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MONEY, CREDIT AND NONFINANCIAL ECONOMIC ACTIVITY: AN EMPIRICAL STUDY OF FIVE COUNTRIES

Benjamin M. Friedman

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Abstract

Data for five major industrialized economies show that the relationship between credit and nonfinancial economic activity exhibits stability comparable to that of the relationship between money and economic activity. Specific orderings among a narrow monetary aggregate, a broad monetary aggregate and a credit aggregate differ depending upon the stability criterion being applied and the country under study. On balance, credit exhibits the most stable contemporaneous relationship among the three aggregates, while the narrow money stock exhibits the most stable dynamic relationship with credit in second place and the broad money stock third.

Further tests for the same five economies also show that, within the total of nonfinancial debt comprising the aggregate, the respective public and private debt components exhibit movements over time that offset one another, and hence act to maintain the stability of total credit in relation to economic activity.

Finally, additional tests for these five economies do not support the notion that the comparability of the respective relationships of credit and money to nonfinancial economic activity is due to any straightforward process whereby "money causes income and income causes credit." The interrelationships among money, credit, real income and prices in each economy are too complex to admit of any such simple interpretation.

Benjamin M. Friedman
Harvard University
Littauer Center 127
Cambridge, MA 02138
(617) 495-4246

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MONEY, CREDIT AND NONFINANCIAL ECONOMIC ACTIVITY: AN EMPIRICAL STUDY OF FIVE COUNTRIES

Benjamin M. Friedman*
Harvard University

Recent research for the United States has shown that one particular credit aggregate, the outstanding indebtedness of all nonfinancial borrowers, bears as close and as stable a relationship to the economy's nonfinancial activity as do any of the monetary aggregates or the monetary base.[1] Moreover, in contrast to the monetary aggregates, among which there seems to be little basis for choice from this perspective, total nonfinancial debt appears to be unique in this regard among major credit aggregates. Hence unlike the monetary (and broader asset-side) aggregates, the stability of the relationship for total nonfinancial debt does not just represent the stability of a sum of stable parts.

The stability of the relationship between total nonfinancial debt and economic activity bears several potentially important implications for economic analysis as well as economic policy. From a theoretical perspective, this finding calls into question the conventional structure of macroeconomic models, which explicitly represents the supply-demand equilibrium for the money market but not for the credit market. With respect to monetary policy, the stability of the credit-to-income relationship immediately suggests that, as long as a central bank operates within an intermediate target framework, perhaps one of its principal targets should be a credit aggregate. With respect to fiscal policy, some of the behavioral hypotheses that are consistent with this finding have direct implications for whether debt-financed government spending (or tax cuts) can provide an effective economic stimulus or can merely "crowd out" private spending.

The object of this paper is to show that the finding of a stable relationship between credit and nonfinancial economic activity is in no way unique to the United States. Sections I-IV replicate for data from four additional countries — Canada, Germany, Japan and the United Kingdom — the comparative analyses of the credit-to-income versus money-to-income relationships previously carried out for U.S. data. These tests span a variety of methodologies including simple comparisons of coefficients of variation (Section I), nominal income regressions (II), vector autoregression generalizations of nominal income regressions (III), and vector autoregression analysis of private and government debt interactions (IV). Section V presents a further vector autoregression analysis for each country, addressing the question of whether the explanation for the stability of the credit-to-income relationship is simply that money "causes" income while income "causes" credit. (The answer is no.) Section VI summarizes the empirical findings and offers brief concluding comments.

I. Comparison of Money and Credit "Velocities"

Each panel of Figure 1 shows, for a particular country, the movement over time of three different ratios relating three of that country's financial aggregates to its nonfinancial economic activity as measured by gross national product.[2] The three financial aggregates are in each case a narrow money stock measure ("M1"), a broad money stock measure ("M2" or "M3") and total nonfinancial debt ("credit"). The data plotted are quarterly values for Canada, Japan, the United Kingdom and the United States. They are annual for Germany (where quarterly credit data are unavailable). The specific sample periods used for the five countries differ according to data availability as of the time of writing, and each series is indexed to 100 at its inception to facilitate ready comparisons.

Table 1 summarizes the stability of these fifteen ratios by showing their respective coefficients of variation (standard deviation normalized by mean), computed first from the raw data plotted in Figure 1 and then from detrended data. What stands out most in intra-country comparisons of coefficients of variation computed from the raw data is simply the difference, already apparent in Figure 1, between those aggregates that exhibit time trends in their respective "reciprocal velocity" ratios — for example, M1 in Canada, the U.K. and the U.S.; M2 in Canada and M3 in Germany; and credit in Germany and the U.K. — and those that exhibit little or no trend. Even so, as judged from the raw data, the credit ratio is more stable than either of the money ratios in three of the five countries.

On the basis of the detrended data, the credit ratio is more stable than either of the money ratios in four of the five countries. Only in Canada does either of the monetary aggregates (actually both, for Canada) exhibit a more stable ratio to income than does credit. (Interestingly enough,

