The Role of the Budget Deficit during the Rise in the Dollar Exchange Rate from 1979–1985*

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I. Introduction

The U.S. dollar appreciated in value over 40% from early 1979 until it peaked in February 1985.[1] Also during this period the U.S. federal government budget deficit grew from $16b to $200b. According to Hakkio and Higgins [15] it is high U.S. interest rates and foreign capital inflows into the U.S. that provide the linkage between these two events. There is a considerable debate in the literature as to the precise influence of budget deficits upon these various linkages. Evans [10], for example, suggests that large deficits did not cause the rise in the dollar. Also, there are numerous studies refuting the association between deficits and interest rates; see Evans [11] and Hoelscher [16] for example. On the other hand, Plosser [25] reports a positive association between government spending and interest rates and Hoelscher [17] reports a positive association between deficits and long-term rates.

This paper uses an open-economy vector autoregression (VAR) model to investigate these linkages, finding that after controlling for the influence of money, inflation, the dollar, and the trade deficit, there is indeed causality running from deficits to long-term interest rates. The model also identifies a relationship between long-rates and the dollar value, thus verifying the linkage, albeit indirect, of budget deficits and the dollar value.

A second concern is that large budget deficits may have led to an accommodative monetary policy causing excessive money growth rates at times. For example, from 1982:07–1983:09 M1 growth averaged 13% and when the dollar value peaked in 1985, M1 was growing at about 12%.[2] A number of authors have examined this issue, yet collectively they have not arrived at a uniform conclusion. Ahking and Miller [1] provide a summary of these studies. The majority of these studies suffer from at least one of two faults that I attempt to correct in this paper. In particular, they either suffer from exogeneity problems stemming from single-equation models or they suffer from omitted variable bias due to the exclusion of international variables. Variance decompositions generated from an open-economy VAR indicate that deficits explain more of the variance of the forecast error of money growth than any other variable. The results also verify that deficits affect inflation only through their influence on the money supply.

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1. Specifically, it appreciated 43% from 1979:01–1985:2 according to the 101 country real dollar index published by M. Cox of the FRB-Dallas. This is the index used in the empirical analysis.

2. Outside of the sample period in this study, M1 grew at approximately 17% during 1986.

Table I. Ex post Real Interest Rates: U.S. and Japan 1979–1985

	1979	1980	1981	1982	1983	1984	1985
U.S.	−.11	−.14	4.95	6.06	5.88	5.93	4.60
JAPAN	2.20	3.12	2.43	4.13	4.49	3.88	4.31
SPREAD	−2.31	−3.26	2.52	1.93	1.39	2.05	0.29

Source—FRB of St. Louis and FR Board of Governors.

Note: The real rates are constructed from U.S. Federal Fund rates and Japanese call money rates, along with respective CPI indexes.

In the next section, the theoretical linkages between budget deficits, interest rates, and the dollar are examined, as are the linkages between deficits and money growth. The VAR methodology is addressed in the next section, followed by empirical results from VAR models and variance decompositions from the sample 1979:01–1985:02. The concluding section provides a brief summary.

II. Deficits, Money Growth, Interest Rates and the Dollar

According to Dornbush [9], real interest rates are the key linkage between domestic economic activity and merchandise trade. Specifically, if the spread between U.S. rates and the rates of our trading partners increases, then foreign capital will flow into the U.S. seeking the relatively high rates of return. This flow of capital will bid up the value of the dollar and lead to a worsening of the U.S. merchandise trade deficit.

While domestic nominal rates have certainly fallen since the early 1980s, ex post real rates have, in fact, risen. The recent history of interest rates in the U.S. and Japan, for example, shown in Table I verifies the rise in U.S. real rates and the increase in the spread between the U.S. and the Japanese rates.

The data in the table indicate an increase of U.S. real rates of over 4.7 percentage points during this period. U.S. rates rose relative to Japanese rates over 4.3 percentage points before the spread narrowed slightly in 1985.[3]

The Federal Reserve is an often mentioned source of this interest rate behavior because of its shift to a non-borrowed reserve operating procedure in October, 1979.[4] Sellon [28] has suggested that the purpose of this regime change was to provide the Federal Reserve with greater control over inflation and money growth, as well as the growth of credit. According to Gilbert [13] this policy was implemented by the widening of the ranges on interest rates. Not surprisingly, Roley and Troll [27] report that this policy indeed generated both higher and more volatile interest rates. However, this connection of money and interest rates was short-lived because according to Gilbert [13], the Federal Reserve in October 1982 abandoned its non-borrowed reserves operating procedure in favor of what was equivalent to an interest rate targeting procedure again. As mentioned, money growth surged at a 13% annual rate following this regime change.

