a shock that initially affects the credit markets ultimately affects real output, it is also entirely possible that what underlies the comovement of these variables with real output is not causal at all. Either the mix or the spread may simply fluctuate in anticipation of changes in real activity that occur for independent reasons.<sup>36</sup> From a purely predictive standpoint -- that is, whether the mix or the spread, or both, can serve as leading indicators -- the distinction is moot. If the leading indicator is to play a role in the central bank's formulation of monetary

policy, however, the distinction is not just relevant but important.<sup>37</sup>

Moreover, from the perspective of gaining an understanding of the nature of interactions between the credit markets and real economic activity, evaluation of competing hypotheses is of the essence.

Bernanke (1990) and Friedman and Kuttner (1993) both considered an explanation for the predictive content of the paper-bill spread that implies no causal influence from the credit markets to real activity. In the context of a model like that developed in Section III, this hypothesis can also potentially account for the predictive content of the loan-paper mix (though not of the volume of paper issuance per se). In contrast to the causal hypotheses sketched above, in which the central elements are the non-price costs of borrowing  $\theta_i$ , here the focus is on the lending risks  $\sigma^2$ .

It is well known (and hardly surprising) that bankruptcies and debt defaults vary with the state of overall economic activity. When lenders anticipate that an economic downturn is about to occur, and hence that defaults by borrowers with cyclically sensitive cash flows have become more likely, the greater perceived risk reduces their willingness to advance funds to private borrowers at any given interest rate. Hence measured interest rates on defaultable credits, like bank loans and commercial paper, rise relative to rates on default-free credits like Treasury bills.<sup>38</sup> At the same time, the volume of issuance of defaultable credits declines. If banks are more averse to assuming such risks than are open-market investors, or if banks are more exposed to such risks because open-market obligations are senior to bank loans in the event of bankruptcy, then loan volume will decline by more than paper volume so that the loan-paper mix also declines.

To the extent that investors' anticipations of future economic fluctuations tend on average to be correct, these induced movements in both the paper-bill

spread and the loan-paper mix will predict movements in real output, despite the lack of any causation running from the credit markets to real activity.

Further, if investors' anticipations in this regard embody information from disparate sources (like knowledge of individual companies), or information that is otherwise difficult to quantify or to summarize in a compact way, the spread and the mix will have predictive content even in the presence of standard aggregate variables that conventionally appear in regressions for real output.

Figure 4 illustrates this mechanism in the context of the model presented in Section III. A positive shock to  $\sigma^2$  causes the  $\Delta L^B$  curve to shift inward, increasing  $r_L$  but reducing  $\Delta L$  for a given  $\Delta L^F$  curve. Similarly, greater  $\sigma^2$  causes the  $\Delta P^H$  curve to shift inward, increasing  $r_p$  but reducing  $\Delta P$  for a given curve. In the bill market, greater  $\sigma^2$  causes both  $\Delta B^B$  and  $\Delta B^H$  to shift outward, while  $\Delta B^F$  shifts inward as firms liquidate securities holdings as a means of financing. If the outward shift for banks and households is greater than the inward shift for firms, as shown in Figure 4, the result is to reduce  $r_B$  (for given quantity of bills outstanding and no response from the central bank). Hence the widening of the paper-bill spread is straightforward, but whether "interest rates" rise or fall depends on which rate one has in mind. Whether the loan-paper mix increases or declines depends on the relative responses of  $\Delta L^B$  and  $\Delta P^H$  to  $\sigma^2$ , as well as on relationships among the various elasticities in (6), (9) and (12). (Once again, this inherently sequential verbal description fails to capture the simultaneity of the underlying model.)

This non-causal hypothesis is similar to the two causal ones described above in that all three imply a widening of the paper-bill spread and, under the right conditions, a decline in the loan-paper mix in advance of a decline in real output. At a finer level of detail, however, the different hypothesized shocks bear differing implications for both prices and quantities. On the price

side, a negative monetary policy shock, a negative bank capital shock and a positive default risk shock all imply increases in  $r_L$  and  $r_P$  before a decline in output, but the monetary policy and bank capital shocks imply an increase in  $r_B$  while the default risk shock implies a decrease in  $r_B$ . On the quantity side, all three shocks imply a decline in  $\Delta L$  before a decline in output, but the monetary policy and bank capital shocks imply an increase in  $\Delta P$  while the default risk shock implies a decrease in  $\Delta P$ . At least in principle, these differences should provide a handle by which to distinguish empirically among the various shocks.

Another Noncausal Hypothesis: Cash Flow Shocks. Finally, Friedman and Kuttner (1993) advanced yet another hypothesis to explain the predictive content of the paper-bill spread with respect to real output, and under the right conditions it too is consistent with the observed comovement of real output and the loan-paper mix. The central focus of this hypothesis is the cyclical variation in nonfinancial firms' cash flows. As in the case of shocks to default risk, but unlike either monetary policy shocks or bank capital shocks, prediction here does not necessarily imply causality.

As (5) makes clear, a crucial determinant of nonfinancial firms' financing is the gap between their investment and their net revenues from operations. Either a positive shock to investment (for example, an increase in unintended inventory investment) or a negative shock to revenue -- each of which is hardly atypical as economic activity nears a business cycle peak -- enlarges firms' financing gap and therefore increases their demand for financing from all sources. In Figure 5, a negative shock to net cash flow in this sense (net of investment, that is) causes the  $\Delta L^F$  and  $\Delta P^F$  curves to shift outward (and  $\Delta B^F$  to shift inward). The result is an increase in quantity in both the loan market and the paper market, and an increase in both interest rates:  $\Delta L$ ,  $\Delta P$ ,  $r_L$  and  $r_P$

are all greater. Given the rise in  $r_L$  and  $r_P$ , the  $\Delta B^B$  and  $\Delta B^H$  curves in the Treasury bill market both shift inward along with  $\Delta B^F$ . Hence  $r_B$  rises as well.

Once again, either the imperfect substitutability of commercial paper and Treasury bills or the non-price element of the cost of commercial paper issuance can account for the behavior of the paper-bill spread under conditions of borrower homogeneity. As more firms borrow in the paper market, and in larger amounts, the increasing cost  $\theta_P$  drives a bigger wedge between what borrowers pay and what lenders receive. Hence  $\Delta P^H$  shifts inward (because what is on the vertical axis is just  $r_P$ ) and  $r_P$  rises relative to  $r_B$ . From the standpoint of accounting for the behavior of the loan-paper mix, here, as in the case of a default risk shock, what matters is just the relative elasticities exhibited by the relevant aspects of the portfolio behavior of firms, banks and open-market lenders as specified in (6), (9) and (12), respectively.

Although this analysis of cash flow shocks therefore bears similarities to that of the other shocks considered above, here too there are differences. On the price side, negative cash flow shocks resemble negative monetary policy shocks or negative bank capital shocks, but differ from positive default risk shocks, in implying that  $r_B$  increases along with  $r_L$  and  $r_P$  in advance of a downturn in real output. On the quantity side, negative cash flow shocks differ from any of the other three in implying that both  $\Delta L$  and  $\Delta P$  increase in advance of a downturn. Once again, such differences are the stuff of empirical analysis.

V. Descriptive Evidence on Responses to Financial Shocks

The central advantage of a model like that developed in Section III is the facility that it provides for examining just this kind of distinction between the effects of different kinds of shocks. Given the model, it is straightforward to say (qualitatively) what comovements between financial prices and financial quantities, and between financial variables and nonfinancial economic activity, follow from any given kind of shock. The empirical question is then whether the corresponding comovements actually observed bear out these predictions.

Monetary Policy Shocks. Although the model developed in Section III includes no explicit dynamics, the relationships under discussion there -- including especially the role of balance sheet stocks -- and the responses to different shocks analyzed in Section IV surely stretch out over time. Investigating the interactions that ensue following any given shock therefore requires a dynamic representation. Figure 6 presents impulse response functions summarizing the behavior of a series of four-variable vector autoregressions designed to focus on the behavior of financial prices and quantities (as well as aggregate nonfinancial activity) in response to monetary policy shocks.

In each four-variable system examined in Figure 6, two of the variables are the level of real output (gross domestic product) and the first difference of the corresponding implicit price deflator, and a third is the federal funds rate, taken as an indicator of monetary policy.<sup>39</sup> The fourth variable in each case is the financial price or quantity variable indicated in the corresponding row of Figure 6; each impulse response shown in that row is based on the vector autoregression with that variable as the fourth variable. In each case the figure shows the estimated impulse response and the associated one-standard-error band around it. For purpose of calculating these responses,

the ordering of the orthogonalization always places output the output first, the output price index second, the federal funds rate third, and the financial price or quantity last. Hence any effects attributed to monetary policy shocks are due entirely to those movements in the federal funds rate that are not predictable from past output and prices, and any effects attributed to the financial price or quantity per se are due entirely to that part of its variation not predictable from past output growth, inflation or funds rate movements. Each vector autoregression considered is estimated using quarterly data for 1960:I-1992:IV, with four lags on each variable included.<sup>40</sup>

Figure 6 presents three impulse responses for each such system, designed to answer the following three questions: First, do monetary policy shocks affect real output? Second, do monetary policy shocks affect the specific financial price or quantity indicated? And third, does that financial variable affect real output independently, in the sense of doing more than just reflecting whatever effect monetary policy is having?

As the left-most column of panels in Figure 6 shows, the answer to the first question is clearly yes. No matter what financial price or quantity the system includes, a positive shock to the federal funds rate always depresses real output. Moreover, these estimated effects are significant not only statistically but also economically. In the case of the first panel shown, for example, a 1% increase in the funds rate (again, independent of what past real growth and inflation would predict) depresses the level of real output by about 0.75% after six quarters.<sup>41</sup>

The first system for which impulse responses are shown in Figure 6 includes the paper-bill spread as the fourth variable. As the middle panel in that row shows, the paper-bill spread does rise immediately and sharply in response to a negative monetary policy shock, just along the lines of the discussion of

monetary policy shocks in Section IV, and so there is strong ground for interpreting the spread as a kind of monetary policy indicator as Bernanke, Kashyap et al., and Friedman and Kuttner have all suggested. In addition, however, as the right-most panel in that row shows, fully orthogonalized shocks to the paper-bill spread also depress real output. Hence either the paper-bill spread is capturing aspects of monetary policy shocks not reflected in the federal funds rate, or the spread contains information about effects on real activity due to shocks from other sources. (Either implication is interesting in a monetary policy context.)

In the next system considered, the financial variable included is the spread between the bank loan rate and the commercial paper rate -- in principle, the key relative price that motivates the financing behavior of firms, and hence the resulting effects on real output, in the model of Kashyap et al. Although negative monetary policy shocks do widen the loan-paper spread, as the Kashyap et al. model predicts, they do so only after a sharp initial contrary movement that is presumably due to banks' sluggishness in adjusting their loan rates.<sup>42</sup> The seemingly counterintuitive finding that fully orthogonalized shocks to the loan-paper spread independently stimulate real output (albeit not significantly) is probably a reflection of this initial contrary movement as well.

The next three systems considered in Figure 5 bear on questions of business financing in the sense of (6) above. First, as is suggested in the discussion in Section IV (and also in the analysis of Kashyap et al.), a negative monetary policy shock causes the volume of commercial paper outstanding to increase. In addition, as is consistent with the discussion of either bank capital shocks or business cash flow shocks in Section IV, whatever shock apart from monetary policy is causing commercial paper volume to increase also independently depresses output. Second, in contrast to the analysis of Kashyap et al. (and

the discussion accompanying Figure 3 above), negative monetary policy shocks cause bank loan volume to increase. The independent effect on output due to fully orthogonalized shocks to loan volume is expansionary, however, as anticipated. Third, negative monetary policy shocks do cause firms to draw down their liquid assets, as described in Section IV, and whatever other shocks cause firms to raise their liquid asset holdings (positive cash flow shocks, for example) independently stimulate real output.

The final two systems considered in Figure 5 focus on questions of bank portfolio behavior in the sense of (9). As the discussion of reserve requirements in Sections III and IV suggests, negative monetary policy shocks lead banks to increase their outstanding volume of non-reservable certificates of deposit.<sup>43</sup> Independent shocks to CD volume are expansionary for real output, however, as would be expected. Negative monetary policy shocks also lead banks to reduce their holdings of government securities (roughly mirroring the movements of the opposite direction in their loan portfolios, shown above). Surprisingly, however -- at least in the context of the discussion of capital requirements and associated shocks in Section IV -- positive shocks to banks' securities holdings from sources other than monetary policy stimulate real output.

Bank Capital Shocks. Measuring the adequacy of banks' capital adequacy in a time series context is problematic for two reasons. First, what matters for banks' portfolio decisions, as in (9), is not just how much capital banks hold but how much they hold compared to required benchmarks that have changed substantially over time. Before 1981 bank regulators in the United States imposed a largely discretionary system of capital requirements based on case-by-case comparisons with similar banks. Between 1981 and 1985, the regulators phased in a uniform minimum requirement of 5.5% of assets for

"primary capital" consisting of equity plus loan loss reserves. Beginning in 1989, a new system required a minimum ratio to assets of 3-5%, depending on portfolio composition and expected future growth, for "tier-1 capital," which excludes loan loss reserves and a portion of preferred equity. In 1992 the Basle guidelines further mandated minimum requirements of 4% for tier-1 capital and 8% for tier-2 capital, based not on total assets but "risk-adjusted" assets.<sup>44</sup>

The second difficulty in measuring banks' capital adequacy is that, as the discussion in Section III emphasizes, what matters is not just the amount of capital that banks in the aggregate hold but the distribution of those holdings across individual banks. Apart from mergers and acquisitions, which are typically slow-moving and laborious transactions, there is no market through which a bank with excess capital can transfer that excess to another bank that is deficient. To the authors' best knowledge, there currently exists no publicly available source of time-series data compactly summarizing the adequacy of banks' capital in a way that captures this distributional aspect.<sup>45</sup>

In the absence of any measure that would adequately address these two problems, Figure 7 presents impulse response functions summarizing the behavior of a series of vector autoregression systems that include a simple measure of aggregate U.S. bank capital holdings based on the difference between banks' aggregate assets and liabilities, divided by aggregate bank assets.<sup>46</sup> The strong and consistent effect of monetary policy shocks, not just on output but also on many of the financial variables shown in Figure 6, serves as a warning against proceeding to investigate the effects of other kinds of shocks without also including monetary policy shocks in the analysis. Figure 7 therefore shows impulse responses drawn from a series of five-variable vector autoregressions that are directly analogous to those underlying Figure 6 except that they also

include the logarithm of the aggregate bank capital ratio. The order of orthogonalization in each system is output first, inflation second, monetary policy (the federal funds rate) third, the capital ratio fourth, and whatever specific financial price or quantity the system includes fifth. Each vector autoregression considered is estimated using quarterly data for 1974:I-1992:II, with three lags on each variable included.

