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The source of fluctuations in money

Evidence from trade credit

Valerie A. Ramey*
University of California at San Diego, La Jolla, CA 92093, USA
National Bureau of Economic Research, Cambridge, MA 02138, USA

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This paper tests the relative importance of technology shocks and financial shocks as sources of fluctuations in money. The model extends the theory of King and Plosser (1984) by recognizing that both money and trade credit provide transactions services. Under certain conditions, the co-movements between money and trade credit can reveal the nature of the underlying shocks. The empirical results strongly suggest that shocks to the financial system account for most of the fluctuations in money in the long run and at business cycle frequencies. On the other hand, technology shocks appear to be more important at seasonal frequencies.

1. Introduction

A distinctive feature of the real business cycle hypothesis is its explanation of the observed procyclicality of money and other financial variables. Contrary to the view prevalent during the 1970s, real business cycle (RBC) models dispute the causal role of money in the positive correlation between money and output [King and Plosser (1984), Plosser (1991)]. According to the theory, most fluctuations in the money stock are not the result of direct manipulation by the monetary authority; rather, money, which is treated as a factor of production, responds passively to fluctuations in production induced by technological

Correspondence to: Valerie A. Ramey, Department of Economics, 0508, University of California at San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0508, USA.

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shocks. Thus, the model predicts a positive correlation between output and money, but the story is one of reverse causality.[1]

The RBC proponents offer several pieces of evidence in favor of their view. First, King and Plosser (1984) show that GNP is more strongly correlated with inside money than with outside money, supporting the view that money is endogenous. Second, the vector autoregressive studies of Sims (1980) and Litterman and Weiss (1985) find that exogenous shocks to the money stock are not an important independent source of fluctuations in output. Third, Boschen and Mills (1988) show that real variables can explain two-thirds of the variation in the growth rate of real output.

While these results cast doubt on changes in the nominal quantity of outside money as an important source of economic fluctuations, they do not refute the possibility that the financial sector can be an important source of shocks. For example, McCallum (1986) argues that the evidence is not inconsistent with a Federal Reserve policy that targets interest rates or real variables. Recent work by Christiano and Eichenbaum (1991), Strongin (1991), and others, which takes into account the operating procedures of the Federal Reserve Board, finds that money supply shocks do affect output. Moreover, the work by Bernanke (1983, 1986) and Gertler (1988) and others suggests that shocks to the financial system can play a key role in economic fluctuations. Although King and Plosser's (1984) model can accomodate such shocks, much real business cycle research has proceeded on the assumption that the key shocks to the economy are from the nonfinancial sector.

This paper seeks to determine the source of the shocks to real money by studying the comovements between money and trade credit. The model is based on the production framework used by King and Plosser, with bank transactions services that serve as inputs into production and with technological shocks that buffet the production function. The key innovation of the theory is the recognition that trade credit between firms also provides transactions services, and represents a substitute for bank transactions services. A simple real business cycle model provides a framework that allows estimation of the relative importance of technology and financial shocks from the observed relationship between trade credit and money balances.

The intuition behind the model is simple. If economy-wide technology shocks are the source of volatility in the economy, then money and trade credit should be positively related; an unbiased shock to technology should affect both factors of production in the same manner. On the other hand, if shocks to the financial sector are the source of volatility, then money and trade credit can be negatively related. Because the two types of transactions services are substitutes, the

[1] Other reverse causality explanations, based on the reaction function of the central bank, were offered twenty years ago by Tobin (1970) and Black (1972). Even earlier, Cagan (1965) conducted a detailed empirical analysis of the determinants of changes in the stock of money.

own-price effect should be negative, while the cross-price effect should be positive. If the price effects dominate the scale effects, then money and trade credit will move in opposite directions in response to a financial shock.

The empirical results support the hypothesis that financial shocks are the primary source of the movements in money at nonseasonal frequencies. Money and trade credit bear a negative relationship to each other, not only in the short run but also in the long run. After accounting for a deterministic trend, money and trade credit appear to be cointegrated, but the cointegrating vector is negative. Thus, the nonstationary deviations of trade credit from the deterministic trend are negatively related to the stochastic trend in the real stock of money. On the other hand, the seasonal comovements are strongly positive, indicating that nonfinancial shocks are most important at seasonal frequencies. These results suggest a re-evaluation of the source of shocks in real business cycle models.

The paper proceeds as follows. The next section discusses some of the characteristics of trade credit and how it can be used as a substitute for money. Section 3 presents the model and analyzes the information one can obtain from the relationships. Section 4 presents the results, and the final section concludes.

2. Trade credit

Trade credit, which is simply accounts payable and accounts receivable, is a source of financing that arises from ordinary business activities. Trade credit is automatically created when one firm (or individual) delays payment of its bill to another firm. Furthermore, the extension of trade credit seems to be an integral part of business: accounts payable represent over 40 percent of the current liabilities of nonfinancial corporations and, for the vast majority of firms, virtually all of their goods and services are sold on credit.[2]

The terms of trade credit are relatively stable, and the main criterion for extending credit is the creditor's selection of the customer. When interest rates rise, lenders reduce the amount of credit to new and marginal firms instead of changing the terms of credit [Nadiri (1969)]. Thus, nonprice rationing is an important element in trade credit. Moreover, while most firms establish credit limits for many of their customers, few ever restrict their receivables in the aggregate. Trade credit, however, involves a higher effective interest rate than credit from banks and financial markets. The most common terms for trade credit are '2/10, net 30', meaning that payment is due in 30 days, but if the firm pays within 10 days, it receives a 2 percent discount. The effective annual interest rate for these credit terms is 37 percent. Part of this high relative interest rate

[2] In a survey of the members of the Credit Research Foundation, Besley and Osteryoung (1985) found that for 87 percent of the firms, 91 to 100 percent of their goods and services are sold on credit.

involves a risk premium; the average loss rate on trade credit is substantially higher than on bank credit [Ferris (1981)]. However, once a firm has passed the initial ten-day period, the cost of delaying payment an extra day is zero until thirty days have passed. In many cases, when liquid assets are low, firms will allow their accounts payable to extend past thirty days. The cost of this strategy might be measured as a reputational cost. Because the practice is not uncommon, a firm that resorts to late payment on occasion probably suffers little loss of reputation.