3. In the VAR model, the yield on AAA rated bonds is used as a proxy for the spread between U.S. rates and a trade weighted average of rates of our trading partners.

4. Bradley and Jansen [2] verify this reported regime change using VAR analysis. Kvasnicka [21; 22] argues that the tight monetary policy, which led to higher interest rates was one of the most important determinants of the rise of the dollar in the early 1980s.

Since the slowing of the U.S. inflation rate during this period only helps in explaining the observed decline in the nominal rate, the only remaining source of high real interest rates is the domestic budget deficit, or, more precisely, the amount of government borrowing in credit markets.[5]

A loanable funds model of interest rate determination such as that described by Hoelscher [16; 17] suggests that after accounting for monetary changes and the stance of the business cycle, an increase in government borrowing to finance the deficit will increase real interest rates. However, one might empirically test a simple interest rate model and find that deficits do not appear to have an impact upon interest rates if the influence of foreign financial flows are excluded. The likelihood of such a finding is not surprising when one considers the magnitude of the foreign capital flows. For example, in 1984 when the federal budget deficit was $170 billion, net foreign investment was $91 billion. One could reasonably argue that if private domestic savings had not been augmented by this foreign capital inflow, our domestic deficit would have had far more serious impacts on interest rates. This concern is addressed by including in the model the U.S. merchandise trade balance as a proxy for net foreign capital flows.

The interest rate equation in the VAR model, along with the variance decompositions will shed light on the above discussion of the relative impacts on interest rates of deficits versus money in the presence of international variables.

The remaining issue of concern is whether or not deficits cause money growth. More important yet is the question of whether deficits are inflationary. Hamburger and Zwick [14], for example, reiterate the monetarist proposition that deficits are inflationary only when accommodated with higher rates of money growth. On the other hand, Miller [24] suggests that deficits may be inflationary irregardless of whether they are accompanied by higher rates of monetary growth.[6] As mentioned earlier, this issue has not been settled using standard closed-economy econometric models.

With regard to Federal Reserve behavior, there is a subtle difference between accommodating the Treasury and its borrowing needs and adhering to interest rate targets. For example, the Fed was quite concerned with interest rate targeting for purposes of market stability over this period of an appreciating dollar; even during the 1979–1982 period according to Poole [26]. Yet, there was also considerable pressure on the Fed to increase money growth for purposes of supplying much needed credit to the Treasury in the face of $200b budget deficits. Thus, to discern between these two distinct sources of monetary growth, it is appropriate to construct a money growth equation containing both interest rates and deficits, as well as the international variables of concern in this study.

The international variables are important because, according to Cross [8] the Federal Reserve was expressing its concern for the high valued dollar and the worsening trade deficit by intervening in exchange markets, even prior to the G-5 meeting in February 1985. Also, the Fed may have been focusing on exchange rates and the trade deficit indirectly by increasing money growth. To the extent this policy pushed interest rates lower, foreign capital flows would have slowed and thereby eased the upward pressure on the dollar. To exclude these international variables would lead to the spurious conclusion that the dramatic changes in observed money growth

5. Consumer prices were rising at an average annual rate of approximately 10% from the start of the sample period until the end of 1981. From then until the present, price growth averaged below 4% with a brief stretch of absolute declines in early 1986.

6. Ahking and Miller [1] provide a thorough discussion of these different schools of thought.

during this period were due only to domestic concerns. The VAR representation will hopefully disentangle all of these separate influences on money growth such that the effect of deficits alone can be examined.

The interest rate and money growth equations will be the focus of concern with regard to the empirical results, however, due to the extensive simultaneity among many of the above variables and because of the dynamic nature of the relationships, a VAR representation is an optimal way to model all of these effects. Such a model can be viewed as a system of reduced form equations —one for each variable in the system.

The variables included are monthly observations of the seasonally adjusted M1 money supply (*M1*), the Consumer Price Index (*CPI*), the seasonally adjusted federal government budget deficit (*DEF*), the yield on Moody's AAA rated bonds (*AAA*), the Dallas Federal Reserve real 101 country trade weighted U.S. dollar exchange rate (*$*),[7] and the seasonally adjusted U.S. merchandise trade balance (*MTB*). The data set spans 1977:01–1985:02.