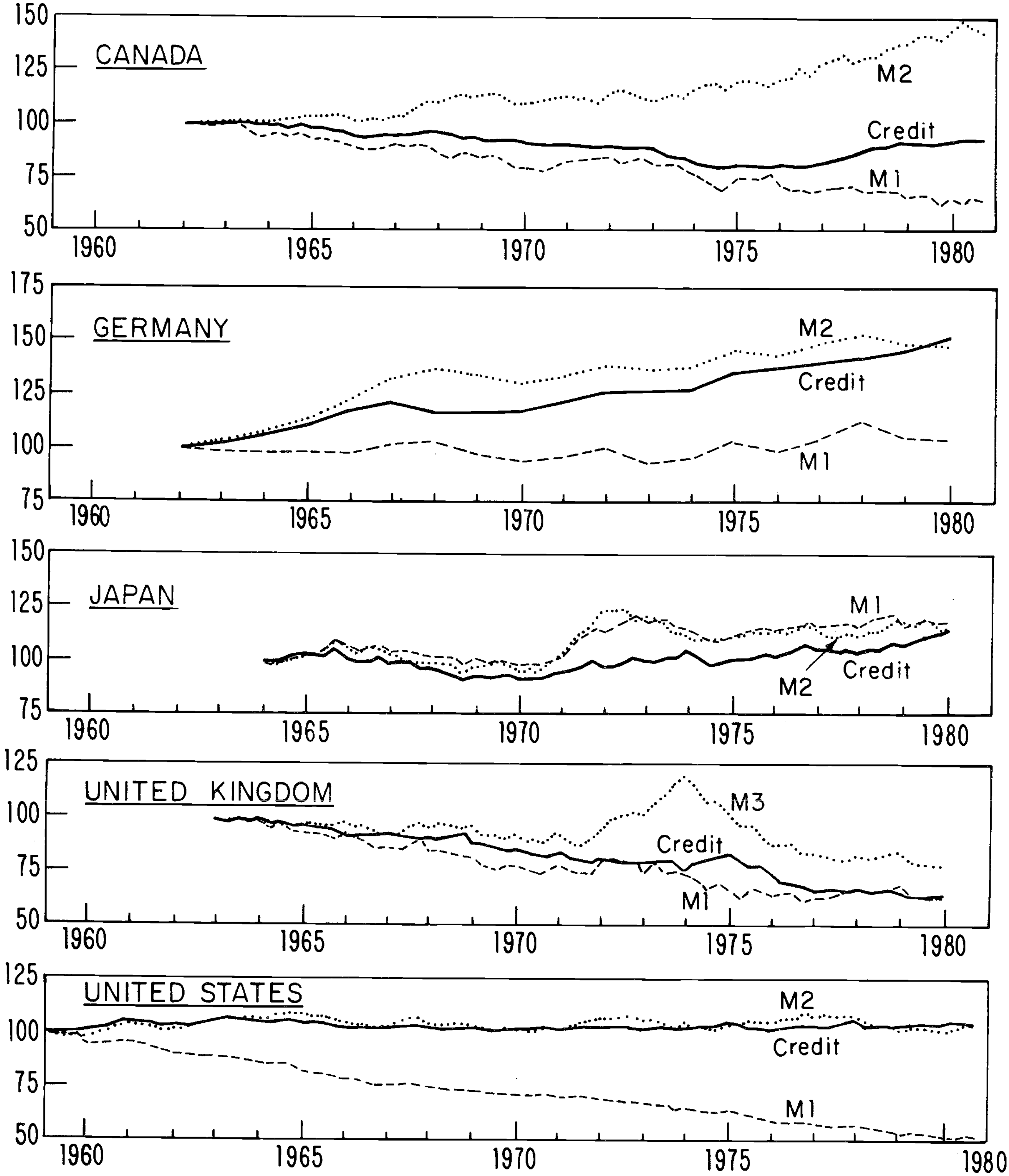

FIGURE 1

FINANCIAL AGGREGATES AS RATIOS TO INCOME FOR FIVE COUNTRIES

Canada is one of the three countries for which the credit ratio is the most stable on the basis of the raw data.) A comparison of the two monetary aggregates, across the four countries in which the credit ratio is more stable than either one, shows that the M1 ratio is more stable than that for M2 or M3 in all but Japan.

In sum, intra-country comparisons of the respective coefficients of variation of the ratios to gross national product of three financial aggregates — narrow money, broad money, and credit — show that credit consistently exhibits either the closest, or nearly the closest, relationship to nonfinancial economic activity.

TABLE 1

STABILITY OF MONEY AND CREDIT "VELOCITY" RATIOS

	Raw	Detrended
Canada (1962:I - 1980:IV)		
Money M1	.131	.030
Money M2	.116	.040
Credit	.065	.047
Germany (1962-1980)		
Money M1	.046	.040
Money M2	.121	.044
Credit	.123	.030
Japan (1964:I - 1980:I)		
Money M1	.081	.057
Money M2	.075	.041
Credit	.052	.040
United Kingdom (1963:I - 1979:IV)		
Money M1	.143	.041
Money M3	.092	.084
Credit	.132	.029
United States (1959:I - 1980:IV)		
Money M1	.188	.020
Money M2	.023	.023
Credit	.014	.013

Notes: Coefficient of variation of ratio to gross national product.
Data from Statistics Canada, Deutsche Bundesbank, Bank of Japan, Bank of England and Central Statistical Office, and Board of Governors of the Federal Reserve System.

II. Comparison of Nominal Income Regressions

Because most of the interesting aspects of financial-nonfinancial interactions are presumably dynamic, simple ratios of contemporaneous observations like those presented in Section I probably fail to capture the concept of "stability" that is relevant for either analyzing economic behavior or formulating economic policy. Relationships admitting a lead or lag pattern provide more useful stability measures.