The principal debate in the trade credit literature concerns theories of how trade credit can be used to circumvent monetary policy. The theories belong to one of two categories, net trade credit theories and gross trade credit theories. Meltzer (1960) proposed a net trade credit theory, arguing that movements in net credit could be used to redistribute money balances from those firms that have access to them to those firms that are in need of them. For U.S. data, Meltzer found that when money was tightened, firms with relatively large cash balances increased the average length of time for which credit was extended. He suggested that large, relatively liquid firms might use the extension of trade credit, rather than direct price reductions, to increase sales during periods of tight money. Brechling and Lipsey (1963) found similar results in their study of 75 British firms. The firms reacted to tight money by lengthening their credit periods, leading to substantial changes in net credit.

On the other hand, Ferris (1981) and Milbourne (1983) have proposed gross trade credit theories. In their models, uncertain delivery time generates a demand for cash balances. They proposed that more transactions could be completed with the same stock of money when firms increased their trade credit given. If every firm increased its trade credit taken by the same amount, each firm's net credit would remain unchanged. Milbourne argued that a cut in the money supply of $10 could be offset by a rise in gross trade credit of little more than fifty cents.

All of these theories and tests are based on the assumption that most movements in the money stock are exogenous. The general idea behind the relationship between money balances and trade credit, though, can be embedded in a real business cycle framework to study the source of the variation in the money stock.

3. Model

In this section, I discuss a modified version of the King and Plosser (1984) model. The first part of the section sketches the features of the model, and the second part explores the equilibrium relationships under some simplifying assumptions.

3.1. Economic environment

Firms in the goods industry face the following production technology:

$$Y_{t+1} = f(K_{yt}, L_{yt}, S_t)\phi_t, \tag{1}$$

where Y_{t+1} is output in period $t+1$, K_{yt} is the capital stock available in period t, L_{yt} is the labor force, and S_t is the amount of transactions services. The shock to technology, ϕ_t, is assumed known when the inputs are chosen in period t.[3] The sequence $\{\phi_t\}$ is assumed to be a strictly positive stochastic process. $\text{Log}(\phi_t)$ may contain one or more of the following: (1) a deterministic trend, (2) a stochastic trend, meaning it may be integrated of order one [I(1)] as in King, Plosser, Stock, and Watson (1991), and (3) seasonal components. Because empirical evidence strongly suggests that GNP is nonstationary [Nelson and Plosser (1982)], one would expect the underlying shocks to the economy to be nonstationary as well.

The point of departure of this model is the assumption that transactions services can be produced by a combination of cash plus bank deposits and trade credit. In particular, suppose the production of transactions services within the firm is governed by

$$S_t = g(M_t, A_t), \tag{2}$$

where M_t is the transactions services from real cash balances and bank deposits ('money') and A_t is the transactions services from real trade debt, or accounts payable. This specification is consistent with the gross trade credit theory developed by Ferris (1981), and is intended to capture his insight that trade credit can lower transactions costs by separating the exchange of goods from the exchange of money. When trading dates are uncertain, trading partners may use trade credit to pool the trading risk in random monetary flows, reducing the precautionary demand for monetary services.

The production functions for the two types of transactions services are given by

$$M_t = h(L_{mt}, K_{mt})\phi_t\lambda_t, \tag{3}$$

$$A_t = j(L_{at}, K_{at})\phi_t, \tag{4}$$

where L is labor and K is capital allocated to the production of each service, ϕ_t is the economy-wide technology shock, and λ_t represents the financial shock.

[3] King and Plosser also include a shock that alters output in an unexpected manner. For ease of exposition, I consider only one type of shock.

λ can be interpreted as a shock that is specific to the financial industry, resulting from changes in regulations or from changes in Federal Reserve policy that affect the production of transactions services.[4] Log(λ) may also have a deterministic trend, a unit root, and seasonal components. Several characteristics of the structure of production of financial services are noteworthy. First, the production of financial services is affected by the same technology shock ϕ_t that affects the production of goods. With this specification, technological progress in the form of growth in ϕ_t will be accompanied by balanced growth between the financial and the goods sectors. Second, following King and Plosser (1984), the production of financial services is instantaneous, but the production of goods takes time. Third, while the production of monetary transactions services takes place in the financial industry, the production of trade credit transactions services takes place in the accounting departments of the goods-producing firms.

The model is completed by an infinite-lived representative individual who maximizes:

$$U_t = \mathrm{E}_t \sum_{i=0}^{\infty} \beta^i u(c_{t+i}, \bar{L} - L_{t+i}), \tag{5}$$

where β is the discount factor, c is consumption, $\bar{L}$ is total time available, and L is hours supplied. E_t is the expectation conditional on period t information. For simplicity, it is assumed that households do not require transactions services from the financial sector.

The resource constraints facing the economy are

$$c_t + K_{yt} - (1-\delta)K_{yt-1} + K_{mt} - (1-\delta)K_{mt-1}$$

$$+ K_{at} - (1-\delta)K_{at-1} \leq y_t, \tag{6}$$

$$L_{yt} + L_{mt} + L_{at} \leq \bar{L}. \tag{7}$$

Thus, consumption plus total investment is limited by the amount of output, and total time allocated to the various productive activities cannot exceed total time available.

The model presented above is a typical real business cycle model, differing only in the expanded opportunities for producing transactions services. Modelling those expanded opportunities will imply certain relationships among the variables that depend on the source of the shocks.