III. VAR Methodology

The VAR model is specified using the multivariate extension of Hsaio [18; 19] proposed by Ahking and Miller [1].[8] The technique makes use of Akaike's final prediction error (FPE) statistic to determine optimal lag length, along with likelihood ratio tests to determine (Granger) causality. Because the steps used in specifying the preliminary VAR are nearly identical to those of Ahking and Miller, one may refer to that article for specifics.

The VAR technique requires stationary data, and for the variables in this study, the autocorrelation functions of various transformations were examined in order to select that which was most parsimonious. In subsequent regressions on a constant and time, it was found that first differences of *DEF*, *AAA*, *$*, and *MTB* produced stationarity, while second differences of logs of M1 and CPI were necessary. These mixed transformations are quite similar to those used by Fackler [12]. Hsiao [19] also employs mixed transformations.

Using the Ahking and Miller technique, a preliminary system is specified containing a matrix of six equations and six sets of lagged variables. To overcome the problem of contemporaneous covariance discussed in Theil [32], the system is estimated using full-information maximum likelihood, thus generating estimates that are asymptotically more efficient than equation-by-equation OLS. Diagnostic over and under-fitting of the model is conducted using likelihood ratio tests to determine the adequacy of the system. Included in this series of hypothesis tests are zero-restrictions on each of the lagged set of variables, which addresses the issue of causality.

IV. Empirical Results

The following VAR model was estimated from 1979:02–1985:02.[9]

7. This measure avoids the problem of not including our smaller trading partners, which is the case for many of the more popular indices. For a discussion of this measure see Cox [7]. This data was made available by the Dallas Federal Reserve Bank. All other data came from the Citibase data tape.

8. This technique incorporates features from Caines, Keng, and Sethi [4], Lutkepohl [23], and Hsaio [19].

9. The starting date is a function of monthly data availability, particularly with regard to the trade deficit, and reflects a two year lag search and appropriate data transformations.

$$\begin{vmatrix} M1_t \\ CPI_t \\ DEF_t \\ AAA_t \\ \$_t \\ MTB_t \end{vmatrix} = \begin{vmatrix} a_{11}^{6}(L) & 0 & a_{13}^{18}(L) & a_{14}^{8}(L) & a_{15}^{1}(L) & 0 \\ a_{21}^{1}(L) & a_{22}^{8}(L) & 0 & 0 & a_{25}^{8}(L) & a_{26}^{4}(L) \\ 0 & 0 & a_{33}^{4}(L) & a_{34}^{1}(L) & 0 & a_{36}^{6}(L) \\ a_{41}^{5}(L) & 0 & a_{43}^{11}(L) & a_{44}^{6}(L) & a_{45}^{1}(L) & 0 \\ 0 & a_{52}^{1}(L) & 0 & a_{54}^{1}(L) & a_{55}^{1}(L) & a_{56}^{4}(L) \\ 0 & a_{62}^{4}(L) & 0 & a_{64}^{10}(L) & a_{65}^{2}(L) & a_{66}^{2}(L) \end{vmatrix} \begin{vmatrix} M1_t \\ CPI_t \\ DEF_t \\ AAA_t \\ \$_t \\ MTB_t \end{vmatrix} + \begin{vmatrix} C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \end{vmatrix} + \begin{vmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \\ e_{5t} \\ e_{6t} \end{vmatrix} \qquad (1)$$

An entry in the coefficient matrix such as $a_{14}^{8}(L)$ has the following interpretation. The subscript 14 identifies the equation number (in this case 1—the *M1* equation) and the explanatory variable (in this case 4—the *AAA* variable). The superscript identifies the order of the lag (in this case 8 lags on *AAA*) and the L is a lag operator. The C_i and e_{it} represent constant and error terms, respectively.

Before examining the economic implications of the above model, it is necessary to review the diagnostic tests to ensure that the model is an appropriate representation of the data. These tests are reported in Table II. Lines 1–23 report results from imposing zero-restrictions on the various lag polynomials. In all cases these restrictions were not appropriate. Lines 24–36 report results from easing the various zero restrictions. The superscripts indicate the length of the lag polynomial tested and are those suggested by the initial FPE statistics. The results indicate that each of these restrictions were appropriate. Lines 37–41 report the results of under-fitting (i.e., reducing the lag length) on certain variables. Rather than under-fitting every variable by some arbitrary amount, lag restriction was based on the observance of t-statistics at a significance level less than 10%. Lines 37, 38 and 41 indicate that these lag restrictions were appropriate while lines 39 and 40 indicate the longer lags were necessary. Lastly, lines 42–47 report the results of over-fitting each variable (on an equation-by-equation basis) by 2 lags. In each case these modifications were not appropriate.