Because these systems show little evidence that shocks to bank capital independently affect output, Figure 7 shows only the effects of bank capital shocks on specific financial prices and quantities and the fully orthogonalized effects of those prices and quantities on output (corresponding to the impulse responses shown in the middle and right-hand portions of Figure 6). When the system's fifth variable is the paper-bill spread the effect of a negative bank capital shock is to widen that spread, as the discussion in Section IV predicts, but the effect is not statistically significant. By contrast, the negative effect on the loan-paper spread is directly inconsistent with what the analysis of bank capital shocks in Section IV implies. Here each spread has significant predictive power with respect to real output, even with the spread placed after the federal funds rate and the bank capital ratio in the orthogonalization.

Negative shocks to bank capital lead to an initial small decline but then, as the discussion in Section IV predicts, an increase in nonfinancial firms' issuance of commercial paper. What is strikingly at odds with the Section IV discussion, however, is that negative bank capital shocks lead to an increase in bank lending. This result presumably reflects the inadequacy of the simple capital-to-asset ratio as discussed above. (Bank loans are a major component of bank assets.) The finding that negative bank capital shocks mostly cause firms to increase their holdings of liquid assets is also inconsistent with the discussion in Section IV. The positive effect on banks' CD issuance and the

negative effect on banks' holdings of government securities are not directly inconsistent with a role for bank capital shocks as described in Section IV, but they may also be due to the simultaneity problem inherent in using the capital-to-assets ratio in this context.

Default Risk Shocks. Figures 8 and 9 present results bearing on the default risk hypothesis, as described in Section IV, by showing impulse responses from a further series of five-variable vector autoregressions that are analogous to those underlying Figure 7 except that the variable that is included in the autoregression and ordered fourth in the orthogonalization is not the bank capital ratio but the spread between the respective interest rates on P2-rated and P1-rated commercial paper. Here the sample used to estimate each autoregression is 1975:I-1992:IV. The autoregression includes three lags on each variable.

Figure 8 plots three impulse responses that are similar in all these systems, regardless of which financial price or quantity is the fifth variable, showing as an example the specific results only from the system that includes the paper-bill spread. First, negative monetary policy shocks depress real output in the presence of the P2-P1 spread, just as was the case in Figure 6 based on the four-variable systems. Second, negative monetary policy shocks also cause the P2-P1 risk spread to widen (presumably because a weakening of real economic activity makes defaults more likely). Third, positive default risk shocks -- that is, a widening of the P2-P1 spread that is not predictable from real growth, inflation or monetary policy -- at first depress output but then, after five or six quarters, are followed by a rise in output (presumably reflecting the nonfinancial economy's usual cyclical properties). Although Figure 8 shows the specifics for only one system, these three responses are characteristic of all of the five-variable systems that include the P2-P1 spread

as the fourth variable.

As Figure 9 shows, when the system's fifth variable is the paper-bill spread, the effect of a positive default risk shock is at first slightly to widen the paper-bill spread but then, surprisingly, to narrow it. This response is directly inconsistent with the account of the default risk hypothesis given in Section IV. It is interesting, however, that the predictive power of the paper-bill spread with respect to real output disappears when, as here, shocks to that spread are orthogonalized with respect to both monetary policy and default risk. Positive default risk shocks briefly widen the loan-paper spread, after an initial delay, but this response by itself neither supports nor disconfirms an empirically relevant role for default risk shocks as described in Section IV.

The results in terms of financial quantities are generally more supportive of a role for default risk shocks. After an initial delay, positive default risk shocks reduce the outstanding volume of commercial paper, and they reduce the volume of bank loans beginning right away. They also cause firms to build up their holdings of liquid assets. Positive default risk shocks also cause banks to cut back on their issuance of CDs and to favor government securities in their asset portfolios.

Cash Flow Shocks. As is clear from (5) and (6), what firms need to finance is the gap between their investment and their net revenues. Either a positive shock to investment (in unintended inventories, for example) or a negative shock to net revenues creates a greater need for financing. Figures 10-12 provide evidence on the cash flow shocks hypothesis of Section IV by presenting results that are analogous to those shown in Figures 8 and 9 except that here the variable that is included in the vector autoregression and ordered fourth in the orthogonalization is either inventory accumulation or corporate earnings. Here

the sample used is 1960:I-1992:IV, and the autoregressions include four lags on each variable.

When the measure of cash flow shocks is inventory accumulation, the results of these investigations are mostly supportive of an empirical role for cash flow shocks as described in Section IV. As the upper panels of Figure 10 show, using the system with the paper-bill spread to illustrate a result that appears in all of these systems, negative monetary policy shocks (again represented by the federal funds rate) at first increase but then depress firms' inventory holdings, while positive inventory shocks (orthogonalized with respect to output, inflation and the federal funds rate) depress subsequent real output. As Figure 11 shows, positive inventory shocks also widen the paper-bill spread, increase the volume of commercial paper, and lead firms to reduce their liquid asset holdings, all as predicted in Section IV. Interestingly, bank loan volume at first does not respond when there is a positive inventory shock, and then declines (perhaps because investment itself subsequently declines). It is also interesting that most of these financial price and quantity variables retain their predictive power with respect to output, even when they are placed after both the federal funds rate and inventory movements in the orthogonalization. Banks' CD volume does not respond significantly to inventory shocks, but banks' holdings of government securities decline.

As the lower panels of Figure 10 illustrate, again using as an example the system including the paper-bill spread, negative monetary policy shocks depress firms' earnings, while independent earnings shocks depress subsequent output but not significantly. As Figure 12 shows, both the paper-bill spread and the loan-paper spread at first widen (as predicted) and then narrow when a negative earnings shock occurs, and commercial paper volume increases (also as predicted) for three quarters. Surprisingly, negative earnings shocks cause bank loan

volume to decrease. As expected, in the face of negative earnings shocks firms reduce their holdings of liquid assets. Banks' reduced CD issuance is consistent with the reduced need to fund in lending, and there is also a (mostly not significant) decrease in banks' government securities holdings.

Overview. Several broad conclusions emerge from this inspection of descriptive results on financial market behavior and real output changes in response to specific kinds of shocks. First, the evidence is broadly supportive of an empirical role for monetary policy shocks not only in affecting real output (that much is well known already) but also in accounting for movements of financial variables like the paper-bill spread and the volume of commercial paper that systematically vary in anticipation of real output fluctuations. Other aspects of these descriptive results are also consistent with what the model developed in Section II implies about how the financial markets respond to monetary shocks. Even so, these results do not support the view that the role of the paper-bill spread as a monetary policy indicator accounts for the entirety of its predictive content with respect to real output.

Second, these exercises provide little evidence to support a role for shocks to bank capital positions in accounting for the comovements of financial prices and quantities, and of nonfinancial economic activity, that are under study here. As the discussion above indicates, however, this negative finding may simply be due to the absence of a satisfactory time series that not only measures aggregate bank capital in comparison to changing capital requirements but also reflects the distribution of banks' capital within the aggregate.

Third, the evidence is broadly supportive of an empirical role for default risk shocks in explaining observed comovements between financial prices and quantities and nonfinancial activity.

Fourth, the evidence is also broadly consistent with an empirical role for

cash flow shocks in explaining these comovements, especially when the measure of such shocks is firms' inventory accumulation but also when the measure used is firms' earnings.

Finally, as is the case for the much simpler exercises reported in Section II, which are informative but have no interpretation of specific shocks in the context of a behavioral model, the results presented here warn against relying heavily on bank-centered variables (most obviously, loan rates and loan volumes) or narrowly bank-centered explanations to capture relationships between the financial markets and nonfinancial economic activity. In part this may be due to the well known inability to measure loan interest rates accurately. But the evidence assembled here, viewed as a whole, also strongly suggests that other short-term credit markets like the commercial paper market play a role in these financial-nonfinancial relationships that is worth explicitly bringing into the analysis.

## VI. Structural Estimates of Key Relationships

Estimating a full-blown empirical counterpart to the model developed in Section III, with all relevant simultaneities taken into account, is a task that clearly lies beyond the scope of this paper. Even so, it is useful at least to examine on a one-by-one basis "structural" estimates of several of the relationships in (6), (9) and (12) that are particularly central to the analysis of the different kinds of shocks considered in Sections IV and V. The question at issue is whether there is empirical support for assuming that these shocks cause specific behavioral relationships to shift in the way illustrated in Figures 3, 4 and 5.

Table 4 presents estimates of four portfolio relationships that play pivotal roles in the model's story of how different shocks affect the financial markets and, through the resulting financial price and quantity effects, nonfinancial economic activity. Each equation is individually estimated twice, once by ordinary least squares and once by two-stage least squares, with quantities  $\Delta P$  and  $\Delta L$ , prices  $r_P$ ,  $r_L$  and  $r_B$ , and inventory investment taken to be endogenous.<sup>47</sup> The set of instruments used for the two-stage estimation includes all exogenous variables that appear in any of the four equations, together with all endogenous variables (or transformations of endogenous variables) that appear as lagged variables. Estimates are based on quarterly data for 1975:I-1992:IV. In addition to the variables indicated in the table, each equation also includes a constant, a time trend, and two dummy variables to allow for the imposition of credit controls in 1980:II and the tax code change at 1986:IV/1987:I. The numbers shown in parentheses below the estimated coefficients are the corresponding t-statistics corrected for heteroskedasticity and for fourth-order moving-average serial correlation.

Firms' Financing. Panel A of Table 4 shows results for the change in

nonfinancial firms' outstanding bank loans,  $\Delta L^F$ , normalized by dividing by the lagged outstanding stock of loans plus commercial paper. The estimated coefficients are, with only one exception, in line with the presumptions indicated in Section III and reflected in the discussion in Section IV. In terms of price effects, a wider loan-paper spread reduces firms' bank borrowing. Including the commercial paper rate independently of the spread shows that while the respective coefficients on the loan rate and the paper rate are of opposite sign, they are not equal in magnitude. In terms of quantity flow effects (normalized like the dependent variable), greater inventory accumulation increases firms' bank borrowing as in Figure 5, at the rate of nearly 50 cents per dollar in the two-stage least squares estimate.<sup>48</sup> In terms of quantity stock effects, a greater share of bank loans in firms' existing short-term liabilities reduces their incremental bank borrowing, although this estimated effect is only marginally significant even in the two-stage estimate. The one exception to the presumptions of Sections III and IV is that greater earnings do not reduce firms' bank borrowing. (The point estimate for this coefficient is even positive, but it is not statistically significant.) The contrast between inventories and earnings in this regard parallels the differences in the analysis of impulse responses reported in Section V.

Panel B shows analogous results for the change in nonfinancial firms' outstanding commercial paper,  $\Delta P^F$ , again normalized by dividing by the lagged outstanding stock of short-term liabilities. In contrast to the results shown above for bank borrowing, issuance of commercial paper displays no discernible response to the loan-paper spread, and the estimated effect of the paper rate has the "wrong" sign. Even in the two-stage procedure, the estimation has presumably failed to identify supply versus demand in this respect.<sup>49</sup> Greater inventory accumulation does increase firms' paper issuance, by 16 cents on the

dollar. Unlike in the case of bank loans, greater earnings reduce firms' paper issuance, by 21 cents on the dollar. The lagged balance sheet stock effect also has the expected sign, and the coefficient is both statistically and economically significant.

Bank Lending. Panel C of Table 4 shows results for the change in banks' outstanding business loans.<sup>50</sup> Comparison to Panel A shows that, in terms of price effects, even the two-stage procedure has again failed to distinguish demand and supply behavior. In other respects, however, the results are in line with the presumptions of Sections III and IV. Expansionary monetary policy, here represented by a greater level of nonborrowed reserves relative to total reserves,<sup>51</sup> leads banks to increase their lending as in Figure 3. Specifically, a .01 increase in the nonborrowed reserve ratio (about equivalent to a half-billion dollar open market operation at 1993 levels) causes banks to increase their loans by .24% relative to outstanding liabilities (or about \$7 billion at 1993 levels) on an annualized basis, although this effect appears to take the form of a change effect. An increase in the default risk associated with business obligations, represented by the P2-P1 spread, reduces banks' lending as in Figure 4. An increase in banks' capital adequacy, again represented by the simple aggregate capital-to-assets ratio used in Section V but here lagged to avoid at least some of the obvious simultaneity, increases banks' lending.<sup>52</sup> The lagged balance sheet composition also has the expected effect.

Households' lending. Panel D of Table 4 shows results for the change in open-market investors' holdings of commercial paper plus certificates of deposit. The demand for commercial paper and CDs depends positively on the paper-bill spread, as expected, and the magnitude of this effect is greater in the two-stage estimate. Inclusion of the paper rate separately again shows that

the respective coefficients on the paper rate and the bill rate are of opposite sign but not equal magnitude. Greater perceived default risk, again represented by the P2-P1 spread, reduces investors' demand for paper and CDs as in Figure 4.<sup>53</sup> The balance sheet stock variable also exhibits the expected effect.

Overall, the four sets of results shown in Table 4 provide further support for thinking about the effects of different kinds of shocks along the lines described in Section IV. Not very surprisingly, these estimated relationships do not always pin down price effects -- that is, the slopes of the curves drawn in Figure 3-5. The equations describing firms' financing decisions, for example, suggest that bank borrowing responds strongly to the relative cost of loans and commercial paper, while paper issuance does not. On the other side of the market, investors' demand for commercial paper bears the expected relationship to relative financial prices, but banks' lending does not. By contrast, these equations do indicate that the kinds of shocks hypothesized in Section IV to shift the curves in Figures 3-5 actually do so, and that such shifts are both statistically significant and of a magnitude to be economically relevant. Further, here the relative magnitudes are also informative. For example, the respective responses of firms' commercial paper issuance and bank borrowing to changing cash flows are not just mirror images of one another, in that inventory accumulation dominates bank borrowing while earnings fluctuations play a greater role in paper issuance.