[4] Alternatively, one could model the financial shocks as affecting the production of trade debt. It seems more likely, however, that the banking industry is the source of most financial shocks that affect the relative price of trade debt versus bank transactions services.

3.2. Equilibrium relationships

This section analyzes the equilibrium relationship between the two types of transactions services and the two types of shocks. Because the goal is not to do a full-scale simulation of the economy, the model presented above will serve only as a guide to the economic arguments. To facilitate the analysis, simplifying assumptions along the lines of King and Plosser (1984) are made. In particular, it is assumed that (1) the depreciation rate of capital is 100 percent, and that (2) the production of each type of transactions service depends only on the labor input and obeys a constant returns to scale technology. Thus, the labor requirement functions for the production of money and trade debt are given by

$$L_m = mM/(\lambda\phi), \tag{8a}$$

$$L_a = aA/\phi, \tag{8b}$$

where m and a are positive constants.

Let us first review King and Plosser's results concerning the effects of a higher than average shock to ϕ_t. A positive shock to this variable leads to an increase in output in the economy. The expansion in output is accompanied by an increase in demand for factors of production, including labor and transactions services. Thus, the level of real money balances will also rise. As long as trade debt is not an inferior input, the level of trade debt should increase as well. Thus, economy-wide technology shocks should lead to positive comovement of money and trade debt; both should rise during booms and fall during contractions.

The implications are even stronger if the technology shocks are nonstationary. In this case, both trade debt and money should be related to the same stochastic trend embodied in the technology shocks. Thus, the two variables should be cointegrated [in the sense of Engle and Granger (1987)], and both should be positively related to the stochastic trend. A regression of trade debt on money would yield a positive coefficient on money and a stationary error term.

A caveat concerning factor prices should be considered, though. The model outlined above implies that changes in the nominal interest rate have no effect on the ratio of trade debt to money. If the cost of holding money is more sensitive to the nominal interest rate, then increases in the nominal interest rate can lead to substitution from money to trade debt. That is, firms would hold fewer precautionary money balances, and as a result would have to resort to using trade debt more frequently. Lacker and Schreft (1991) show in the context of an endowment economy with transactions costs that the ratio of money to trade credit depends on the nominal interest rate.

Thus, it is important to review the behavior of interest rates in the general equilibrium model. Part of the variation in the nominal interest rate is due to variations in the real rate of interest caused by technology shocks. In particular, a positive shock to ϕ leads to a higher real interest rate [King and Plosser (1984)]. Another part of the variation in the nominal interest rate is, of course, the expected rate of inflation in the general price level. In the King and Plosser model with currency, prices tend to be countercyclical, but the results are not clear on the cyclicality of the inflation rate. In any case, the nominal interest rate is likely to be acyclical or slightly procyclical in the model.

While variations in interest rates may influence the short-run fluctuations in money, they cannot affect the long-run fluctuations in the context of the standard model. Even if the technology shock is nonstationary, the model predicts that the real interest rate will be stationary since rates of return in these types of models must be stationary. As long as the rate of inflation is stationary, the nominal interest rate should be stationary. Thus, according to the model, the nominal interest rate cannot be related to the stochastic trend in money or trade debt. The data, however, suggest that nominal interest rates are close to being nonstationary, and that the real interest rate and the rate of inflation seem to have different stochastic trends. Thus, the empirical work presented later will account for the effect of the nominal interest rate.

Consider now the consequences of variations in λ. A higher than average shock to the financial industry, $\lambda_t > 1$, will also lead to an expansion in the level of bank transactions services and an increase in the output of goods. If $\log\lambda_t$ is I(1) and is the only source of the stochastic trend in the economy, then the long-run relationship between output and bank financial services will be the same as in the case of the economy-wide technology shock. Thus, positive comovements between output and bank transactions services are consistent with both stories. On the other hand, the relationship between trade debt and λ will be ambiguous. The positive shock to $\log\lambda$ leads firms to substitute away from trade debt to money, resulting in a negative effect on trade debt. In contrast, the increase in output that results from the positive shock to $\log\lambda$ causes an increase in the demand for all inputs, including trade debt. This scale effect leads to a positive response of trade debt. Thus, the net effect is ambiguous. If the substitution effect dominates the scale effect, then money and trade debt will be negatively related.

In general, one can obtain decision rules for trade debt and money as functions of the underlying shocks. The decision rules for trade debt and money can be written as

$$A_t = l(\underset{+}{\phi_t}, \underset{?}{\lambda_t}), \tag{9a}$$

$$M_t = n(\underset{+}{\phi_t}, \underset{+}{\lambda_t}). \tag{9b}$$

The signs below the arguments denote the sign of the partial derivative of the function with respect to that argument. As discussed above, an increase in ϕ leads to a boom in which output, money, and trade debt increase. Alternatively, an increase in λ leads to an increase in output and money, but the effect on trade debt is ambiguous. If the substitution effect outweighs the scale effect, the sign will be negative.

With the application of a log-linear approximation to the equations in (9), the decision rules for trade debt and money can be written as follows:

$$\log A_t = \text{constant} + \theta_1 \log \phi_t - \theta_2 \log \lambda_t, \tag{10a}$$

$$\log M_t = \text{constant} + \beta_1 \log \theta_t + \beta_2 \log \lambda_t. \tag{10b}$$

By the arguments above, θ_1, β_1, and β_2 should be positive. If the substitution effect of λ outweights the scale effect on trade debt, θ_2 will also be positive (so the effect will be negative). To see the implied relationships between trade debt and money, multiply (10b) by a parameter ψ and subtract it from (10a) to obtain the following equation:

$$\log A_t = \text{constant} + \varphi \log M_t + (\theta_1 - \varphi\beta_1)\log \phi_t$$
$$- (\theta_2 + \varphi\beta_2)\log \lambda_t. \tag{11}$$