Allowing for the noted under-fitting in lines 37, 38, and 41, the above system seems to be an adequate VAR representation of the data.

The economic implications of the VAR model derive from the causality that is inferred from the diagnostic tests of Table II. Causality in this instance refers to Granger causality and implies incremental predictive content, not causality in terms of theory. For example, in those cases in the model where the zero restrictions were *not* appropriate, the implication is that the inclusion of past values of some variable X improves upon the prediction of a variable Y and its "own" past lags; thus, one would say that X Granger-causes Y.

With regard to the issue of whether deficits cause interest rates, the model suggests that changes in interest rates (*AAA*) are influenced by prior changes in budget deficits (*DEF*) after controlling for the effects of inflation and the other variables. This is substantiated by the likelihood ratio test reported in line 13. (This shows up as the lag polynomial a_{43} in the model). Recall that this relationship between deficits and interest rates is one of the primary linkages connecting deficits and the dollar exchange rate during this period. Interestingly, inflation (*CPI*) did not have a direct Granger-causal influence on interest rates, however, its indirect effect is shown to operate through its causal relationship with the exchange rate (*\$*) and the trade deficit (*MTB*).[10]

The rest of the linkages connecting budget deficits and exchange rates are also present. To

10. The failure to identify direct causality running from CPI to AAA is not alarming given the findings in the literature on an inverted Fisher effect. Carmichael and Stebbing [5] for example, argue that nominal rates will remain invariant to changes in inflationary expectations in typical tests using financial yields.

Table II. Hypothesis Tests of the VAR

Hypothesis	Chi-Square Statistic	Hypothesis	Chi-Square Stat
1. $a_{11}(L) = 0$	82.72***	24. $a_{12}^{2}(L) \neq 0$	.85
2. $a_{13}(L) = 0$	47.51***	25. $a_{16}^{1}(L) \neq 0$	1.11
3. $a_{14}(L) = 0$	26.86***	26. $a_{23}^{1}(L) \neq 0$	1.46
4. $a_{15}(L) = 0$	5.54**	27. $a_{24}^{4}(L) \neq 0$	5.04
5. $a_{21}(L) = 0$	4.23**	28. $a_{31}^{1}(L) \neq 0$	.73
6. $a_{22}(L) = 0$	43.98***	29. $a_{32}^{1}(L) \neq 0$	.15
7. $a_{25}(L) = 0$	22.87***	30. $a_{35}^{1}(L) \neq 0$	1.10
8. $a_{26}(L) = 0$	12.38***	31. $a_{42}^{1}(L) \neq 0$	1.47
9. $a_{33}(L) = 0$	106.59***	32. $a_{46}^{1}(L) \neq 0$	.90
10. $a_{34}(L) = 0$	4.18**	33. $a_{51}^{1}(L) \neq 0$	.96
11. $a_{36}(L) = 0$	25.66***	34. $a_{53}^{1}(L) \neq 0$	.01
12. $a_{41}(L) = 0$	18.34***	35. $a_{61}^{1}(L) \neq 0$	.08
13. $a_{43}(L) = 0$	32.95***	36. $a_{63}^{1}(L) \neq 0$	.00
14. $a_{44}(L) = 0$	51.55***	37. $a_{14}^{7}(L)$ vs. $a_{14}^{8}(L)$	.27
15. $a_{45}(L) = 0$	13.62***	38. $a_{26}^{1}(L)$ vs. $a_{26}^{4}(L)$	2.08
16. $a_{52}(L) = 0$	2.85*	39. $a_{36}^{1}(L)$ vs. $a_{36}^{6}(L)$	16.84**
17. $a_{54}(L) = 0$	5.72**	40. $a_{41}^{1}(L)$ vs. $a_{41}^{5}(L)$	11.56*
18. $a_{55}(L) = 0$	3.01*	41. $a_{44}^{5}(L)$ vs. $a_{44}^{6}(L)$	2.29
19. $a_{56}(L) = 0$	9.91**	42. $a_{11}^{8}(L), a_{13}^{20}(L), a_{14}^{10}(L), a_{15}^{3}(L)$	4.38
20. $a_{62}(L) = 0$	17.72***	43. $a_{21}^{3}(L), a_{22}^{10}(L), a_{25}^{10}(L), a_{26}^{6}(L)$	8.03
21. $a_{64}(L) = 0$	23.28**	44. $a_{33}^{6}(L), a_{34}^{3}(L), a_{36}^{8}(L)$	5.84
22. $a_{65}(L) = 0$	9.64***	45. $a_{41}^{7}(L), a_{43}^{13}(L), a_{44}^{8}(L), a_{45}^{3}(L)$	8.76
23. $a_{66}(L) = 0$	56.44***	46. $a_{52}^{3}(L), a_{54}^{3}(L), a_{55}^{3}(L), a_{56}^{6}(L)$	13.14
		47. $a_{62}^{6}(L), a_{64}^{12}(L), a_{65}^{4}(L), a_{66}^{4}(L)$	5.11