## VII. Analyzing the 1988-92 Credit Slowdown

What, then, caused the dramatic slowdown in lending that took place in the U.S. credit markets during 1989-92? And to what extent did the factors underlying the credit slowdown play a role in bringing on the 1990-91 business recession, or the unusually sluggish business recovery that has followed?

Figure 13 illustrates the unusual character of the recent slowdown in short-term business credit extensions by plotting the quarterly net increase in the two categories of lending that are the main focus of the model in Section III and the empirical investigations in Section V and VI: commercial and industrial loans at banks, and commercial paper issued by nonfinancial businesses (scaled in each case by dividing by the sum of loans and paper outstanding at the end of the previous quarter). Especially for bank loans, the experience from late 1989 onward was quite extraordinary. In the fifteen years before 1990, bank loan contraction was limited to a few isolated quarters, like the credit control episode in 1980 and the time of the tax law change at yearend 1986.<sup>54</sup> By contrast, the outstanding volume of bank loans shrank steadily throughout 1991-92. Net issuance of commercial paper was also negative for a sustained period from late 1990 to early 1992, although this phenomenon does not represent such a sharp contrast with previous experience.

Figure 14 plots the independent innovations, during 1986-92, in four variables used above to represent the four different shocks analyzed in Section IV: monetary policy (the federal funds rate), bank capital (the capital-assets ratio), default risk (the P2-P1 spread), and business cash flows (inventory accumulation). Each series of innovations is extracted from a distinct vector autoregression system analogous to those described in Section V. The federal funds rate innovations are from a system including output growth, inflation, the federal funds rate and bank loans (normalized by the lagged stock of loans plus

paper), orthogonalized in that order. The capital ratio innovations are from the system including output, output prices, the federal funds rate, the capital ratio and bank loans, orthogonalized in that order. The P2-P1 spread innovations and the inventory innovations are from systems analogous to that used for the bank capital innovations, but with either the spread or inventory accumulation used as the fourth variable. The sample used to estimate the underlying autoregressions is 1975:I- 1992:IV (1975:I-1992:II in the case of the system including the capital ratio). The dotted lines plotted for each series indicate one-standard-deviation bands.

Given the response patterns predicted in Section IV and (to a greater or lesser extent, depending on the specific variable in question) documented empirically in Sections V and VI, several of the innovation series shown in Figure 14 constitute potentially contributing factors behind the slowdown in bank lending. Monetary policy shocks were mostly positive (that is, contractionary) during this period, albeit also mostly small except in early 1987. Bank capital shocks were sharply negative in 1987 and again in late 1989, but sharply positive in between (and also at the very end of 1992). Default risk shocks were very sharply positive in late 1990. Inventory shocks varied substantially, but never much exceeded one standard deviation.

Figure 15 plots the cumulative effect on outstanding bank loans attributable to each of these four series of innovations.<sup>55</sup> Because each innovation from Figure 14 and therefore each cumulative effect shown here is based on a separate autoregression system, it is not legitimate to "add up" these effects as if they were consistently estimated components of a unified explanation of the lending slowdown. Nonetheless, the results are at least intuitively informative. Especially for 1991-92, the period of sharpest decline in outstanding loans (see again Figure 13), these results point to bank capital

shocks, default risk shocks and cash flow shocks as all having played a noticeable role. By contrast, the effect of monetary policy shocks was to increase bank lending throughout this period.

Figure 16 plots the cumulative effect on output attributable to the same four series of innovations. Here monetary policy shocks do play a major role in accounting for the generally slow growth of real output beginning in 1989. Default risk shocks are also especially important during the recession that, according to the official NBER chronology, began in July 1990 and ended in March 1991. It is interesting that bank capital shocks, which did play a role in the 1990-92 credit slowdown as shown in Figure 15, had no discernable independent effect on real output throughout this period.<sup>56</sup> Nor did inventory accumulation.

Repeating this set of exercises with the focus on commercial paper in place of bank loans yields broadly similar results.<sup>57</sup> The most interesting difference is that when the autoregression system's final variable is commercial paper, the estimated effect on real output attributable to default risk shocks is even greater than shown in Figure 16. In the trough quarter of the recession, for example, the contribution of default risk to the annualized growth rate of real output is -4.5%, rather than -3.3% as shown in the second panel of Figure 16.

#### VIII. Summary of Empirical Conclusions

The overall goal of this paper is to move the focus of the rapidly growing "credit view" analysis of financial-nonfinancial interactions, and especially the empirical aspects of that analysis, toward a perspective that explicitly incorporates both financial prices and financial quantities. The model of the short-term credit markets provided here shows how both financial prices and financial quantities can bear on nonfinancial economic activity. It also shows that at least the qualitative aspects of observed relationships among financial prices, financial quantities and real activity can be explained in a fairly straightforward way, once the conceptual framework used for the analysis is broad enough to encompass the relevant credit market phenomena.

Because a key element of this model (non-price costs of borrowing) is not readily observable, and also because the task would lie beyond the scope of this paper in any case, the empirical analysis here stops short of estimating a fully specified version of the model that stands behind the paper's qualitative analysis. Even so, the several levels of empirical investigation carried out in the paper -- single-equation estimation, examination of impulse responses from estimated vector autoregressions, and simultaneous-equation estimation of specific structural relationships -- lead to specific findings that, for the most part, reinforce one another.

First, financial price variables and financial quantity variables both have predictive power with respect to real economic activity. Moreover, the predictive content of financial prices and financial quantities, respectively, is not identical. The two dimensions of what is happening in the credit markets contain at least partly independent information about subsequent fluctuations of real output. Among financial prices, much of that information is contained in relative interest rate relationships like the paper-bill spread

or the P2-P1 quality spread.

Second, monetary policy plays an important role in affecting both the credit markets and nonfinancial economic activity. Monetary policy shocks systematically shift behavioral relationships that are central to financial effects on nonfinancial activity. They also account for part of the predictive power of financial price and quantity variables with respect to real output. Variables like the paper-bill spread also have predictive content with respect to real output that is beyond what can readily be ascribed to their role as indicators of monetary policy, however. In the most recent experience in the United States, tight monetary policy appears to have been important in accounting for the slow growth of real output, but not the slowdown in credit per se.

Third, shocks to banks' capital positions also appear to have significant effects on financial variables, albeit not discernably beyond the financial markets. An important limitation here, however, stems from the conceptual shortcomings of the time series used in this paper as a measure of capital adequacy.

Fourth, changing perceptions of the risk of default on business liabilities also systematically shift the behavior of lenders in the credit market, and these shifts in turn affect key financial quantity variables like the volumes of financing done in various short-term markets. The evidence also suggests that these shifts in turn importantly affect both financial price relationships and nonfinancial activity. In the most recent experience, an increase in perceived default risk appears to have been an important factor underlying the credit slowdown as well as the business recession.

Fifth, effects arising from business firms' nonfinancial activities -- their inventory accumulation and their operating earnings -- shift their

financing behavior, and these shifts also affect both prices and quantities in the short-term credit markets. Firms' inventories and earnings not only respond to monetary policy, and hence act as a vehicle for conveying the effect of monetary policy shocks to the demand side of the short-term credit markets, but also have effects on these markets independently of monetary policy.

Finally, a consistent result running throughout this paper's empirical analysis is that the observed movements of either price or quantity variables defined specifically with respect to the banking system (interest rate spreads involving the bank loan rate, for example, or in some cases the volume of bank lending) bear a weaker correspondence to prior expectations than do the movements of analogous variables defined with respect to the credit markets more broadly (for example, spreads involving the commercial paper rate, or the volume of commercial paper issuance). This finding is certainly not inconsistent with a "credit view" perspective, but it does caution against centering any credit view analysis narrowly on the role of the banking system.

Footnotes

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1. Wojnilower (1992) has made this point as well.
2. Tobin was an early advocate of assigning a central role to inside agents' balance sheets in this context. See, for example, Model III in Tobin (1969) and the overview provided there.
3. See Duesenberry (1957) for a statement of early views to this effect. More recent empirical contributions in this vein include Fazzari et al. (1988), Gertler and Gilchrist (1992) and Oliner and Rudebusch (1992).
4. Anderson (1964) first made this point in the context of firms' holdings of liquid assets. A recent example of a model in which liquid assets held matter for investment decisions is Whited (1991).
5. See, for example, Jensen and Meckling (1976), Stiglitz and Weiss (1981) and Myers and Majluf (1984). Greenwald and Stiglitz (1988) provided a useful summary of many of these lines of research.
6. See, for example, Bernanke and Blinder (1988), Bernanke and Gertler (1989) and Romer and Romer (1990).
7. See, for example, Wojnilower (1980), Eckstein and Sinai (1986), Owens and Schreft (1992) and the earlier references given in those papers.
8. See again Stiglitz and Weiss (1981).
9. Data for industrial production, the price level, and all money or credit aggregates, are seasonally adjusted. Data for interest rates are not.
10. Previous research going back to Sims (1980) has emphasized the criterion of significance even in the presence of the interest rate. When a regression like (1) does not include an interest rate regressor, other variables may be significant merely because they proxy for the effect of interest rates.
11. Kuttner (1992) reported similar results for analogous tests based on quarterly data.
12. Because considerations of stationarity dictate entering either the paper rate or the bill rate separately in differences, but the spread in levels,

the form of the constraint here is

$$\begin{aligned}\theta_1 + \phi_1 &= 0 \\ \theta_2 + \phi_2 - \phi_1 &= 0 \\ &\vdots \\ \theta_6 + \phi_6 - \phi_5 &= 0 \\ &\vdots \\ \theta_7 - \phi_6 &= 0\end{aligned}$$

where the  $\theta_i$  and  $\phi_i$  are the distributed lag coefficients on the spread and on the bill rate, respectively. Friedman and Kuttner (1993) reported a similar result.

13. Even with these markets and three kinds of private-sector agents, however, this model can account for the observed interactions in only limited ways. For example, because there is no market for long-term assets or liabilities, the entire "term structure" dimension of portfolio choice is omitted. There is also no role here for international aspects of even the short-term markets. A companion paper, currently in progress, expands the model by further distinguishing between nonfinancial firms that can borrow in the open market and those that cannot, and introducing credit advances between them (trade credit).
14. A more realistic model would reflect the fact that nonfinancial firms also typically hold deposits and sometimes issue long-term debt, and that some firms' equity value reflects "good will" as an asset. Adding deposits to the left-hand side of (3) and expanding (6) to include an additional portfolio equation would make the model more complex but does not seem to provide any further analytical insights. Doing the same for long-term debt on the right-hand side of (3) would introduce a variety of potentially interesting substantive issues, but for the most part they lie well beyond the scope of this paper. Assets like "good will" are also beyond the scope of this paper.
15. In principle, issuance of equity securities is another potential source of funds for nonfinancial firms. In practice, most U.S. firms are more likely to retire equity securities than to issue more, and aggregate net issuance of equity by nonfinancial business corporations has been negative in most years since World War II. Expanding the model to include a market for corporate equities (as either a source or a use of funds) would raise many questions that lie beyond the scope of this paper.
16. See Theil (1971), Ch.11, for a discussion of aggregation and the familiar "representative agent" model. Here as elsewhere, a genuinely plausible description of the relevant behavior is unlikely to satisfy the standard aggregation conditions.

17. More specifically, these balance sheet stocks will enter the equations describing firms' behavior if the firm itself is responsive to such considerations as the risk of bankruptcy or the volatility of its net revenues. By contrast, if the banks and other investors who hold the firms' securities are sensitive to these matters but the firms themselves are simply present value maximizers, then firms' balance sheet stocks will affect their behavior indirectly via the market-determined rates of return on their obligations, but balance sheet stocks would not appear directly as arguments of the equations describing the firms' behavior.
18. The argument here is analogous to that made explicitly, just below, about the role of capital in banks' behavior.
19. The resulting solution would presumably be of the Kuhn-Tucker form.
20. In parallel to the treatment of nonfinancial firms above, the model developed here assumes that banks cannot raise capital by issuing new equity within the period; see again footnote 15.
21. The practice of treating the quantity of reserves as a direct argument of the deposit supply function, on the ground that banks have a target level of free reserves for given levels of interest rates, is standard in the literature of money supply; see, for example, Meigs (1962) and Modigliani et al. (1970). The parallel treatment here of bank capital follows the reasoning set forth by Brainard (1964).
22. Representing certificates of deposit as a distinct asset in investors' portfolios would again make the model more complex without adding insight that is directly relevant here.
23. Modeling not only firms' borrowing and capital spending but households' borrowing and accumulation of nonfinancial assets too would add little in the context of this model. Open-market investors like pension funds and insurance companies do little free-standing borrowing, and their holdings of nonfinancial assets are also limited.
24. See again footnote 16.
25. See again, for example, Bernanke (1983), Bernanke and Gertler (1986) and Gertler and Gilchrist (1992). For a summary of the earlier literature treating bank customer relationships, see Hodgman (1961).
26. Since  $\theta_L$  represents a marginal cost of borrowing, for  $\theta_L$  to increase with  $L$  and  $\Delta L$  requires that fees and other charges rise more than in proportion to the volume of lending.
27. To the extent that part of the charges making up either  $\theta_L$  or  $\theta_P$  merely serve to cover some entity's direct expenses associated with a specific transaction, it presumably does not matter whether that expense is incurred by and reimbursed to a bank or, for example, a rating agency or a securities dealer. For purposes here, however, both  $\theta_L$  and  $\theta_P$  are to be interpreted as net of such direct expenses, and hence as profit to some

entity involved in the transaction.