Consider first the estimation of eq. (11) when the shocks are nonstationary. There are five separate possibilities. Suppose first that ϕ_t is the only source of trends (deterministic and stochastic) in the economy. In this first case, an ordinary least squares (OLS) regression of $\log A$ on $\log M$ will produce an estimate of $\varphi = \theta_1/\beta_1 > 0$. φ will take this positive value because it is the only one that will eliminate the nonstationary component, $\log\phi_t$, in the error term. Now suppose λ_t is the only source of nonstationarity in the economy. The OLS estimate of φ will be $\varphi = -\theta_2/\beta_2$, which is negative if θ_2 is positive. In this case, φ must be negative in order to eliminate the nonstationary component from the error term. In these first two cases, money and trade debt are *deterministically cointegrated* [Ogaki and Park (1992)] in the sense that one coefficient eliminates both the stochastic and deterministic trend. A third possibility, though, is that ϕ_t has a stochastic trend while λ_t has a deterministic trend. In this case, trade debt and money will not be deterministically cointegrated. If, however, a deterministic trend is included in the regression, the estimate of φ will be equal to $\theta_1/\beta_1 > 0$, and money and trade debt will be *stochastically cointegrated*. Likewise, in the fourth case, if λ_t has a stochastic trend while ϕ_t has only a deterministic trend, the estimate of φ will be negative and the error term will be stationary in a regression containing a deterministic trend. Finally, if both

ϕ_t and λ_t contain stochastic trends, then in general no value of φ will leave the error term stationary, and trade debt and money will not be cointegrated.

Similar reasoning applies for the analysis of cyclical and seasonal shocks. If economy-wide technology shocks are the principal source of stationary shocks, then changes in trade debt and changes in money should be positively related. Financial shocks, on the other hand, should lead to negative comovements. Extending the model to allow for durable capital or other sorts of rigidities may induce lags in the relationship, but should not affect the sign of the relationship. The next section presents an empirical study of the relationships.

4. Empirical results

4.1. Data

The data on business holdings of money and trade debt are from the Flow-of-Funds reports of the Federal Reserve. These data, which extend from 1952 to the second quarter of 1991, summarize various balance sheet items for nonfinancial business on a quarterly basis. The trade debt variable comes directly from the nonfinancial business balance sheets. A major change in accounting assumptions caused a large discontinuity in the Flow-of-Funds trade debt data in the fourth quarter of 1974. The Federal Reserve Bulletin (July 1978) reported data using both methods for the fourth quarter of 1974, so I used this information to splice the trade debt series.[5] Four monetary variables are analyzed. The first is the item 'checkable deposits and currency' from nonfinancial business balance sheets. This variable will be referred to as 'business M1'. The second variable is 'checkable deposits and currency' plus 'time deposits', also from the Flow-of-Funds data. This variable will be referred to as 'business M2'. The other two monetary variables are aggregate M1 and M2.[6] All nominal variables are deflated by the implicit price deflator for GNP. Finally, the nominal interest rate on six-month commercial paper and real GNP, both from CITIBASE, are also included in the analysis.

4.2. Results

The empirical analysis begins with simple plots of the data. Fig. 1 plots the raw data (in logs) for real trade debt, real business M1, and real business M2, while fig. 2 plots the data after deterministic seasonals and a linear time trend have been removed from the variables.

[5] Using dummy variables instead of splicing does not change the results presented below.

[6] The aggregate M1 and M2 nominal variables were constructed by multiplying the Business Condition Digest real variables by the CPI.

Fig. 1 shows that real trade debt trends upward relative to both definitions of real money from 1952 to 1982. Business M1 actually falls during this period. After 1982, money holdings show an unprecedented increase, while trade debt declines. All variables display substantial seasonal variability.

Fig. 2, which presents the detrended, deterministically deseasonalized data, illustrates some interesting patterns. All variables display highly persistent

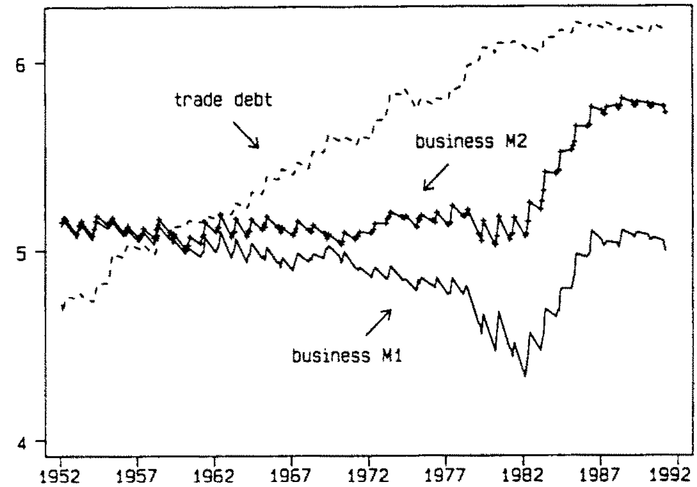

Fig. 1. Money and trade debt, log of real unadjusted quarterly data, 1952:1–1991:2.

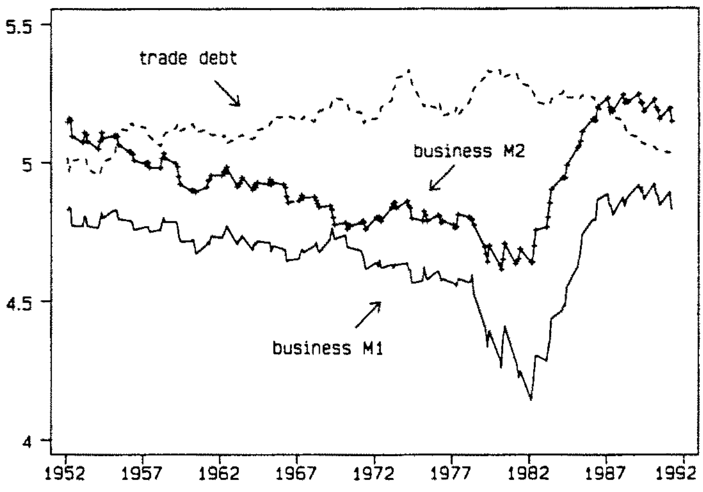

Fig. 2. Money and trade debt, log of real detrended, seasonally adjusted quarterly data, 1952:1–1991:2.