Table 2 presents summary statistics for equations estimated for the same data analyzed in Section I, for each country, relating the growth of nominal gross national product to a moving average of the growth of each of the three financial aggregates listed in Table 1, plus a moving average of a fiscal policy measure. Each equation is estimated in the familiar form

$$\Delta \ln Y_t = \alpha + \sum_{i=0}^{N} \beta_i \Delta \ln F_{t-i} + \sum_{i=0}^{N} \gamma_i \Delta \ln E_{t-i} + \mu_t \quad (1)$$

where Y is gross national product; F is any of the three aggregates; E is government expenditures, measured on a full-employment basis;[3] α, the β_i and the γ_i are estimated scalar coefficients; and the β_i and γ_i are both constrained to lie along fourth-degree polynomials with the implied $\beta_{-1} = \beta_{N+1} = \gamma_{-1} = \gamma_{N+1} = 0$. For the four sets of equations based on quarterly data, the lag lengths are N = 4. For Germany the lag lengths based on annual data are N = 2, with the β_i and γ_i unconstrained.[4]

For researchers familiar with nominal income regressions based on U.S. data, perhaps the most striking feature of the results shown in Table 2 is not the intra-country comparisons at all but the inter-country comparisons of overall performance. In contrast to the three U.S. regressions, not one of the twelve non-U.S. regressions has a standard error smaller than .010

(that is, 4% per annum for quarterly data). Only two of the twelve non-U.S. regressions, those based on M1 for Canada and Germany, have coefficients of determination above .20; and neither of these two have Durbin-Watson coefficients close to 2.00. Relationships of this kind apparently have much less ability to "explain" the variation of nominal income in countries other than the United States, perhaps because of the greater openness of their respective economies.

The within-country comparisons indicate that the equation based on M1 has the greatest explanatory power for three of the five countries. The equation based on credit performs best for the other two countries, and is second-best in two of the three for which M1 is superior. Only in the case of Germany does credit not outperform at least one of the two monetary aggregates.[5]

TABLE 2

SUMMARY STATISTICS FOR NOMINAL INCOME REGRESSIONS

	SE	$\bar{R}^2$	DW
Canada			
Money M1	.0100	.27	1.62
Money M2	.0107	.14	1.50
Credit	.0104	.18	1.47
Germany			
Money M1	.0222	.24	1.08
Money M2	.0279	—	.97
Credit	.0277	—	1.18
Japan			
Money M1	.0163	.00	1.85
Money M2	.0157	.07	2.00
Credit	.0153	.12	2.11
United Kingdom			
Money M1	.0193	.15	2.29
Money M3	.0195	.13	2.24
Credit	.0191	.17	2.39
United States			
Money M1	.0076	.41	2.01
Money M2	.0081	.32	1.76
Credit	.0079	.37	2.14

Notes: SE = standard error of estimate.

$\bar{R}^2$ = coefficient of determination, adjusted for degrees of freedom (missing value indicates negative).

DW = Durbin-Watson statistic.

Sample periods and data sources as in Table 1.

III. Comparison of Multivariate Vector Autoregressions

Because of widespread criticisms of the methodology underlying nominal income regressions like those in Section II, researchers investigating the money-to-income (or, here, credit-to-income) relationship have increasingly turned to methods that relate the variation of income not to the entirety of the variation of money but to that part of it which cannot already be deduced either from the past history of money itself or from the joint past history of both money and income.[6] A useful approach to analyzing the dynamic interrelationships among economic time series in this way is the vector autoregression.[7] In brief, the vector autoregression methodology first expresses each of a system of variables as a function of lagged values of itself, lagged values of the other variables, and a disturbance term; then solves this representation to express each variable as a function of the entire history of the disturbances associated with it and the other variables; and, finally, investigates the direction and magnitude of the response of each variable to given independent shocks, or "innovations," to any or all variables in the system. The vector autoregression is straightforward to estimate empirically, and simulation of the solved-out system can then show the system-wide reactions that follow in response to innovations in particular variables.

A representation of the money-to-income or credit-to-income relationship that is more general along these lines (but that omits the fiscal policy variable, to keep the system small) is the vector autoregression

$$\begin{bmatrix} \ln F_t \\ \ln Y_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{bmatrix} \begin{bmatrix} \ln F_{t-1} \\ \ln Y_{t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \end{bmatrix} \tag{2}$$

where the μ_i are disturbances, and the α_i and B_{ij} are, respectively, fixed scalar coefficients and fixed-coefficient lag operator polynomials to be estimated.[8] Solution of the autoregression (2) yields a moving-average representation of the form

$$\begin{bmatrix} \ln F_t \\ \ln Y_t \end{bmatrix} = \begin{bmatrix} \xi_1 \\ \xi_2 \end{bmatrix} + \begin{bmatrix} \theta_{11} & \theta_{12} \\ \theta_{21} & \theta_{22} \end{bmatrix} \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \end{bmatrix} \tag{3}$$

where the ξ_i and θ_{ij} are, respectively, fixed scalar coefficients and fixed-coefficient lag operator polynomials derived from recursive substitution of the α_i and B_{ij} in (2) to express both F and Y as functions of the current values and past histories of both μ_1 and μ_2.

Although the normalization convention imposed in (2) in order to estimate the system constrains the zero-lag elements of the four polynomials to $\theta_{11} = \theta_{22} = 1$ and $\theta_{12} = \theta_{21} = 0$, so that μ_1 is "the F disturbance" and μ_2 "the Y disturbance" in the usual sense, in general the μ_1 and μ_2 series generated in the estimation of (2) are not independent. Simulations of (3) to trace the time paths of F and Y resulting from specific movements of μ_1 and μ_2 would contain all the information that the vector autoregression system can provide, but it is easier to think intuitively about the implications of such a simulation when it is possible to identify as its driving force an independent innovation in either F or Y. Hence it is useful either to subtract out of μ_1 that part of its variation that is correlated with μ_2 so as to leave the residual to represent the independent innovation in F or, alternatively, to subtract out of μ_2 that part of its variation that is correlated with μ_1 so as to leave the residual to represent the independent innovation in Y. The orthogonalization of (3) that extracts the independent F innovation (as ε_1) is simply [9]