28. Some of the non-interest costs of issuing commercial paper, like the cost of establishing a dealer relationship, are mostly one-time costs. More paper being issued by the same firms that have always issued paper therefore has a different implication than does more paper being issued because there are new issuers. An aggregate relationship like (14) necessarily blurs this distinction.
29. Whether or not investment is co-determined with net revenues, so that the financing gap I-NR is a jointly determined variable in (6), is a matter of time lags.
30. Bernanke (1990) also argued along these lines.
31. As Friedman and Kuttner (1993) explained, the differential tax treatment of Treasury bills and commercial paper can account for some widening of the paper-bill spread as interest rates in general rise, but they also showed that the part of the variation of the spread not accounted for in this way also has predictive content with respect to real output.
32. Moreover, the paper-bill spread systematically widens in these circumstances even when, as in the results presented in Section I and in Friedman and Kuttner (1992, 1993), the paper rate is calculated from issues of P1-rated issuers only. Hence the heterogeneity at work would have to be within the P1-rated subset of firms.
33. Nonfinancial corporations do not normally place their own commercial paper.
34. See, for example, Syron (1991).
35. See Baer and McElravey (1993) for a detailed account of the Basle standards and a brief but comprehensive history of previous bank capital requirements in the United States.
36. The distinction at issue here is the same as that highlighted by Tobin (1970) in a different context.
37. See, for example, Friedman (1990).
38. Measured interest rates on defaultable securities would rise relative to default-free rates even if lenders were risk neutral, because the expected gross return equals the quoted gross interest rate times the probability of payment. The increase will, of course, be greater when lenders are risk averse.
39. Bernanke (1990), Bernanke and Blinder (1992) and other researchers have had empirical success using the federal funds rate as a monetary policy indicator. See Sims (1992), however, for arguments against identifying funds rate innovations as monetary policy shocks.
40. To use data from the entire 1960-92 sample for this purpose is to ignore the many changes in market structures, business practices and government policies that have taken place during this period. Which if any such

changes have amounted to a structural break in the context of the models estimated here is an interesting question, but one that lies well beyond the scope of this paper. See Akhtar and Harris (1987), Bosworth (1989), Friedman (1989) and Mauskopf (1990), for example, for analyses along those lines in the specific context of monetary policy.

41. Not surprisingly, this effect is more muted in samples restricted to the period after Regulation Q interest ceilings ceased to be effective. For example, in the 1975-92 sample used in Section VII to investigate the most recent experience, a 1% increase in the federal funds rate depresses real output by 0.33% after eight quarters.
42. This delay could explain part of the timing pattern observed by Romer and Romer (1990).
43. Not surprisingly, this effect is stronger in post-Regulation Q samples (see again footnote 41). In the 1975-92 sample, the maximum effect on CD issuance is 1.8% and highly significant, in contrast to the marginally significant 1.2% at the maximum as shown in Figure 6.
44. See again Baer and McElravey (1993) for a comprehensive review.
45. In separate research, the authors are currently constructing such a measure by applying the cross-section regression approach of Baer and McElravey (1993) to the full set of individual-bank call report data available for each quarter since 1976.
46. Data are from Table 1.25 in the Federal Reserve Bulletin. The relevant series are available on a consistent basis beginning in 1973:I and ending (as of the time of writing) in 1992:II. The difference between assets and liabilities is not identical to equity capital as defined in the call reports, but it is conceptually similar and it is also quantitatively similar to the aggregate equity capital from the call reports as given in Special Table 4.22 in occasional Bulletins.
47. Because each equation is individually estimated, the estimates are not as efficient as they would be if the four equations were estimated jointly as a single system. In addition, because only four equations are estimated, instead of the ten included altogether in (6), (9) and (12), these estimates do not exploit the relevant cross-equation restrictions.
48. Allowing for the joint determination of firms' inventory accumulation and bank borrowing by treating inventories as endogenous for purposes of the two-stage estimation further raises the estimated coefficient to .665.
49. An alternative explanation is that when interest rates rise firms' financing requirements increase for reasons not otherwise captured by the equation's independent variables.
50. Because this equation includes the lagged bank capital ratio, the sample extends only through 1992:III (see again footnote 46).
51. The ratio of nonborrowed reserves to total reserves -- or, equivalently, one minus the borrowed reserve ratio -- is a standard indicator of monetary

policy that is usually assumed to be closely related to the federal funds rate. Using the funds rate directly to represent monetary policy shocks, as in the impulse response analysis in Section V, seemed to be a poor idea here in light of the presence in the equation of the loan rate and the paper rate.

52. This result is especially noteworthy in that the simple correlation between the aggregate capital ratio and bank lending is negative, and the impulse response for bank lending shown in Figure 7 also has the unexpected sign.
53. One way to gauge intuitively the magnitude of the effect of greater default risk is to renormalize the equation so that the paper-bill spread is the dependent variable and investors' net purchases of commercial paper is an (endogenous) independent variable. Estimating the equation in this inverted form indicates that a given widening of the P2-P1 spread widens the paper-bill spread by an approximately equal magnitude.
54. Bank loans also contracted during the 1974-75 recession.
55. The computation takes account of the entire past history of each innovation (since 1975:I), not just the series beginning in 1986:I.
56. See again, however, the discussion in Section V of the inadequacy of the simple capital-to-assets ratio for purposes of this paper. The more satisfactory time series that the authors are constructing from the call report data, using the method of Baer and McElravey (1993), may yield different results.
57. These results, in a form comparable to Figures 14-16, are not shown here but are available from the authors on request.

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**Table 1**

F-Statistics for Alternative Financial Indicators  
in Real Output Equations

	Sample period:		
	60:1-92:12	60:1-79:9	73:6-92:12
Base	1.26	0.62	1.01
M1	1.98*	1.36	1.54
M2	3.27***	3.42***	1.05
Debt	1.07	0.84	0.31
Paper-Bill spread	7.49***	3.65***	6.64***
Nonfinancial paper	3.02***	1.31	6.56***
Total paper	3.32***	3.57**	2.49**
Loans			0.86
Mix			2.13*

\* Significant at the 10% level

\*\* Significant at the 5% level

\*\*\* Significant at the 1% level

Notes: The regressions are based on monthly data for the sample indicated, six lags of each included variable. Analogous results using twelve lags are similar except for M2, which is not significant in the full sample, and Total paper, which is not significant in the post-1973 sample.

**Table 2**  
**F-Statistics for Quantity Variables**  
**In Combination with the Paper-Bill Spread**

	Spread	Quantity variable
Base	6.33***	0.87
M1	5.81***	0.93
M2	6.16***	0.76
Debt	6.65***	0.47
Nonfinancial paper	5.62***	5.54***
Total paper	5.82***	1.85*
Loans	6.58***	1.02
Mix	5.97***	1.71

- \* Significant at the 10% level
- \*\* Significant at the 5% level
- \*\*\* Significant at the 1% level

Notes: The regressions are based on monthly data for the 73:6–92:12 sample, six lags of each included variable. Analogous results using twelve lags are similar except for Total paper, which is not significant, and the mix, which is significant at the 10% level.

**Table 3**  
Performance of Mix and Paper-Bill Spread Components

Regressions with financial flows

	Sum of coefficients	<i>F</i> -statistic
Separate paper and lending terms:		
Weighted $\Delta$ commercial paper	-0.82**	2.49**
Weighted $\Delta$ bank lending	-0.38	1.24
Mix and paper terms:		
$\Delta$ mix	-0.38	1.48
Weighted $\Delta$ commercial paper	-1.21	1.86*

Regressions with interest rates

	Sum of coefficients	<i>F</i> -statistic
Separate paper and bill rate terms:		
$\Delta$ paper rate	-1.23*	2.99***
$\Delta$ bill rate	1.01	2.98***
Spread and paper rate terms:		
Paper-Bill spread	-0.85***	6.03***
$\Delta$ paper rate	-0.08	3.10**
Bill constraint	...	6.05***

- \* Significant at the 10% level
- \*\* Significant at the 5% level
- \*\*\* Significant at the 1% level

Notes: The regressions are based on monthly data for 1973:6 through 1992:12, six lags of each included variable.

**Table 4**

Estimates of structural relationships in the short-term credit market

## (A) Bank borrowing by nonfinancial corporations

---

Ordinary least squares:												
$\Delta L^F = -0.030$	$(r_L - r_P) +$	$0.021$	$r_P +$	$0.386$	$\Delta INV +$	$0.261$	$\Delta NR -$	$0.738$	$MIX(-1)$	SE	DW	
(2.44)		(5.81)		(2.24)		(1.41)		(1.15)		0.064	1.36	
Two-stage least squares:												
$\Delta L^F = -0.043$	$(r_L - r_P) +$	$0.020$	$r_P +$	$0.471$	$\Delta INV +$	$0.116$	$\Delta NR -$	$1.513$	$MIX(-1)$	SE	DW	
(2.36)		(4.25)		(2.67)		(0.57)		(1.95)		0.064	1.40	

---

## (B) Commercial paper issuance by nonfinancial corporations

---

Ordinary least squares:												
$\Delta P^F =$	0.004	$(r_L - r_P) +$	0.007	$r_P +$	0.163	$\Delta INV -$	0.211	$\Delta NR +$	0.636	MIX(-1)	SE	DW
	(0.57)		(4.82)		(2.98)		(1.99)		(2.30)		0.031	2.04
Two-stage least squares:												
$\Delta P^F =$	0.003	$(r_L - r_P) +$	0.007	$r_P +$	0.158	$\Delta INV -$	0.212	$\Delta NR +$	0.623	MIX(-1)	SE	DW
	(0.19)		(3.00)		(2.71)		(2.15)		(1.84)		0.031	2.00

---

Table 4 (continued)

## (C) C&amp;I lending by U.S. chartered commercial banks

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Ordinary least squares:															
$\Delta L^B = -0.008$	$(r_L - r_P)$	$+ 0.009$	$r_P$	$+ 0.169$	$NBR$	$- 0.185$	$NBR(-1)$	$- 0.205$	$LA(-1)$	$- 0.038$	$RISK$	$+ 3.567$	$KA(-1)$	SE	DW
(3.90)		(12.01)		(2.15)		(2.00)		(1.57)		(4.46)		(4.35)		0.013	2.03
Two stage least squares:															
$\Delta L^B = -0.012$	$(r_L - r_P)$	$+ 0.011$	$r_P$	$+ 0.238$	$NBR$	$- 0.217$	$NBR(-1)$	$- 0.271$	$LA(-1)$	$- 0.039$	$RISK$	$+ 4.111$	$KA(-1)$	SE	DW
(3.41)		(6.64)		(2.22)		(2.05)		(1.89)		(3.91)		(4.27)		0.014	2.12

---

## (D) Demand for commercial paper and negotiable CDs

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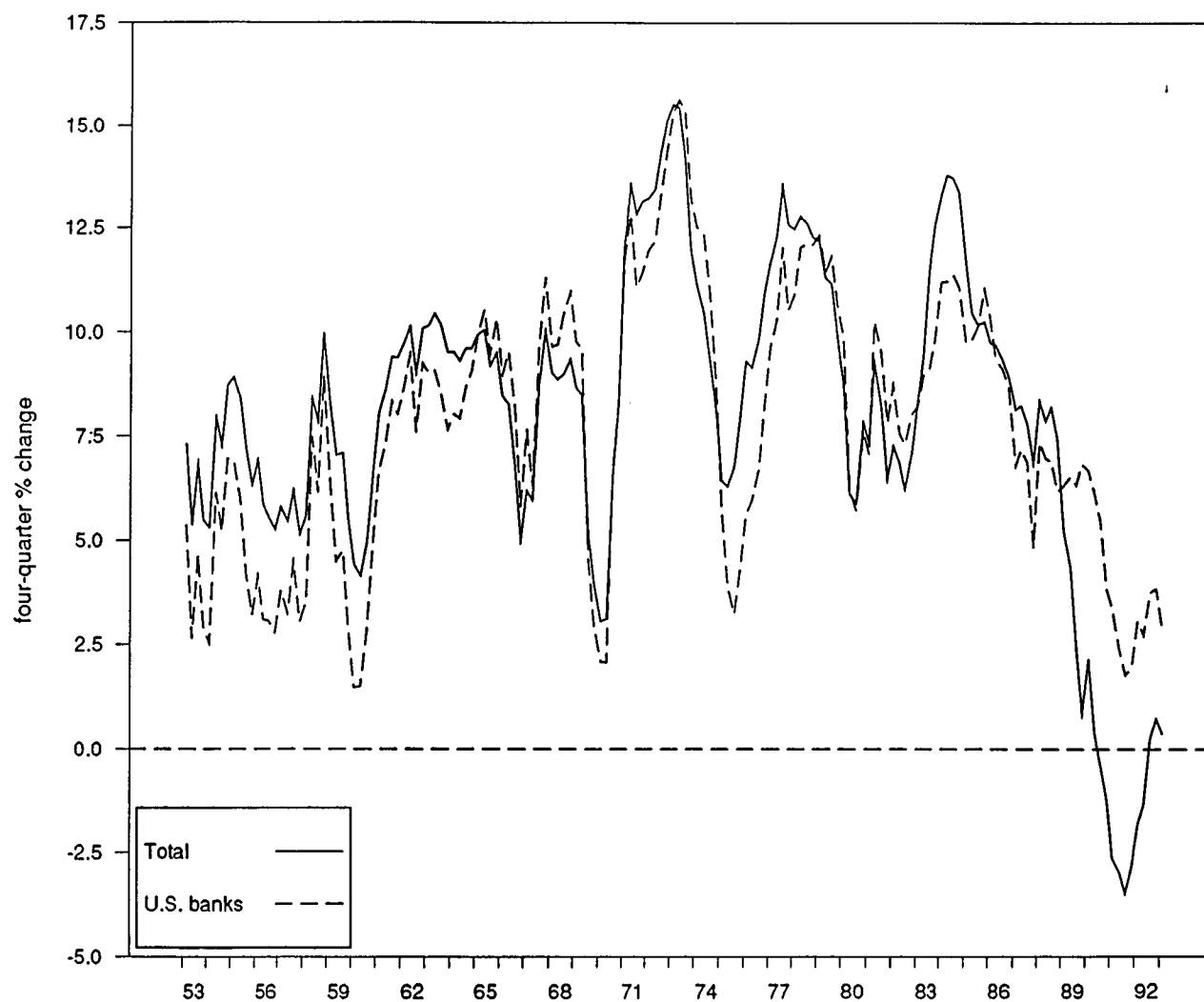
Ordinary least squares:												
$\Delta P^H + \Delta CD^H =$	$0.167$	$(r_P - r_B) +$	$0.016$	$r_P +$	$0.188$	$\Delta B -$	$0.666$	$PSHARE(-1) -$	$0.214$	$RISK$	SE	DW
	(5.34)		(4.66)		(1.41)		(3.80)		(5.41)		0.054	1.29
Two stage least squares:												
$\Delta P^H + \Delta CD^H =$	$0.204$	$(r_P - r_B) +$	$0.016$	$r_P +$	$0.291$	$\Delta B -$	$0.861$	$PSHARE(-1) -$	$0.235$	$RISK$	SE	DW
	(2.75)		(2.64)		(1.58)		(3.06)		(5.85)		0.055	1.27

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Notes: Equations are estimated on quarterly data over 1975:1 through 1992:4. Parentheses contain  $t$ -statistics corrected for heteroskedasticity and fourth-order MA serial correlation.