variations, but the variations in trade debt tend to be in the opposite direction of the variations in the two monetary variables. For example, in the periods 1955–57, 1959–60, 1969–70, and 1978–81 the level of real money balances held by firms fell, while the level of real trade debt rose. The peaks in trade debt occurred in the quarters 1956:3, 1960:3, 1969:4, 1974:2 1980:1, and 1981:2; each of these peaks occurred during 'credit crunches' [as defined by Eckstein and Sinai (1986)]. The unprecedented rise in real money relative to trend beginning in 1982 was accompanied by a decline in real trade debt. In general, the plots suggest that when money balances rise, trade debt falls, and when money balances fall, trade debt rises.

The remainder of the section will conduct a statistical analysis of the data to determine whether the series indeed bear the negative relationship suggested by the plots. I will begin by examining the long-run behavior, and follow with an analysis of the cyclical and seasonal comovements of the variables. The first step in the long-run analysis is a test for the nonstationarity of the series. To this end, table 1 reports augmented Dickey–Fuller tests for several relevant series. All series, except the interest rates and inflation rate, are deflated by the implicit price deflator and are in logs. The columns labelled 'optimal lags' are the lags included in the tests, chosen using the procedure advocated by Campbell and Perron (1991).[7]

According to table 1, the test statistics do not warrant a rejection of the presence of a unit root at conventional significance levels in all cases but two. The first exception is in the case of trade debt when no trend is included. It is clear, however, that this result is due to misspecification, for when the trend is included it is very significant (as the plots show it should be) and the test statistic for a unit root falls considerably. Thus, it seems that the series is best described as having both a unit root and a deterministic trend. The second exception is the commercial paper rate. The test statistic is marginal at the 10 percent significance level, both with a trend and without a trend. The possibility that interest rates may have unit roots is a highly controversial topic.[8] For the purposes of this paper, the only claim made is that a unit root model seems to be a good approximation of the time series properties of all of the variables in question during the period under study.

Given the evidence on the stochastic trends, the proper way to proceed is to examine whether there are any cointegrating relationships between the series. One issue in testing for cointegration relationships is whether the null hypothesis should be noncointegration or cointegration. The null of noncointegration is used in most work, in part because the test is so easy to formulate. Ogaki and Park (1992) argue, however, that in the context of estimating preference

[7]The results did not change in any case if the lags were set arbitrarily at 2, 4, or 8.

[8]See, for example, Cochrane's discussion of the Campbell and Perron paper in the *1991 NBER Macroeconomics Annual*.

Table 1

Augmented Dickey-Fuller tests, quarterly, 1954:4-1991:2.[a]

Variables	No trend		With trend	
	Test statistics	Optimal lags	Test statistics	Optimal lags
Trade debt	− 2.56	9	− 0.19	9
Business M1	− 2.28	8	− 2.31	8
Business M2	− 0.64	8	− 1.85	8
Aggregate M1	− 0.55	7	− 1.78	7
Aggregate M2	− 0.51	10	− 2.34	10
Commercial paper rate	− 2.56	5	− 3.12	5
Inflation rate	− 2.20	3	− 2.09	3
Real interest rate	− 1.71	7	− 2.07	7

[a]All variables, except the interest rate and inflation variables, have been deflated with the GNP deflator. A drift term was included in the tests. Seasonal dummy variables were included in the tests involving the balance sheet data. The optimal lags were chosen as described in Campbell and Perron (1991), with $k_{max} = 12$ quarters. The critical values are: with no trend, −2.88 at the 5 percent significance level and −2.58 at the 10 percent significance level; with trend, −3.44 at the 5 percent significance level and −3.14 at the 10 percent significance level.

parameters the null hypothesis of cointegration should be used. I have chosen to use the null hypothesis of noncointegration for two reasons. First, it seems reasonable to allow for the presense of multiple stochastic trends in the null hypothesis, and this corresponds to the hypothesis of noncointegration. Second, as the empirical results show, the null hypothesis of noncointegration will be rejected in several key cases, so the noted low power of these tests is not a problem here.

Table 2 reports the results of the cointegration tests. The first column tests the null hypothesis of no cointegration against the alternative of deterministic cointegration. The third column presents the test of the null hypothesis against the alternative of stochastic cointegration. The only difference between the two tests is that the latter allows for a deterministic time trend in the cointegrating regression. The columns labelled 'optimal lags' are the lags included in the tests, chosen using the procedure advocated by Campbell and Perron (1991).

The first part of table 2 studies cointegration between trade debt and the other variables. In no case is there evidence of deterministic cointegration between trade debt and any other variable. This implies that one parameter vector cannot eliminate both the stochastic and deterministic trend. Thus, it suggests that, at the least, one of the underlying shocks to the system has a stochastic trend while the other has a deterministic trend. On the other hand, trade debt appears to be stochastically cointegrated with both business M1 and business M2, based on rejections of the null hypothesis at the 5 percent

Table 2
Cointegration tests, quarterly, 1955:1–1991:2.[a]

Variables	Deterministic cointegration: Test statistics	Deterministic cointegration: Optimal lags	Stochastic cointegration: Test statistics	Stochastic cointegration: Optimal lags
	(1) Dependent variable: Trade debt			
Business M1	− 1.23	8	− 4.27	4
Business M2	− 2.00	8	− 3.66	8
			− 4.84	4
Aggregate M1	− 2.04	2	− 2.69	11
			− 3.96	4
Aggregate M2	− 2.17	9	− 0.61	9
Commercial paper rate	− 2.16	5	− 2.90	6
	(2) Dependent variable: Business M1			
Commercial paper rate	− 2.58	3	− 2.95	3
Aggregate M1	− 1.88	8	− 4.37	4
	(3) Dependent variable: Business M2			
Commercial paper rate	− 0.91	8	− 2.78	5
Aggregate M2	− 1.92	9	− 2.13	9