$$\begin{bmatrix} \ln F_t \\ \ln Y_t \end{bmatrix} = \begin{bmatrix} \xi_1 \\ \xi_2 \end{bmatrix} + \begin{bmatrix} \Phi_{11} & \Phi_{12} \\ \Phi_{21} & \Phi_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \tag{4}$$

where the ξ_i are again as in (3), the ϕ_{ij} elements for each lag flow from the corresponding θ_{ij} according to

$$\begin{bmatrix} \phi_{11} & \phi_{12} \\ \phi_{21} & \phi_{22} \end{bmatrix} = \begin{bmatrix} \theta_{11} & \theta_{12} \\ \theta_{21} & \theta_{22} \end{bmatrix} \begin{bmatrix} 1 & \lambda \\ 0 & 1 \end{bmatrix} \tag{5}$$

and the ε_i innovations follow from the μ_i disturbances according to

$$\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} = \begin{bmatrix} 1 & -\lambda \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \end{bmatrix} \tag{6}$$

for

$$\lambda = \frac{\text{cov}(\mu_1, \mu_2)}{\text{var}(\mu_2)} . \tag{7}$$

Table 3 presents summary simulation results based on the vector autoregression system (2) estimated for each country, using in turn each of the three financial aggregates, and then solved for the corresponding moving-average representation (3) and orthogonalized as in (4)-(7). The estimation of (2) includes eight quarters of lags on each variable in each system based on quarterly data, and two years of lags on each variable in the systems based on German annual data. The values shown in the table, for each of the fifteen systems, are the respective time paths of each "reciprocal velocity" ratio F/Y, solved simply as $\ln(F/Y) = \ln(F) - \ln(Y)$, that result from a simulation of (4) in response to a 1% innovation in F in the initial quarter (or year) only.[10] For the systems estimated using quarterly data, the table shows values for the initial quarter and then for the final quarter in each of the first five years. For the systems estimated using

TABLE 3

DYNAMIC RESPONSES OF BIVARIATE VECTOR AUTOREGRESSION SYSTEMS

			Dynamic Response of the Aggregate-to-Income Ratio to a 1% Impulse Innovation in the Aggregate		
			Money (M1)	Money (M2/M3)	Credit
Canada:	Quarter	1	1.00%	1.00%	1.00%
		4	.77	.20	-.38
		8	.05	-.17	-.63
		12	-.30	-.10	.44
		16	-.24	.03	.57
		20	-.14	-.01	.43
Germany:	Year	1	1.00	1.00	1.00
		2	.08	.93	.02
		3	-.13	.87	-.02
		4	.29	.85	.33
		5	.29	.89	.13
Japan:	Quarter	1	1.00	1.00	1.00
		4	.92	.71	.32
		8	.62	.20	-.25
		12	.09	-.34	-.56
		16	.19	-.24	-.28
		20	.30	.21	-.15
United Kingdom:	Quarter	1	1.00	1.00	1.00
		4	.23	.95	1.07
		8	.07	1.31	.26
		12	-.28	-.09	-.30
		16	-.25	-.88	-.58
		20	.13	-.96	-.26
United States:	Quarter	1	1.00	1.00	1.00
		4	-.15	.93	.17
		8	.35	.67	.78
		12	-.01	-.27	.61
		16	-.25	-.36	.33
		20	-.23	-.06	.06

German annual data, the table shows values for the first five years.

By construction, Y remains unaffected in the initial period in which an independent innovation occurs in F, so that in each case the F/Y ratio rises by the full 1% of the innovation in F. In each system, however, the bulge in F/Y shrinks as Y rises or F declines, or both. The question of the stability of the relationship between F and Y is then a matter of the speed and smoothness with which the bulge disappears. In the absence of a largely arbitrary judgment of the exact time horizon that is relevant, any comparisons among these results admit interpretation in a descriptive way only. Even so, the intra-country comparisons are suggestive in several respects.

The most straightforward aspect of these comparisons is the relatively weak performance of the broader monetary aggregate. Only for Canada do the simulation results show the ratio of M2 to income returning rapidly to its baseline after the one-period impulse innovation in M2. For Japan the M2 ratio's return is slower, and for Germany it is scarcely noticeable. For both the United Kingdom and the United States, an M3 or M2 innovation induces still further movements of the respective ratio away from the baseline, followed by substantial over-correction on the return.

The comparison between M1 and credit on this criterion of stability is much closer, although on balance M1 has the edge. After an innovation in M1, the M1-to-income ratio returns to its baseline quite quickly in three countries, and moderately so in a fourth (Canada). Only for Japan is the return somewhat slow and unsteady. Credit performs well in this context in two countries (Germany and the United States) and moderately well in a third (Japan). For Canada, however, the return of the credit ratio shows substantial over-correction, and for the United Kingdom it shows both slowness and over-correction. By a rough margin of one country out of five, therefore, M1 appears to have the more stable relationship to income in this context.