The variables are defined as follows: NR is the book value of firms' earnings, INV is inventory accumulation, MIX is bank loans as a share of firms' loans and paper, NBR is the ratio of nonborrowed reserves to lagged total reserves, LA is the ratio of banks' total lending to total credit, PSHARE is the ratio of outstanding commercial paper and CDs to the sum of paper, CDs and Treasury bills. RISK is the difference between the yields on P2 and P1 rated paper.

In each regression, the commercial paper rate ( $r_P$ ), and the interest rate spreads ( $r_L - r_P$ ) and ( $r_P - r_B$ ) are endogenous. Earnings (NR), default risk (RISK), reserves (NBR), the flow supply of Treasury bills ( $\Delta B$ ), and inventories (INV) are assumed to be exogenous. The remaining variables are treated as lagged endogenous variables, and used as instruments. Lagged inflation and real GDP growth are also included as instruments.



**Figure 1:** Growth in depository credit, 1953:1–93:1

Holder/obligor:	Asset/liability:						Flow constraint:
	Bills	Loans	Paper	Deposits	CDs	Reserves	
Nonfinancial firms	$+\Delta B^F$	$-\Delta L^F$	$-\Delta P^F$				$= NR - I$
Banks	$+\Delta B^B$	$+\Delta L^B$		$-\Delta D^B$	$-\Delta CD^B$	$+\Delta R^B$	$= 0$
Households	$+\Delta B^H$		$+\Delta P^H$	$+\Delta D^H$	$+\Delta CD^H$		$= NS$
Government	$-\Delta B^G$					$-\Delta R^G$	$= -DEF$
Market clearing condition:	$= 0$	$= 0$	$= 0$	$= 0$	$= 0$	$= 0$	

**Figure 2:** Financial assets and liabilities, by holder and obligor

Figure 3  
Effects of Monetary Policy Shocks

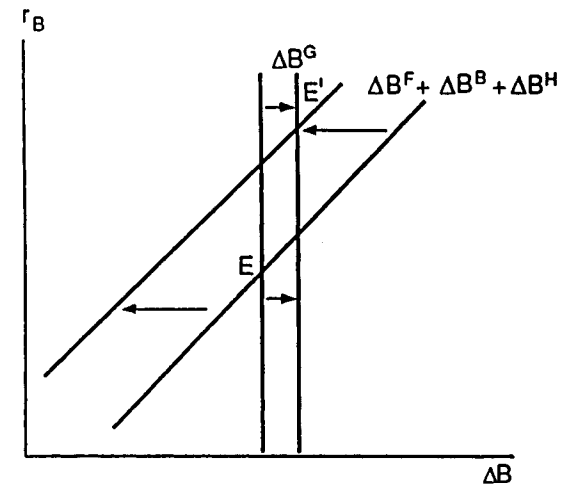
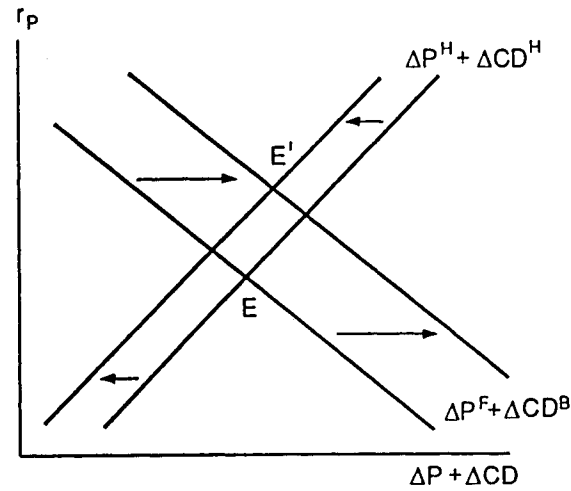
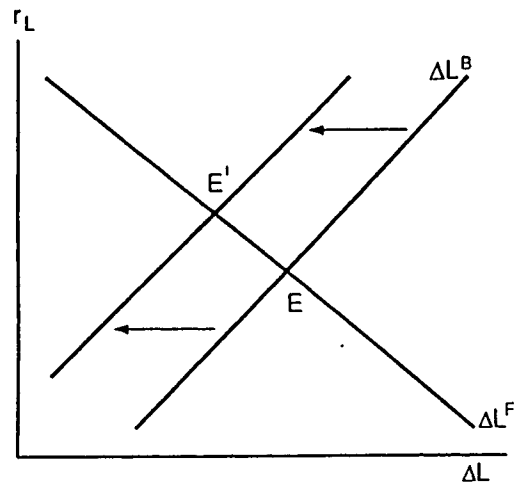
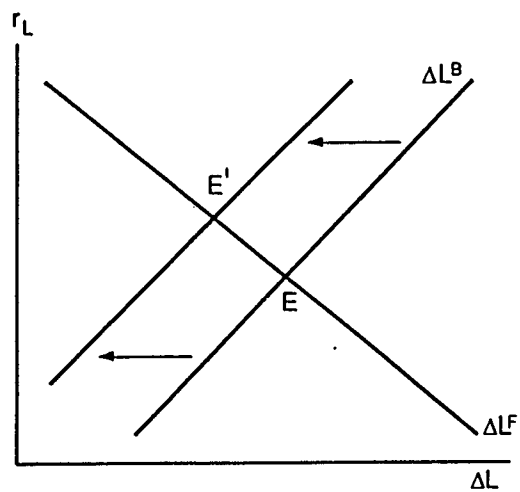
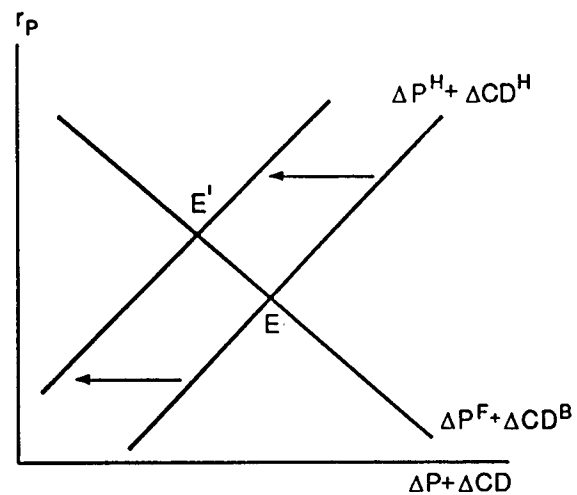


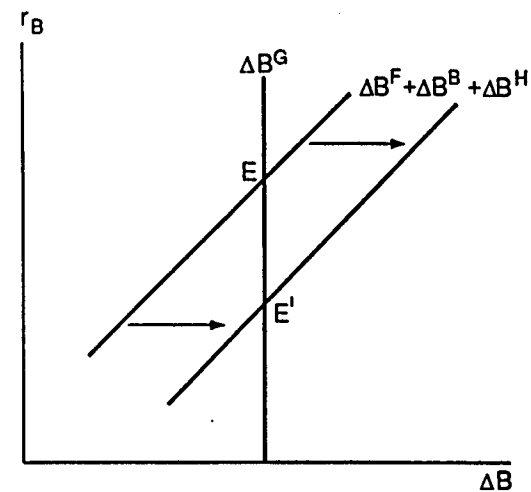
Figure 4  
Effects of Default Risk Shocks