[a]All regressions contain a constant term and seasonal dummy variables. The optimal lags were chosen as described in Campbell and Perron (1991), with $k_{max} = 12$ quarters. The critical values for deterministic cointegration are −3.38 for the 5 percent significance level and −3.07 for the 10 percent significance level. The critical values for stochastic cointegration are −3.85 for the 5 percent significance level and −3.55 for the 10 percent significance level. The critical values are taken from MacKinnon (1991).

significance level. The test statistic for business M2 is shown for both four and eight lags, because the eighth lag is marginally significant while the fifth through the seventh are not significant. There is mixed evidence on the relationship between trade debt and aggregate M1. The table again shows the test statistics for two different lags. The eleventh lag was marginally significant, so eleven lags were included in one of the tests. The result of this test is a failure to reject noncointegration. However, if one treats the eleventh lag as insignificant, and successively eliminates the other lags, the optimal lag length is four lags. The test statistic from this specification compels us to reject the null hypothesis at the 10 percent level.[9] Trade debt does not appear to be cointegrated with aggregate M2 or the interest rate and inflation variables.

[9]In no other case did the number of lags make much of a difference in the test statistic.

These results are consistent with the cointegration test results in the last part of the table. The results in the second half of the table suggest that business M1 and aggregate M1 are stochastically cointegrated, while business M2 and aggregate M2 do not share common stochastic trends. Thus, trade debt, business M1, business M2, and aggregate M1 all share the same stochastic trend, while aggregate M2 and interest rates have different stochastic trends. Aggregate M2 may have a different trend because consumer demand for M2 may have different driving forces.

Given that the tests suggest common stochastic trends, it is valid to estimate long-run relationships between trade debt and money by estimating cointegrating equations. For ease of exposition, I will concentrate on only the business definitions of money, since they are mostly closely related to trade debt. The equations are estimated using two methods: Stock and Watson's (1992) dynamic OLS (DOLS) method and Johansen's (1991) full information maximimum likelihood (FIML). The DOLS method corrects for simultaneity bias in small samples by adding leads and lags of the first differences of the right-hand-side variables. The number of leads and lags were chosen using the procedure advocated by Campbell and Perron (1991). The t-statistics reported incorporate HAC (heteroskedasticity- and autocorrelation-consistent) standard errors, using a Parzen kernel with eight lags. The FIML method, on the other hand, estimates the cointegrating vectors in a vector error correction model. Both estimators are asymptotically efficient, but several studies have shown that Johansen's method does not always perform well in small samples [Stock and Watson (1992) and Park and Ogaki (1991)]. In the specification used here, eight lags of the first differences of each variable were included.

Table 3 reports the estimates of the cointegrating vectors. The first two columns use the business M1 definition of money, while the last two columns use the business M2 definition of money. In each case, the regression is estimated first without, and then with, the commercial paper rate. As is evident from the table, in all four cases using either method, trade debt is negatively related to the money variable and the coefficient is always significant. The coefficient estimates on business M1 are higher (in absolute value) when the Johansen method is used, but are similar for business M2 across methods. When the commercial paper rate is included, it has a positive effect on trade debt in all but one case. Even when the commercial paper rate is included, though, the coefficient on money is still negative and significant. Furthermore, in most cases, the coefficient does not change dramatically. Finally, in every case, trade debt appears to have a strong positive trend.

These results might be interpreted as follows. The negative long-run relationship between trade debt and money suggests that the source of the stochastic trend in these variables is shocks to the financial sector. Any effects of scale seem to be well represented by the deterministic trend, so that the substitution effect dominates in the response to the stochastic trend. Thus, not only are trade debt

Table 3

Cointegrating regressions for trade debt (sample period varies with the number of leads and lags, t-statistics in parentheses).

Variables	Money = Business M1		Money = Business M2	
A. Estimated by dynamic OLS[a]				
Trend	0.0091 (39.6)	0.0084 (29.7)	0.011 (43.3)	0.0099 (44.9)
Money	− 0.44 (− 8.1)	− 0.31 (− 4.0)	− 0.49 (− 10.2)	− 0.34 (− 9.1)
Commercial paper rate		0.016 (3.5)		0.017 (7.3)
# of leads of Δ money	4	4	2	2
# of lags of Δ money	10	10	12	12
# of leads of Δ cp	–	1	–	2
# of lags of Δ cp	–	0	–	2
B. Estimated by Johansen's method[b]				
Trend	0.0085 (16.0)	0.0096 (15.9)	0.011 (51.1)	0.011 (23.6)
Money	− 0.52 (− 4.8)	− 0.83 (− 3.5)	− 0.41 (− 8.6)	− 0.40 (− 6.6)
Commercial paper rate		− 0.035 (− 1.9)		0.0006 (0.10)

[a]The number of leads and lags were chosen as described in Campbell and Perron (1991), with $k_{max} = 12$ quarters. Seasonal dummy variables were also included in the regressions.

[b]Each equation of the vector error correction model (VECM) contains eight lags of each variable included in the cointegration relationship. Seasonal dummy variables were also included in each equation.

and money cointegrated, but they have a long-run negative relationship. These comovements are consistent with the following hypothesis: the key source of fluctuations in money is not aggregate technology shocks, but rather shocks to the financial sector. Furthermore, the effects of these shocks operate through channels other than the nominal interest rate.

Are trade debt and money also negatively related in the short run? With the long-run structure of the model established, we can now attempt to answer this question. The investigation will begin with an analysis of the data at non-seasonal short-run frequencies.