A further element in the tendency of recent researchers to eschew reliance on simple nominal income regressions like those in Section II has been an increasing reluctance to focus on the relationship between money (or, here, credit) and nominal income without distinguishing between the real and price components of nominal income variation.[11] Table 4 presents simulation results that are analogous to those shown in Table 3 but are based on the trivariate system

$$\begin{bmatrix} \ln F_t \\ \ln X_t \\ \ln P_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} + \begin{bmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{bmatrix} \begin{bmatrix} \ln F_{t-1} \\ \ln X_{t-1} \\ \ln P_{t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \end{bmatrix} \tag{8}$$

solved for the corresponding orthogonalized moving-average representation

$$\begin{bmatrix} \ln F_t \\ \ln X_t \\ \ln P_t \end{bmatrix} = \begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \end{bmatrix} + \begin{bmatrix} \Phi_{11} & \Phi_{12} & \Phi_{13} \\ \Phi_{21} & \Phi_{22} & \Phi_{23} \\ \Phi_{31} & \Phi_{32} & \Phi_{33} \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \tag{9}$$

where P is the gross national product price deflator (1972 = 1.0), X is real income (Y/P), and all other symbols are exactly analogous to their counterparts in (2) and (4). Like Table 3, Table 4 again shows simulation results for each of the three asset or liability ratios, in each case solved simply as $\ln[F/(X \cdot P)] = \ln(F) - \ln(X) - \ln(P)$, in response to a 1% innovation in the respective aggregate.[12]

These results for the trivariate systems indicate even more comparability among the three financial aggregates, in their respective relationships to income, than do the results for the corresponding bivariate systems.

TABLE 4

DYNAMIC RESPONSES OF TRIVARIATE VECTOR AUTOREGRESSION SYSTEMS

			Dynamic Response of the Aggregate-to-Income Ratio to a 1% Impulse Innovation in the Aggregate		
			Money (M1)	Money (M2/M3)	Credit
Canada:	Quarter	1	1.00%	1.00%	1.00%
		4	.72	.09	-.58
		8	.01	-.18	-.78
		12	-.26	-.09	.29
		16	-.12	-.17	.33
		20	-.10	-.15	.60
Germany:	Year	1	1.00	1.00	1.00
		2	-.38	.58	-.15
		3	-.62	.32	.09
		4	.50	.22	.37
		5	.31	-.11	-.38
Japan:	Quarter	1	1.00	1.00	1.00
		4	.56	.61	.59
		8	.16	-.12	-.38
		12	-.28	-.35	-.25
		16	-.21	-.47	-.32
		20	-.26	-.21	-.46
United Kingdom:	Quarter	1	1.00	1.00	1.00
		4	.20	.96	.76
		8	.04	1.56	.48
		12	-.29	-.07	.13
		16	-.25	-.99	-.89
		20	.13	-1.02	-.56
United States:	Quarter	1	1.00	1.00	1.00
		4	-.28	.81	-.30
		8	.36	.78	.23
		12	.09	-.12	.26
		16	-.21	-.33	-.06
		20	-.10	-.07	-.08

The Ml-to-income ratio returns rapidly and smoothly to its baseline after an innovation in Ml in two countries, the United Kingdom and the United States, and moderately so in two others, Canada and Japan. (It is interesting that the one exception here is Germany, while in the bivariate results the one country for which Ml performs poorly is Japan.) The credit-to-income ratio also returns to its baseline rapidly and smoothly in two countries, here Germany and the United States. In Canada and the United Kingdom, however, the credit ratio exhibits a temporary but substantial over-correction, and in Japan the over-correction is fairly modest but persistent nonetheless. Canada is again the only country for which the broader money ratio shows strong stability on this criterion, although the respective M2 results for Germany and the United States also show stability after some delay.

On balance, the intra-country comparisons of stability in bivariate and trivariate vector autoregression generalizations of the more familiar nominal income regressions suggest, somewhat weakly, that the money-to-income relationship is either more or less stable than the credit-to-income relationship according to whether the "money" in question is a narrow or a broad monetary aggregate, respectively. This conclusion about the relative stability among the three aggregates in this sense is somewhat different from that indicated by nominal income regressions themselves, and quite different from that indicated by comparisons of coefficients of variation. Hence the specific criterion for judging stability appears to be important for the implied ordering. Moreover, the country-by-country differences between the results shown in Tables 3 and 4 further reinforce the importance of the choice of criterion, in that even the difference between bivariate and trivariate autoregressions can alter the results for any given country.

IV. Interactions Between Public and Private Debt

An argument for the stability of an aggregate inevitably relies on some notion of negative covariance among that aggregate's components. Moreover, as the analysis in Sections II and III has emphasized, for many purposes what is important is not just the precisely contemporaneous covariation but the joint movement of two or more series over time. In the case of an economy's total nonfinancial debt ratio, stability requires that movements in any one sector's debt relative to economic activity typically be offset by movements in the opposite direction in at least some other sector's debt.

The vector autoregression methodology used in Section III to examine the dynamic covariation between aggregate credit and income in each country is equally suitable for analyzing the dynamic covariation among the respective debt totals of different sectors comprising each country's aggregate credit. Although in principle it would be possible to apply this analytical apparatus to as full a disaggregation as each country's data sources permit, doing so would yield so many partial relationships as to confound rather than enhance understanding. Hence some more compact — that is, more fully aggregated — way of organizing the data is needed. In light of the theoretical literature on financial aspects of fiscal policy, one procedure that makes sense intuitively is to distinguish between the government and private components of total nonfinancial debt, while continuing to aggregate fully within the private sector.[13]