Loan Market

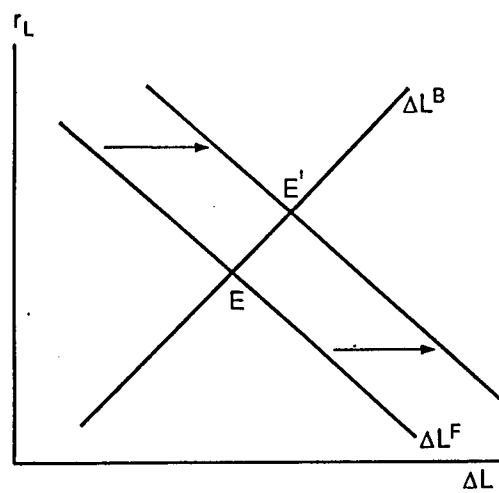


Paper Market

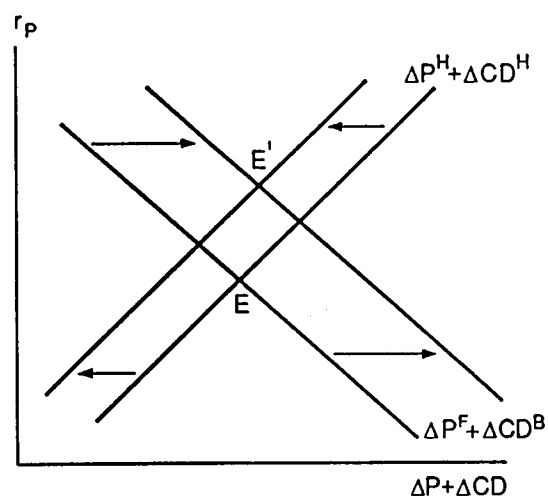


Bill Market

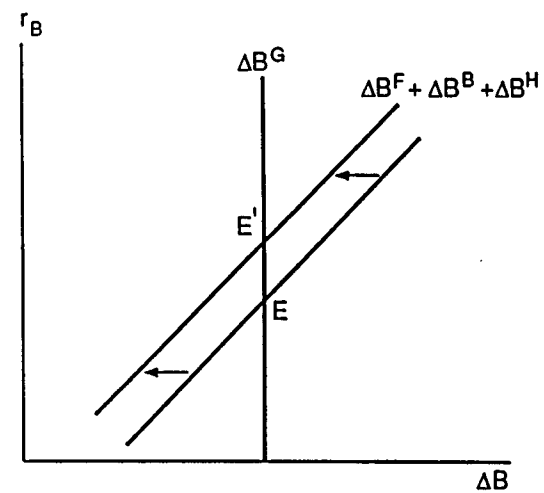
Figure 5  
Effects of Cash Flow Shocks



Loan Market



Paper Market



Bill Market

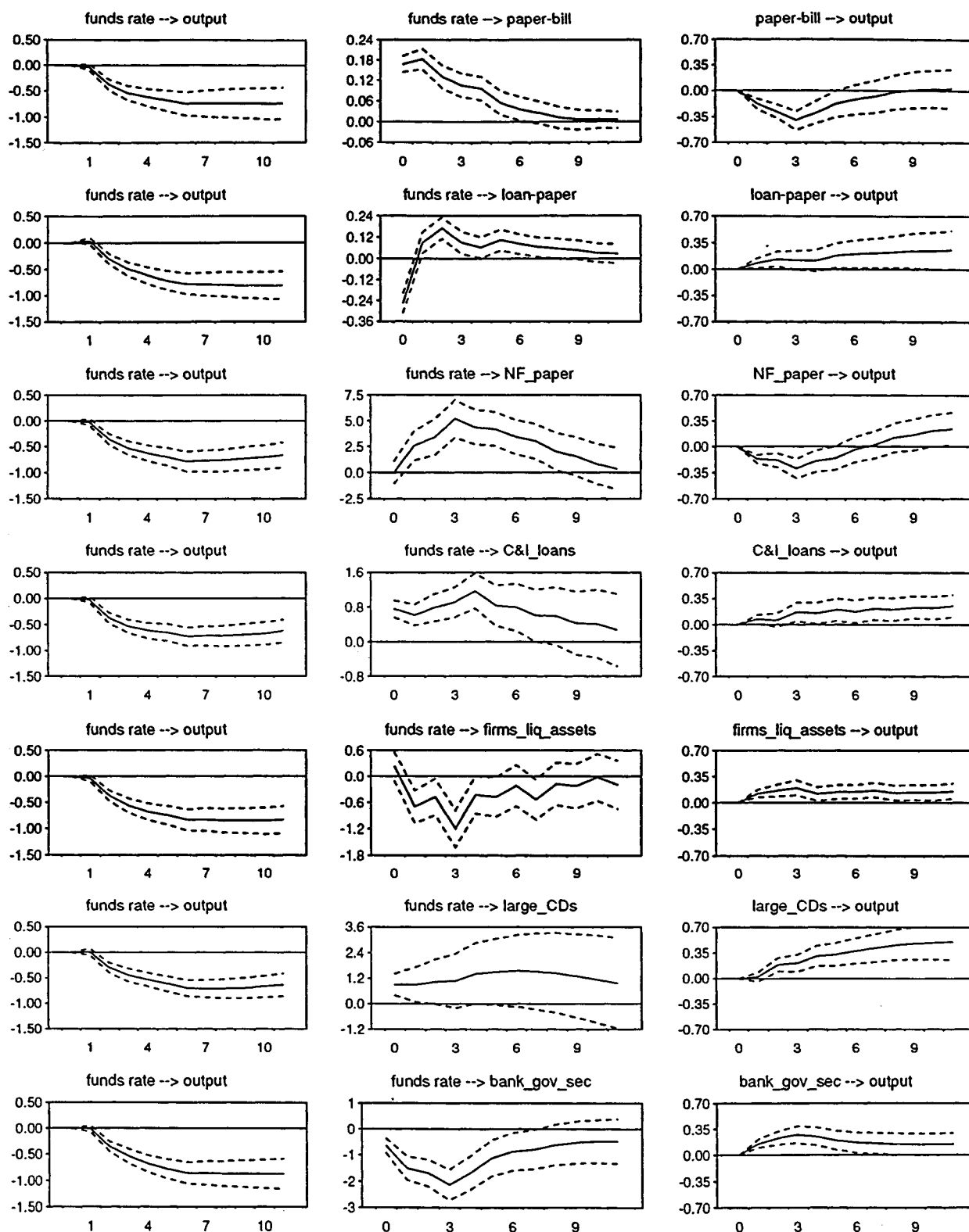
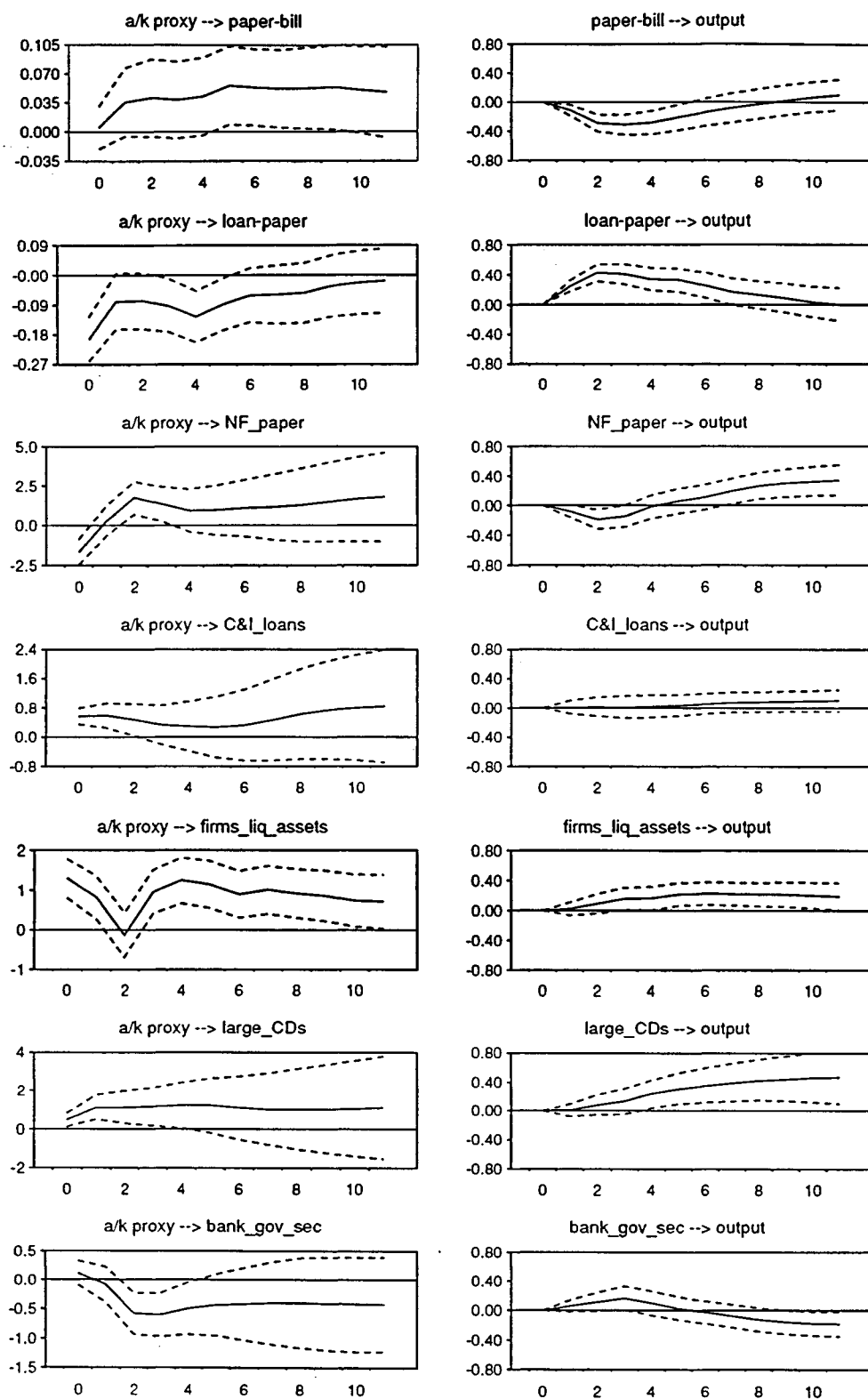
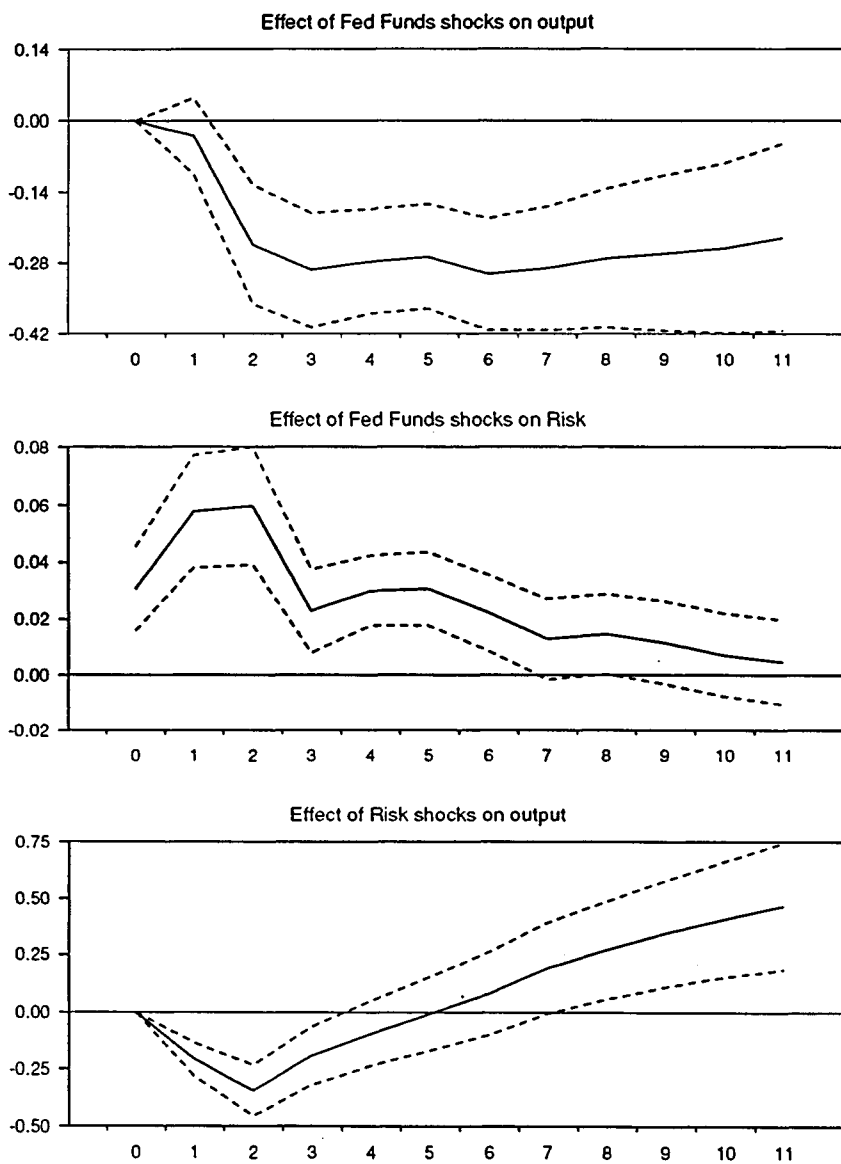