The most straightforward way to characterize the short-run relationships is through impulse response functions. To this end, the estimated parameters of the vector error correction model (VECM) are used to estimate the response of money and trade debt to innovations in the system. The system is structured as follows. In order to eliminate the influence of interest rates, the VECM is estimated for the trivariate system of trade debt, money, and interest rates.

Interest rates are always placed first in the ordering, and are allowed to enter the cointegrating relationship. Eight lags of the differences of each variable are included. Impulse response functions are estimated for two cases, one with money placed before trade debt and one with trade debt placed before money. For economy, results are shown for only the business M2 definition of money. The results are similar for the business M1 definition, and for the system with interest rates excluded.

Fig. 3 shows the impulse response functions to a one-standard-deviation shock to the first difference of the relevant variable. Panel A shows clearly that a negative shock to money, which leads to a permanently lower level of money, is accompanied by a permanent rise in trade debt. Trade debt shows a slight hump shape in response, but even in the short run the two variables tend to move in opposite directions. The jagged path of money stems from apparent stochastic seasonality. Trade debt converges to a higher level and money to a lower level as a consequence of the initial shock. Panel B, on the other hand, shows the effect of a positive shock to trade debt. The paths here also show trade debt and money moving in opposite directions. Thus, money and trade debt move in opposite directions even in the short run, even after interest rate effects have been extracted.

Finally, let us investigate the seasonal comovements of money and trade debt. This analysis can be viewed as a check on the previous results. A priori one would expect that nonfinancial shocks are important at seasonal frequencies, as much seasonal variation can be attributed to taste shocks, such as Christmas, and supply shocks, such as the weather. Thus, trade debt and money should be positively related at seasonal frequencies.[10]

Table 4 presents a description of the seasonal patterns in the variables. Two methods are used: seasonal dummy variables and X-11.[11] The seasonal dummy method regresses the first difference of the variable on the seasonal dummies. The X-11 method applies a multiplicative decomposition of the level of the variables; the log of the seasonal component is then used in the analysis.

The first panel of table 4 shows the coefficients on the seasonal dummy variables for the annualized percentage growth rates of trade debt, business M1 and business M2. For all three variables, the coefficient on the first-quarter dummy is negative and significant. The estimates show that the growth rate of trade debt during the first quarter is ten percentage points less than the average, while the growth rates of money during the first quarter are more than twenty percentage points less than average. In contrast, all variables show fourth-quarter growth rates that are significantly greater than average, over 5 percent

[10] I am grateful to an anonymous referee for suggesting these arguments to me.

[11] There was no evidence of seasonal unit roots, as discussed by Hylleberg, Engle, Granger, and Yoo (1990).

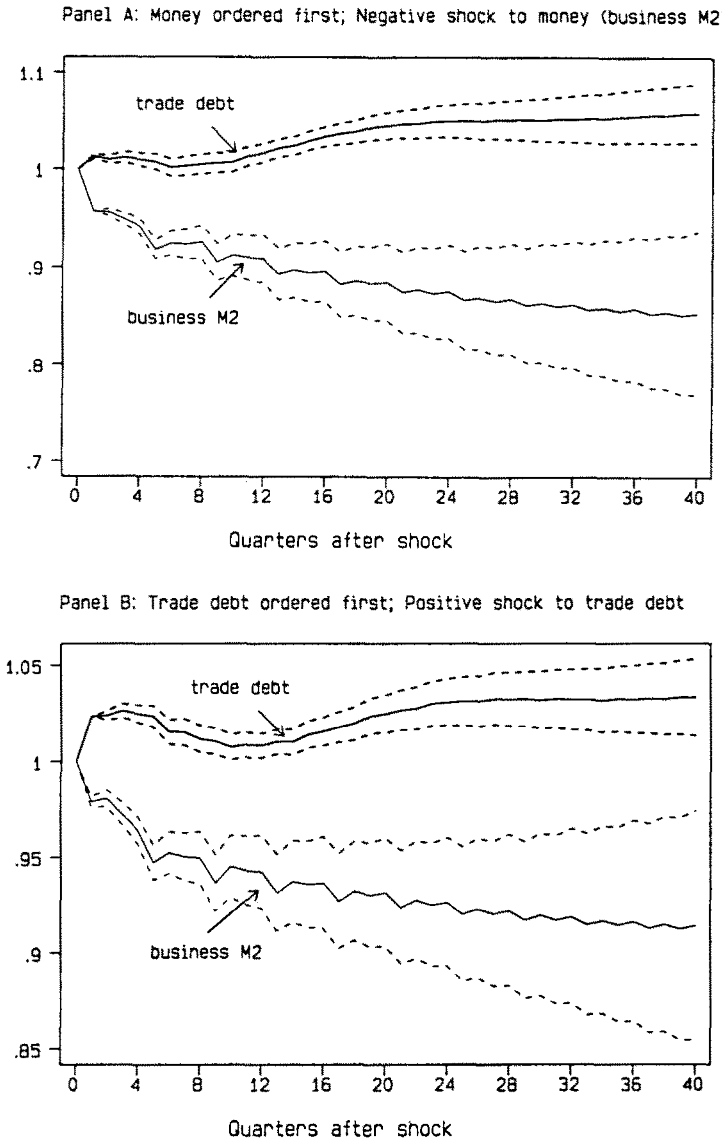

Fig. 3. Impulse response functions, dashed lines show bootstrap one-standard-error bands.

for trade credit and near 20 percent for money. The results are somewhat mixed for the second and third quarters. The money variables display second-quarter growth rates that are slightly higher than average, while the second-quarter growth rate of trade debt is essentially equal to the average. Finally, all variables show zero or slightly higher than average growth rates in the third quarter.

Table 4
Seasonal correlations, quarterly, 1952:1–1991:2, t-statistics in parentheses.