The bivariate vector autoregression representing the interaction of the public and private sectors' respective outstanding debt totals, each measured as a ratio to gross national product (so that for each country the two sum to the aggregate credit ratio plotted in Figure 1), is

$$\begin{bmatrix} (CG/Y)_t \\ (CP/Y)_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} B_{11} & B_{12} \\ B_{21} & B_{22} \end{bmatrix} \begin{bmatrix} (CG/Y)_{t-1} \\ (CP/Y)_{t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \end{bmatrix} \qquad (10)$$

where CG and CP indicate government debt and private debt, respectively, and all other symbols are as in (2). Solution of this autoregression into its moving-average representation yields

$$\begin{bmatrix} (CG/Y)_t \\ (CP/Y)_t \end{bmatrix} = \begin{bmatrix} \xi_1 \\ \xi_2 \end{bmatrix} + \begin{bmatrix} \Theta_{11} & \Theta_{12} \\ \Theta_{21} & \Theta_{22} \end{bmatrix} \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \end{bmatrix} \qquad (11)$$

and orthogonalization in turn yields

$$\begin{bmatrix} (CG/Y)_t \\ (CP/Y)_t \end{bmatrix} = \begin{bmatrix} \xi_1 \\ \xi_2 \end{bmatrix} + \begin{bmatrix} \Phi_{11} & \Phi_{12} \\ \Phi_{21} & {}_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \qquad (12)$$

where ε_{1t} is the independent innovation associated with the government debt ratio if the system is orthogonalized by (5)- (7), while ε_{2t} is the independent innovation associated with the private debt ratio if the off-diagonal positions of 0 and λ are reversed in (5) and (6) and var(μ_1) replaces var(μ_2) in the denominator of (7).

Table 5 presents summary simulation results based on the vector autoregression system (10), estimated for each country and then orthogonalized in each of these two ways. The first column of the table shows the simulated five-year response of the total nonfinancial debt ratio (CG+CP)/Y to a 1% innovation in CG/Y, based on the orthogonalization that extracts that independent innovation as ε_1. The second column shows analogous results for the response of (CG+CP)/Y to a 1% innovation in CP/Y, based on the alternative orthogonalization that extracts that independent innovation as ε_2. The estimation of (1) relies on annual data for all five countries, with two years of lags on each variable in each system.

TABLE 5

INTERACTION OF PUBLIC AND PRIVATE DEBT RATIOS

		Dynamic Response of Aggregate Debt-to-Income	
		Innovation in Public Debt	Innovation in Private Debt
Canada:	Year 1	1.00%	1.00%
	2	.57	1.67
	3	.35	1.87
	4	.31	1.79
	5	.35	1.65
Germany:	Year 1	1.00	1.00
	2	1.03	.55
	3	.86	-.28
	4	.72	-.52
	5	.58	-.27
Japan:	Year 1	1.00	1.00
	2	3.04	.48
	3	.15	.11
	4	.47	.05
	5	.10	.01
United Kingdom:	Year 1	1.00	1.00
	2	-.37	.68
	3	-.30	-.10
	4	-.23	-.41
	5	.11	-.21
United States	Year 1	1.00	1.00
	2	.42	.06
	3	.35	-.08
	4	.32	-.06
	5	.26	-.06

By construction, whichever of CG/Y or CP/Y does not experience the 1% innovation in the first year remains unchanged in that year, so that the aggregate debt ratio (CG+CP)/Y also rises by 1%. Soon thereafter, in most cases, a gradual decay in the component ratio experiencing the innovation and an induced offsetting response in the other component ratio combine to return the aggregate ratio to (or at least toward) the pre-innovation baseline. For an innovation in the government debt ratio, the simulations for Canada, the United Kingdom and the United States all show prompt interactions of this kind, and those for Germany and Japan do as well (albeit more slowly in Germany) after a counter-stable reaction in the second year.[14] For an innovation in the private debt ratio, the simulations for Japan, the United Kingdom and the United States all show this stable pattern, and that for Germany does also except for some over-correction. In sum, except only for Japan in the case of an innovation in the government debt ratio and Canada in the case of an innovation in the private debt ratio, these results provide evidence of offsetting dynamic interactions between public and private debt behavior that tend to restore the stability (in relation to income) of their sum in the context of a disturbance in either one.

V. Questions of Causality

The finding that the stability of the credit-to-income relationship is comparable to that of the money-to-income relationship is interesting in many respects. Nevertheless, its potential importance for issues of economic analysis and economic policy fundamentally depends on the behavior underlying this empirical phenomenon. Alternative behavioral mechanisms, each consistent with this basic observation, imply different answers to familiar questions about individuals' and firms' perceptions, about their actions in the financial markets, about the connection between spending-saving decisions and borrowing-lending decisions, and about the effects of monetary and fiscal policies. Investigating the behavioral determinants of the stability of the credit-to-income relationship constitutes a major challenge for macroeconomic research, but one that lies well beyond the scope of this paper.[15]

Even at the outset, however, it is important to clarify one dimension of the uncertainty surrounding the source (or sources) of the stability of the relationship between aggregate credit and income. In particular, this finding would be of limited usefulness if credit were merely the "tail" being wagged by the "dog" consisting of the rest of the economy — that is, if the other major aspects of economic activity were predetermined with respect to credit, rather than jointly determined along with credit. The same proposition also holds, of course, for the relationship between economic activity and money (however measured). A stable money-to-income relationship is of little value for economic policy if variations in money are simply after-the-fact responses to variations in nonfinancial economic activity.

In the context of this paper's focus on intra-country comparisons of money versus credit, the important question is whether credit is more or less fundamentally bound up in the joint determination of nonfinancial economic activity than is money. Does money "cause" income while income in turn "causes" credit? Is the reverse true? Does some dichotomy render nonfinancial activity predetermined with respect to both money and credit? Or are money and credit both jointly determined along with behavior in nonfinancial markets?