Figure 6: Dynamic effects of monetary policy shocks



**Figure 7: Dynamic effects of capital/asset shocks**



**Figure 8: Monetary policy, risk shocks, and output**

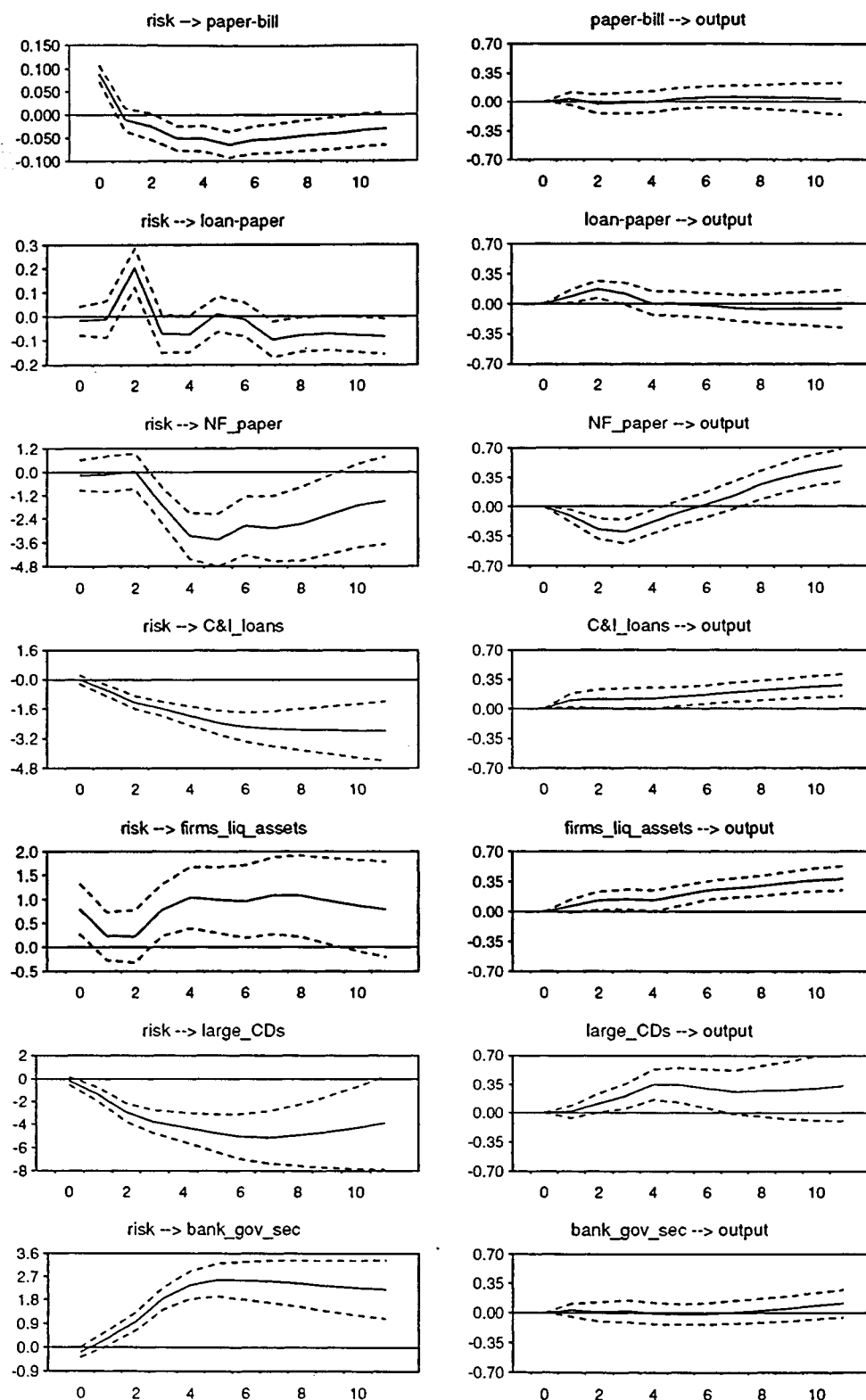


Figure 9: Risk, financial variables, and output

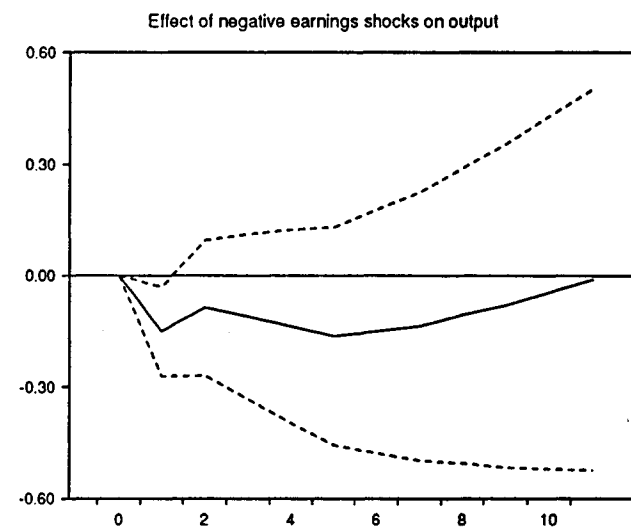
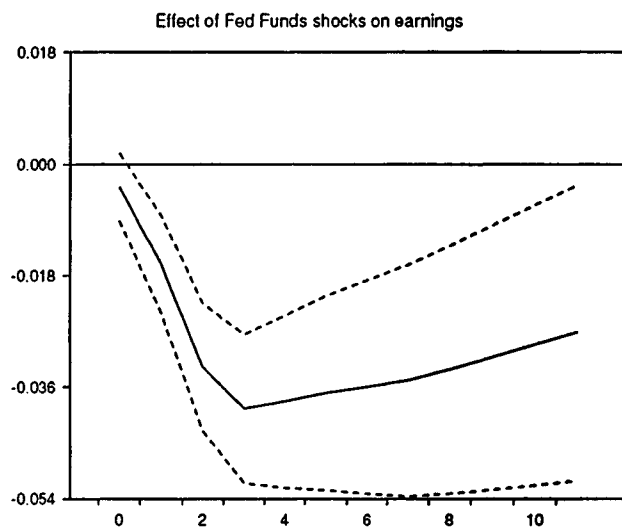
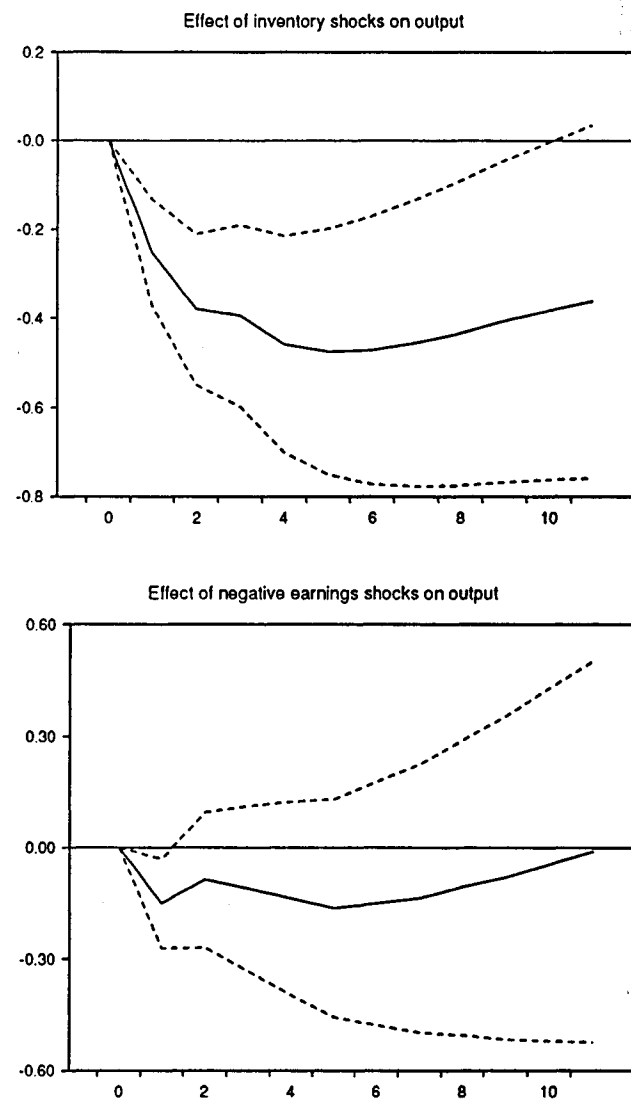
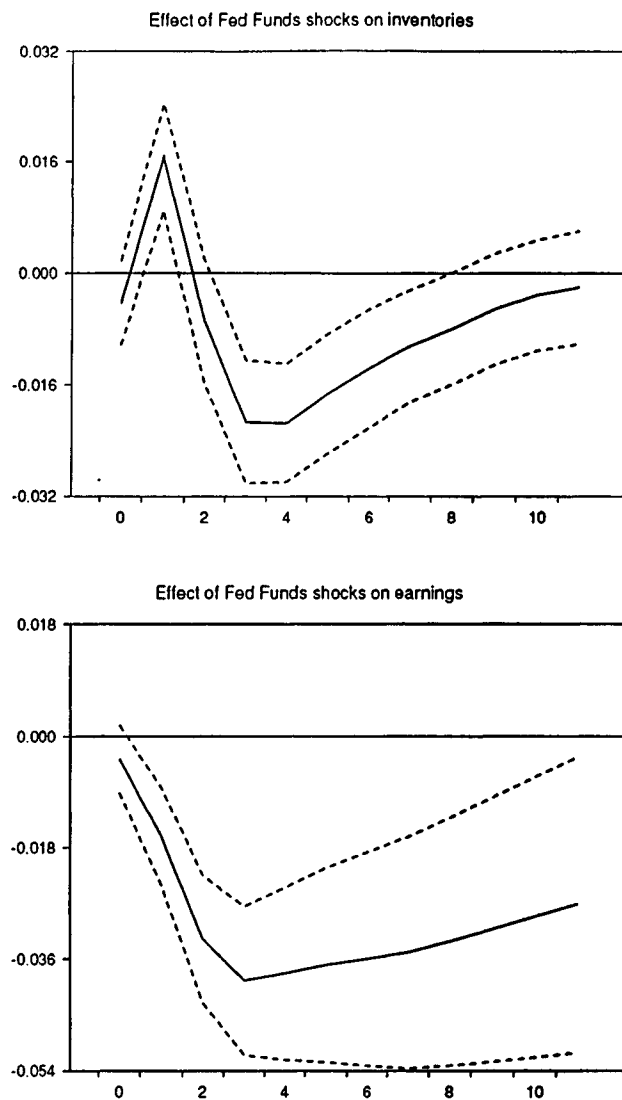
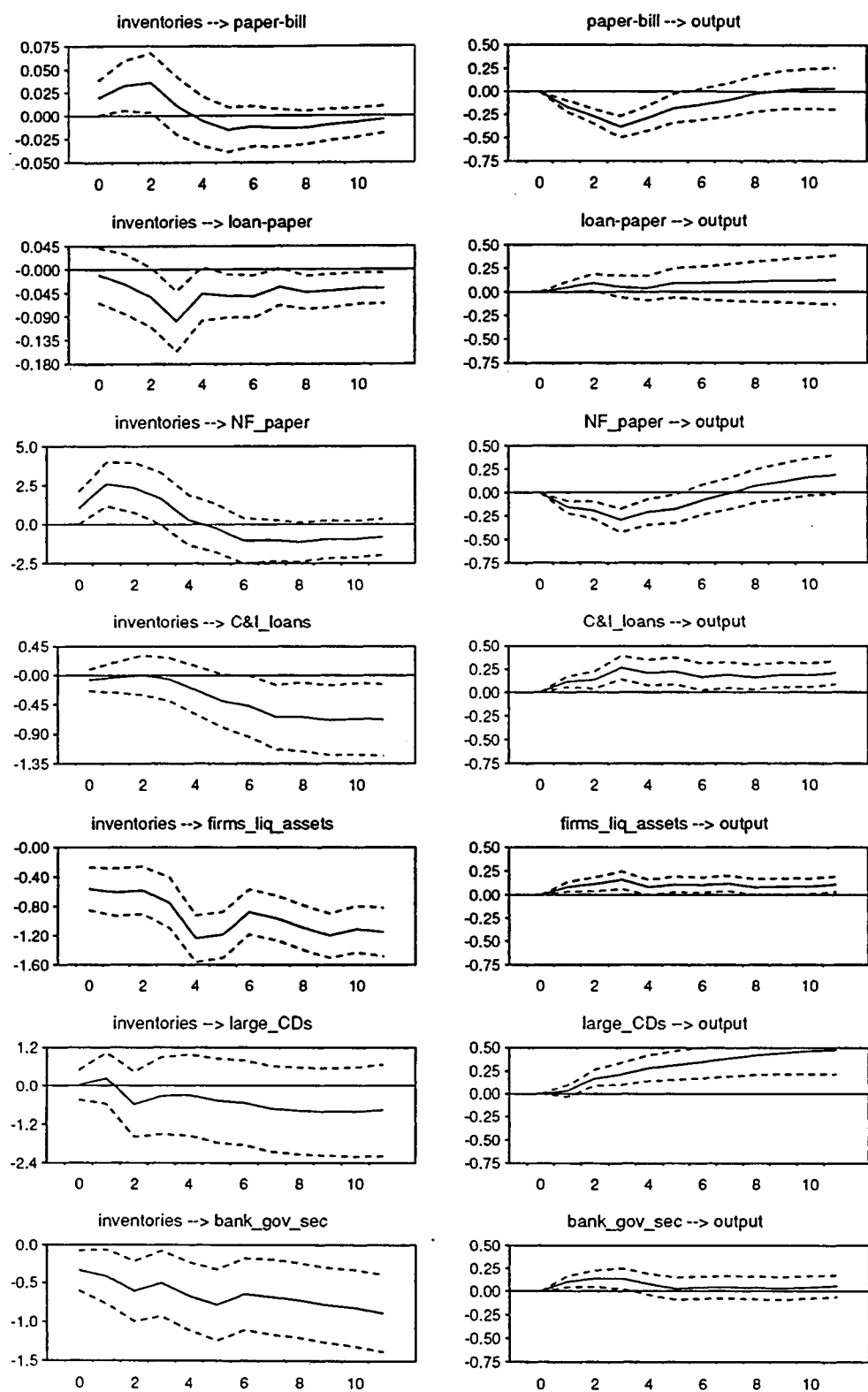
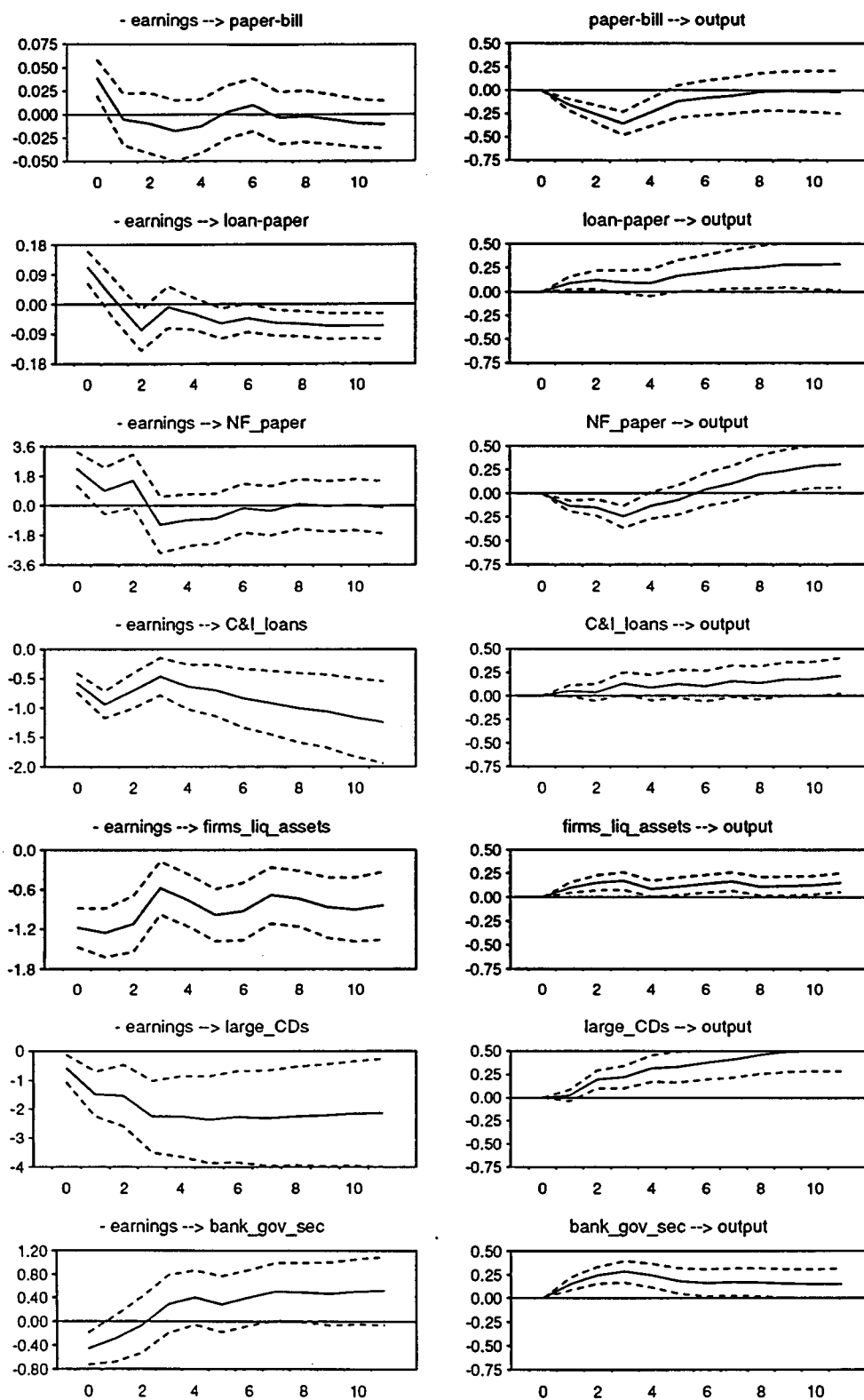


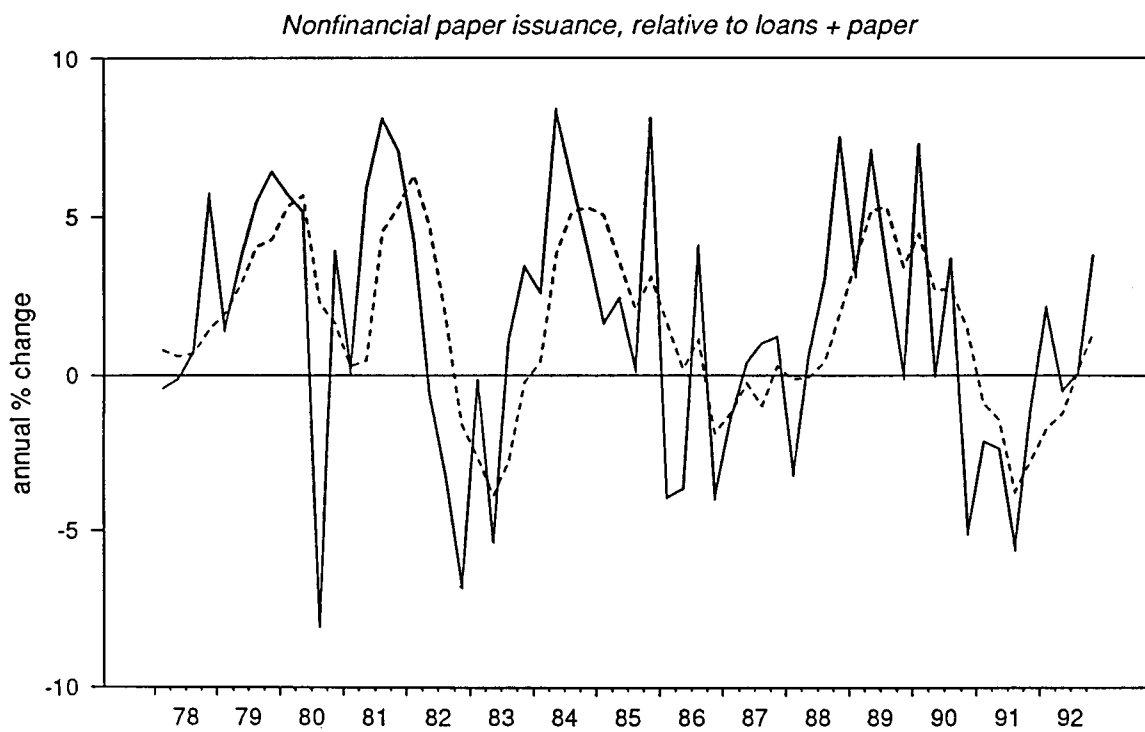
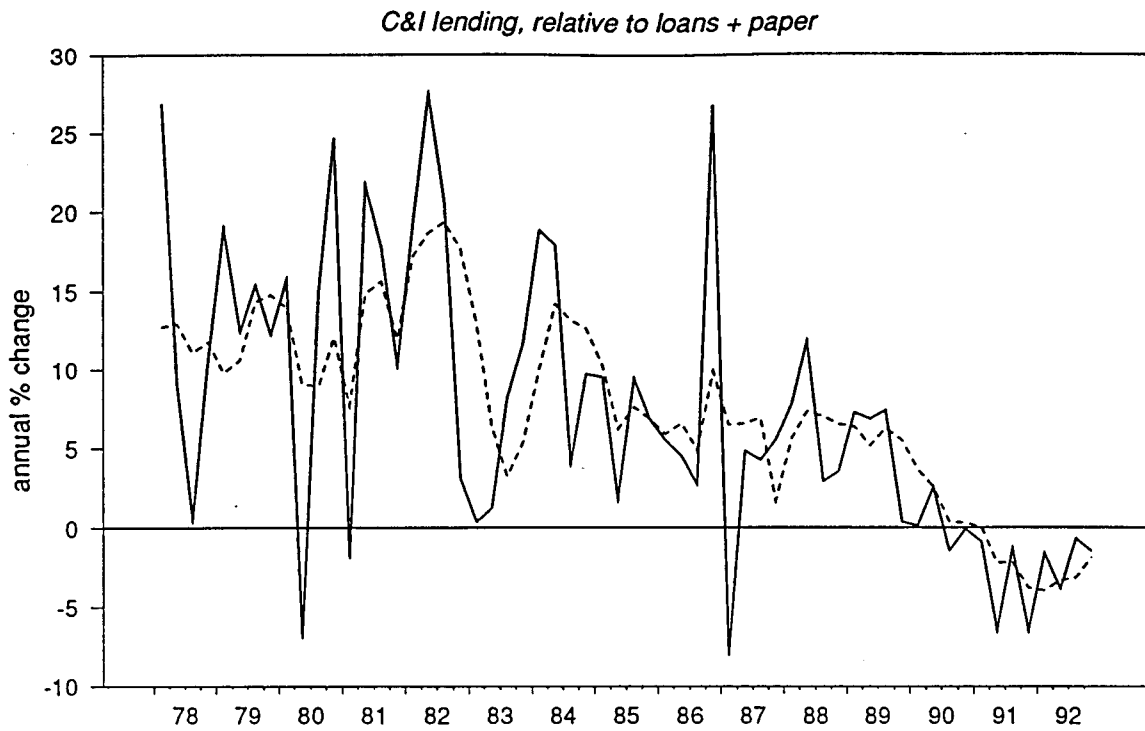
Figure 10: Monetary policy, cash flow shocks, and output