(1) Coefficients on seasonal dummy variables[a]

Quarters	Trade debt	Business M1	Business M2
First	−10.3	−28.8	−21.4
	(−10.0)	(−14.0)	(−13.7)
Second	−0.96	5.07	2.92
	(−0.94)	(2.5)	(1.9)
Third	5.47	3.34	0.81
	(5.3)	(1.6)	(0.52)
Fourth	5.74	20.3	17.6
	(5.6)	(9.9)	(11.3)

(2) Regressions of seasonal components obtained with dummy variables

$$\Delta \log(\text{trade}) = \text{constant} + 0.333\ \Delta \log(\text{business M1})$$

$$\Delta \log(\text{trade}) = \text{constant} + 0.415\ \Delta \log(\text{business M2})$$

(3) Regressions of seasonal components obtained with X-11[b]

$$\Delta \log(\text{trade}) = \text{constant} + \underset{(17.0)}{0.306} \log \Delta(\text{business M1})$$

$$\Delta \log(\text{trade}) = \text{constant} + \underset{(16.6)}{0.406}\ \Delta \log(\text{business M2})$$

[a]Normalized so that the sum is zero.
[b]The reported t-statistics do not contain a correction for the fact that the seasonal components are estimated.

The second panel of the table summarizes these relationships by regressing the seasonal component of trade debt on the money variables. In both cases, the relationship is positive. Interestingly, the coefficients in the seasonal regressions are the negatives of the coefficients in the cointegrating relationships presented in table 3, despite the fact that the two sets of regressions use components that are orthogonal to each other. The final panel of table 4 shows the regression of the X-11 seasonal factors. Again, trade debt is positively related to both definitions of money, and the coefficients are the negatives of the cointegrating coefficients. The method of extracting the seasonal components does not alter the results.

To summarize the results so far, there seems to be a significant negative relationship between money and trade debt in both the (nonseasonal) short run and in the long run. On the other hand, there is a significant positive relationship between money and trade debt at seasonal frequencies. The theory presented in the previous section interprets the nonseasonal results as implying that most of the movements in money are due to financial shocks. Thus, the data are

Table 5
Cointegration tests with real GNP, quarterly, 1955:2–1991:2.[a]

Variables	Deterministic cointegration		Stochastic cointegration	
	Test statistics	Optimal lags	Test statistics	Optimal lags
Business M1	− 0.99	8	− 1.97	1
Business M2	− 2.05	8	− 2.38	1
Trade debt	− 2.76	4	− 2.03	5
Aggregate M1	− 1.90	5	− 1.78	1
Aggregate M2	− 3.39	10	− 2.20	12

[a]All variables are in logarithms. Tests involving Flow-of-Funds data included seasonal dummy variables. The critical values for deterministic cointegration are −3.38 for the 5 percent significance level and −3.07 for the 10 percent significance level. The critical values for stochastic cointegration are −3.85 for the 5 percent significance level and −3.55 for the 10 percent significance level. The critical values are taken from MacKinnon (1991).

inconsistent with the real business cycle explanation for the procyclicality of money.

What do these results imply about the source of shocks to GNP? Recall from the theoretical section that if there is one stochastic trend in the economy, real money and real GNP should be cointegrated. In combination with the results presented above, cointegration between money and GNP would imply that shocks to the financial sector are the source of the stochastic trend in GNP.

Table 5 shows the test statistics for the cointegration tests between the various (real) monetary variables and trade debt and real GNP. According to the test statistics, only GNP and aggregate M2 seem to be (deterministically) cointegrated. Hence, while there is some evidence for a common stochastic trend between output and M2, neither output nor aggregate M2 is cointegrated with trade debt and the other definitions of money. Thus, the stochastic trend shared by business M2 and trade debt is not the only stochastic trend affecting output. This result is not surprising, since one would expect other shocks, such as oil prices, government spending, and taxes, to be important determinants of the stochastic behavior of real output. That is, GNP is probably driven by more than one stochastic trend. The presence of more than one stochastic trend in real GNP, though, does not imply that financial shocks are unimportant, only that they are not dominant in the stochastic behavior of GNP.

If the nonfinancial shocks are important, however, it is more difficult to explain the observed cointegrating relationship between money and trade credit. As discussed earlier, money and trade credit should not in general be cointegrated in the presence of two stochastic trends. One possible explanation for the finding of cointegration is that the other shocks have little impact on the financial variables because the scale effects are small, or are well represented by a deterministic trend. Under this scenario, most of the deviations of trade debt and money from the deterministic trend are due to substitution effects.

In any case, the negative relationship between money and trade credit suggests that shocks to the financial system are the key determinant of fluctuations in money. The results, however, do not distinguish between shocks to the nominal money supply and other types of shocks. Other potentially important financial shocks are credit controls, bank failures, deregulation, changes in reserve requirements, and technological innovation. These latter types of shocks could easily be incorporated into a real business cycle model, as they do not rely on sticky prices for a transmission mechanism.

5. Conclusions

This paper has presented a simple theoretical extension of King and Plosser's real business cycle model with transactions services as an input. The theoretical analysis shows that comovements between money and trade debt can potentially reveal the source of the fluctuations in money. The empirical results indicate that money and trade debt are negatively related in both the short and the long run. Thus, the primary impetus to money seems to be financial shocks that change the cost of bank transactions services relative to trade debt. However, this impetus is not the only nonstationary trend in real output.

The results suggest that it would be fruitful to incorporate a financial sector in calibrated real business cycle models. One could then study the responses of aggregate variables to shocks to the financial sector. Indeed, several authors have begun incorporating liquidity effects in equilibrium models [Fuerst (1992) and Christiano and Eichenbaum (1992)]. In a sense, shocks to the banking industry are more plausible as sources of business fluctuations than shocks to the goods industry because of the central role of banks in the economy. Banking services are used by all sectors of the economy whereas, with the notable exception of oil, most goods are an input for only a fraction of the other sectors. Thus, incorporation of financial effects in fully-specified dynamic models should enhance our understanding of business cycle fluctuations.

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