Following Granger [5] and Sims [8, 10], Table 6 presents test statistics based on the estimation of (8), with first the M1 money stock and then credit used as the financial aggregate. The estimation again includes eight quarters of lags on each variable in each system based on quarterly data. Because the choice of lag length affected the results in the system based on German annual data, the table presents separate results for Germany based on lags of two years and four years, respectively, on each variable. For each variable in each estimated equation, the table reports the F-statistic for a test of the null hypothesis that all of the β_{ij} coefficients on that variable in that equation are zero — in other words, the hypothesis that that particular independent variable does not incrementally contribute to explaining the variation of the dependent variable in that equation, beyond the explanation already provided by the other included variables.

Although there is little uniformity in results across the five countries (apart from the tendency of each variable to be significantly related to its own past history), these test statistics do not support the notion that money affects nonfinancial economic activity in some sense that credit does not. The coefficients on the lagged money values are significantly different from zero at the .10 level in the real income equations in Canada, the United Kingdom and the United States, while the analogous coefficients on credit significantly differ from zero only for Germany and the United

TABLE 6

EXOGENEITY TESTS IN SYSTEMS INCLUDING EITHER MONEY OR CREDIT

	Equation	F(X)	F(P)	F(M)	F(C)
Canada	X	8.13*	1.99***	2.91**	—
	P	1.02	42.84*	1.02	—
	M	1.11	1.59	13.14*	—
	X	5.11*	1.31	—	1.04
	P	2.19**	67.99*	—	2.23**
	C	1.95***	4.04*	—	32.83*
Germany (N=2)	X	11.41*	6.00**	2.17	—
	P	2.61	21.77*	3.00	—
	M	.73	6.27**	4.20***	—
	X	16.06*	13.31*	—	4.83**
	P	3.37***	16.82*	—	1.21
	C	8.34*	10.02*	—	1.91
Germany (N=4)	X	1.43	1.12	1.84	—
	P	.23	1.22	3.82	—
	M	.12	.94	1.25	—
	X	45.50*	36.18*	—	29.93*
	P	2.94	15.57**	—	3.08
	C	1.06	3.08	—	0.23
Japan	X	39.61*	2.20**	1.10	—
	P	1.23	23.06*	3.41*	—
	M	1.70	1.46	25.65*	—
	X	42.90*	1.89***	—	1.32
	P	1.83	16.83*	—	3.52*
	C	1.18	2.97**	—	26.80*
United Kingdom	X	1.46	2.44**	2.46**	—
	P	1.11	32.40*	.69	—
	M	.94	1.39	9.21*	—
	X	1.34	1.55	—	1.41
	P	.85	9.81*	—	.17
	C	1.32	.82	—	28.61*

(continued on next page)

Table 6 (Continued)

	Equation	F(X)	F(P)	F(M)	F(C)
United States	X	65.69*	1.68	1.85***	—
	P	.54	152.28*	.86	—
	M	3.96*	3.01*	58.23*	—
	X	5.11*	2.73**	—	2.02***
	P	1.15	45.81*	—	2.50**
	C	1.45	1.97***	—	66.00*

Notes: X = gross national product in constant prices
P = gross national product deflator
M = money (M1)
C = credit

* significant at .01 level
** significant at .05 level
*** significant at .10 level

TABLE 7

EXOGENEITY TESTS IN SYSTEMS INCLUDING BOTH MONEY AND CREDIT

	Equation	F(X)	F(P)	F(M)	F(C)
Canada	X	4.99*	1.72	2.86**	1.23
	P	1.06	47.73*	1.13	2.17***
	M	1.38	1.38	8.08*	1.73
	C	1.53	4.04*	3.62*	40.10*
Germany	X	14.27*	8.44**	1.74	3.84***
	P	2.91	20.12*	2.05	.72
	M	.48	4.47***	3.35***	.15
	C	16.05*	14.19*	3.50***	3.52***
Japan	X	21.15*	1.87	.88	1.05
	P	2.93**	12.27*	2.51**	2.60**
	M	1.50	1.35	3.58*	1.33
	C	.65	.94	.86	3.81*
United Kingdom	X	1.47	2.06***	1.79	1.00
	P	.67	7.69*	.51	.12
	M	.64	1.03	3.54*	.95
	C	.73	.91	1.00	15.51*
United States	X	5.04*	2.08***	1.15	1.28
	P	.80	27.34*	.60	1.98***
	M	3.79*	3.62*	24.09*	1.23
	C	1.10	1.49	1.18	60.13*

Note: See Table 6 for definitions of variable symbols.

States.[16] By contrast, the money coefficients are significantly different from zero in the price equations only for Japan, while the analogous credit coefficients are significantly nonzero not only for Japan but also for Canada and the United States.

The results are somewhat more consistent with the notion that money is predetermined with respect to nonfinancial economic activity while credit is not. Apart from the results for Germany, which differ here according to the lag length, the respective sets of coefficients on real income and prices are both insignificantly different from zero at the .10 level in the money equations for all countries except the United States. In the credit equations the coefficients on income are significantly nonzero only for Canada (and for Germany with two years of lags); but the coefficients on prices are nonzero for Canada, Japan and the United States (and again Germany with two years of lags).

If neither money nor credit is in the situation of simply being affected by nonfinancial activity while not affecting it, then systems that exclude one aggregate or the other — like those underlying the results shown in Table 6 — are misspecified. Table 7 presents analogous test statistics based on the estimation of a four-variable vector autoregression that generalizes (8) by including both M1 and credit (in addition to real income and prices, as before).

The results for these four-variable systems do not support the idea that money affects nonfinancial economic activity in some way that credit does not, nor the idea that money is predetermined with respect to economic activity in some way that credit is not. In the equations for real income the coefficients on money are significantly nonzero only in the case of Canada, while the coefficients on credit are significantly nonzero only in the case of Germany.[17] In the price equations, the coefficients on money are significantly nonzero only for Japan, while the coefficients on credit are significantly nonzero for Canada, Japan and the United States. In the equations for money, the coefficients on real income are significantly nonzero only for the United States, while the coefficients on prices are significantly nonzero for Germany and the United States. In the credit equations the coefficients on real income are significantly nonzero only for Germany, while the coefficients on both prices and money are significant for Canada and Germany.