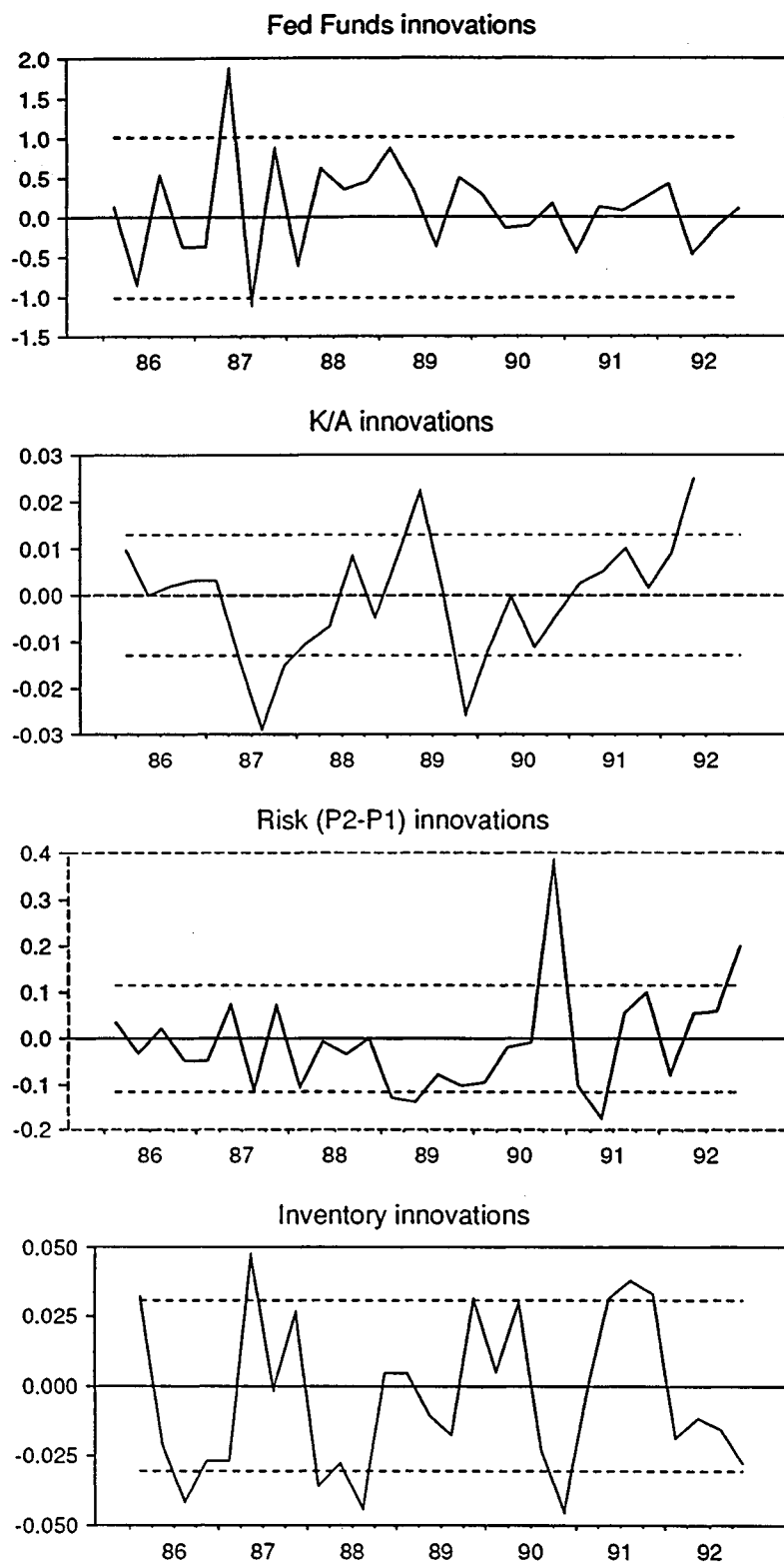
**Figure 11:** Inventory shocks, financial variables, and output



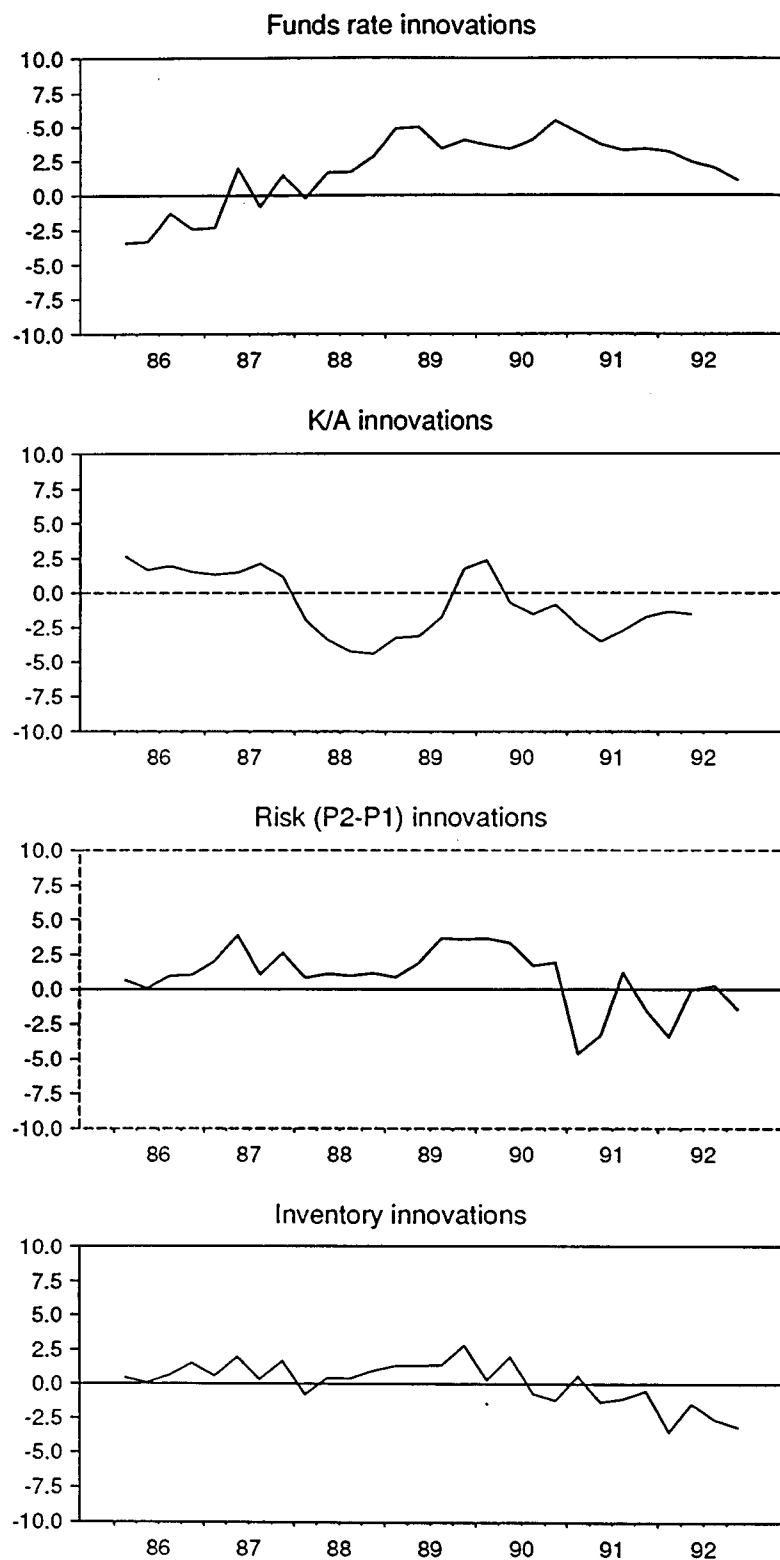
**Figure 12:** Earnings shocks, financial variables, and output



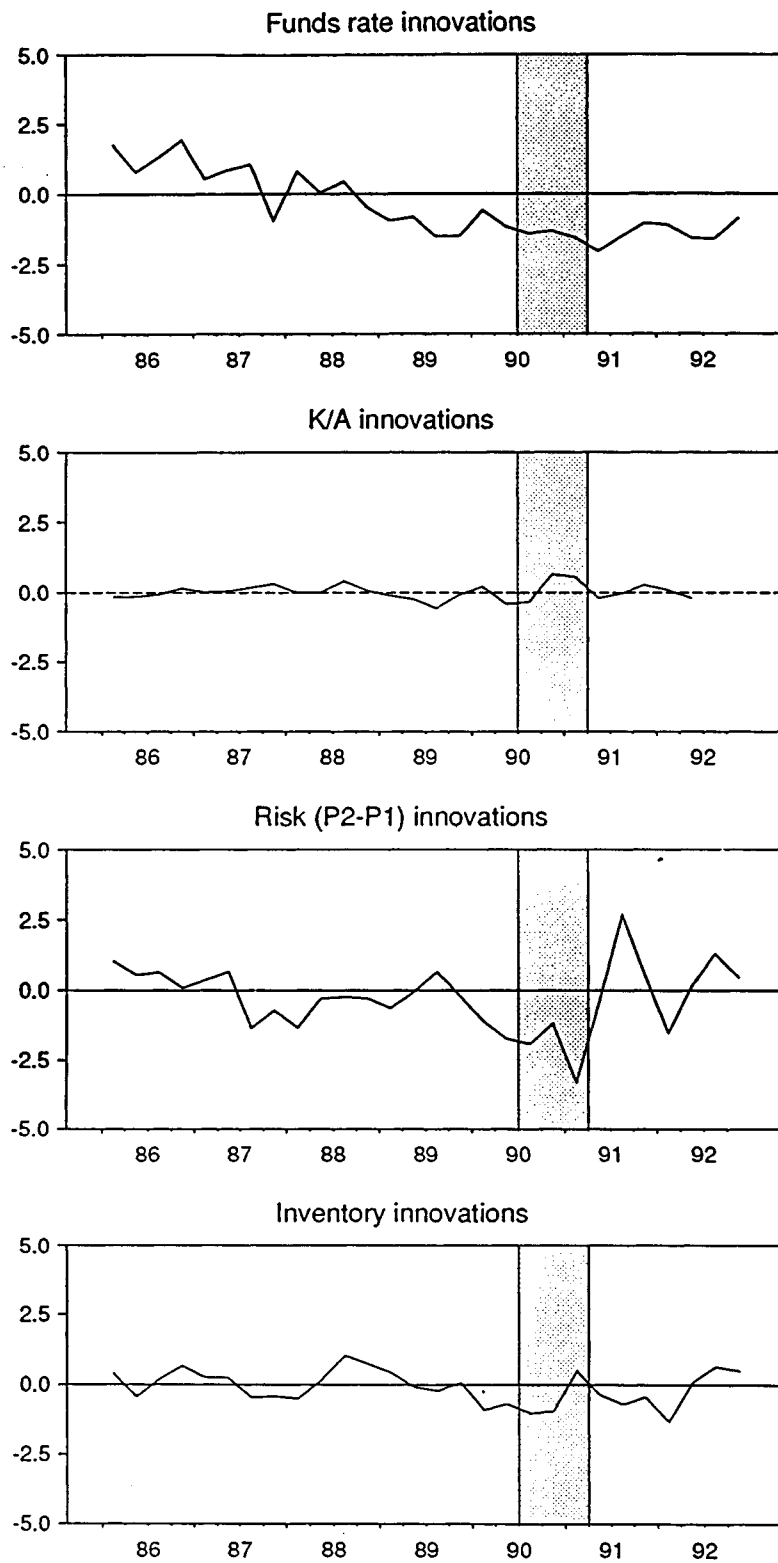
**Figure 13: C&I lending and commercial paper issuance**



**Figure 14:** Estimates of recent shocks



**Figure 15:** Shocks' estimated effect on C&I lending



**Figure 16: Shocks' estimated effect on real GDP growth**