Although the results of these two sets of exogeneity tests add little to understanding of the economic behavior connecting money, credit and nonfinancial economic activity, they do show that there is no evidence to warrant dismissing the observed stability of the credit-to-income relationship on the supposed ground that behavior in the credit market — unlike that in the money market — is determined after the fact, without effect on behavior in nonfinancial markets.

VI. Summary of Conclusions

A series of different tests, based on a range of methodologies and on data for five major industrialized economies, shows that the relationship between credit and nonfinancial economic activity exhibits stability that is comparable to that of the relationship between money and economic activity. Specific orderings among a narrow monetary aggregate, a broad monetary aggregate and a credit aggregate (defined in each case as total nonfinancial debt) differ depending upon the stability criterion being applied and the country under study. To the extent that the results as a whole admit of generalization, credit exhibits the most stable contemporaneous relationship among the three aggregates, while the narrow money stock exhibits the most stable dynamic relationship with credit in second place and the broad money stock third. Further tests also show that, within the total nonfinancial debt (credit) aggregate, the respective public and private debt components exhibit movements over time that offset one another, and hence act to maintain the stability of total credit in relation to economic activity.

Moreover, additional tests for the same five economies do not support the notion that the comparability of the respective relationships of credit and money to nonfinancial economic activity is due to any simple process whereby "money causes income and income causes credit." The interrelationships among money, credit, real income and prices in each economy are too complex to admit of any such straightforward interpretation. Hence the economic behavior underlying the stability of the credit-to-income relationship reamins a major puzzle — though, on reflection, no more so than the stability of the money-to-income relationship (for any "inside" definition of money).

Unraveling that puzzle is an important and challenging task for macroeconomic research. In the meanwhile, the empirical fact that the credit-to-income relationship is roughly as stable as the money-to-income relationship raises important caveats about the conventional focus of macroeconomic theory on the economy's assets but not its liabilities, about the conventional inclusion in macroeconomic models of an explicit representation of the money market but not the credit market, and about the convention focus of central bank policy on monetary aggregates but not credit aggregates.

Footnotes

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1. See Friedman [2, 3].

2. For the monetary aggregates these ratios are the reciprocals of the familiar "income velocity" measures. In the case of the United Kingdom, the income measure is gross domestic product.

3. In the case of Japan, the only available series for E is not seasonally adjusted. The three regressions for Japanese data therefore also include seasonal dummy variables. Once again, in the case of the United Kingdom the income measure is gross domestic product.

4. The choice of N = 2 versus N = 4 slightly affects the ordering in the regressions for the German annual data. With N = 4 (and the polynomial constraint on the β_i and γ_i) the respective sets of (SE, $\bar{R}^2$, DW) values are (.0232, .16, 1.66) for M1, (.0336, —, 1.16) for M2 and (.0357, —, 1.26) for credit.

5. With both $\bar{R}^2$ values negative, it is difficult to say that credit "outperforms" M3 despite the slight difference in standard errors. Also, see again footnote 4.

6. The most prominent criticisms of nominal income regressions like (1) have focused on the assumption of exogeneity with respect to nominal income of the two right-hand-side variables, as well as on the failure to distinguish the autoregressively deterministic from stochastic components of the variation of all three variables. See, for example, Goldfeld and Blinder [4], Sargent [7], and Modigliani and Ando [6]. See Section V below for tests of the exogeneity assumption for the money or credit aggregates.

7. See Sims [9] for a discussion of the vector autoregression methodology and its underlying rationale.

8. The use of levels of logarithms in (2) instead of differences of logarithms as in (1) has essentially no effect as long as the lag lengths of the B_{ij} are sufficient to provide roots near the unit circle. (If no roots near the unit circle are needed, then the differencing in (1) is incorrect in the first place.) Including a time trend in (2) would in general make a difference, but for the U.S. data results based on the alternative specification including a time trend differed little from those shown in Table 3 below.

9. The alternate orthogonalization that extracts ε_2 as the independent innovation in Y simply reverses the off-diagonal positions of 0 and λ in (5) and (6), with var(μ_1) replacing var(μ_2) in the denominator of (7).

10. Results based on U.S. data indicated that the response of F/Y to independent innovations in Y show little difference according to which aggregate is used for F; see Friedman [3].

11. The exogeneity tests presented in Section V below provide further support for distinguishing movements of real income and prices.

12. Results based on U.S. data indicated that the response of F/(X•P) to independent innovations in either X or P show little difference according to which aggregate is used for F; see again Friedman [3].

13. How to treat the debt of sub-national governmental jurisdictions for this purpose is a subtle question. The procedure followed here was to treat as "public" only the debts of national governments, as far as the available data permitted drawing distinctions.

14. The individual components of the simulation for Germany in the second year show a movement to 1.18 in CG/Y, offset in part by an induced reaction of -.15 in CP/Y. The (CG+CP)/Y ratio continues to decline after the fifth year, falling below .10 in the ninth year.

15. See Friedman [1] for a beginning along these lines.

16. These results for the United States differ from those reported in Friedman [2], which were based on a different sample period and a different definition of money.

17. This result for the United States again differs from that reported in Friedman [2] for a different sample period and a different definition of money. The German results shown are for N = 2; in the results for N = 4 (not shown), nothing was significant except F(X) in the equation for X.