Note: ***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

the extent the merchandise trade balance is an appropriate proxy for net foreign capital flows, the presence of the *AAA* variable (a_{64}) in the MTB equation, along with the test result in line 21, indicates that prior changes in interest rates indeed Granger-cause changes in foreign capital flows after controlling for the effects of inflation and other variables. The presence of *MTB* (a_{56}) in the *$* equation, along with the test result in line 19, completes the connection that capital flows do in fact influence the exchange rate.

Also, the influence of interest rates on the exchange rate is seen more directly by the presence of *AAA* (a_{54}) in the *$* equation along with the test result in line 17. Participants in exchange markets may respond directly to changes in interest rates (specifically, changes in spreads between countries) with appropriate purchases or sales of foreign exchange, thus affecting the exchange rate.

This evidence suggests that Evan's [10] finding that exchange rate spreads do not respond as predicted to changes in the deficit may be the result of a misspecified model. There is no theoretical reason in a single equation model of exchange rates to suspect a direct influence of budget deficits. Indeed, in the above system budget deficits do not have a direct causal relationship with exchange rates (i.e., $a_{53} = 0$ as seen in line 34).

Turning to the issue of deficits and money growth, in the M1 equation money growth is seen to be influenced by prior changes in deficits, interest rates and the exchange rate, each of which was previously discussed as having a theoretical connection with money growth. This result is verified by the test results in lines 2, 3, and 4 respectively in Table II. The 18 month lagged

Table III. Variance Decompositions: Proportion of 24 Month Variance Explained 79:2–85:2

	Due to innovations in:					
Percent Variation in:	*M1*	*CPI*	*DEF*	*AAA*	*$*	*MTB*
M1	26.7	9.1	33.8	9.2	9.6	11.6
CPI	1.5	65.1	3.1	1.8	20.7	7.9
DEF	4.6	12.4	59.2	2.3	4.2	17.4
AAA	4.6	7.2	32.1	37.2	15.7	3.3
$	0.7	5.4	4.0	4.3	80.7	5.0
MTB	4.8	15.5	7.9	9.0	14.1	48.7

relationship between *DEF* and *M1* suggests that deficits were quite a persistent problem to which the Federal Reserve felt obliged to respond. These results, coupled with the absence of *DEF* in the inflation equation and the presence of *M1* in the inflation equation indicates that deficits affect inflation only in an indirect manner—through their influence on money growth. This offers support for the monetarist proposition that deficits are inflationary only when accommodated with higher rates of monetary growth. Also, the *AAA* (a_{14}) and *$* ($a_{15}$) variables appearing in the money equation indicate the Federal Reserve's concern for interest rate targeting and exchange rate management.

Sims [29; 30; 31] introduced a more discerning test of causality based on the variance decomposition of a variable's forecast error variance. The decompositions are generated from a moving average representation of the VAR system and show the proportion of forecast error variance for each variable that is attributable to both its own innovations and those from the other variables. Thus, relationships among the variables may be evaluated in terms of degree of causality. Table III presents the results of this procedure.

The importance of the budget deficit during this period is seen quite clearly from an examination of this table. Aside from "own lags" in the AAA equation, deficits explain more of the forecast error variance of bond rates (32.1%) than any other variable, including money growth. This offers additional support for the proposal that causality really does run from deficits to interest rates, especially after controlling for the effects of international variables.

In the M1 equation, deficits explain more of the forecast error variance of money growth (33.8%) than any of the other variables, including M1 "own lags." This percentage is three times greater than that explained by interest rates or the dollar value and is an indication of the extent to which the relatively excessive rates of money growth were designed to accommodate federal deficits.

A potential caveat exists in the above discussions of Granger-causality. To the extent that some of the variables are forward looking, there will arise a version of the observational equivalence problem discussed in Buiter [3]. As an example, consider one-way causality running from foreign capital flows to the dollar exchange rate. Ceteris paribus, increased capital flows into the U.S. will tend to drive up the value of the dollar. However, suppose that foreign market participants fear a reduction in their (dollar denominated) asset purchasing power in an environment of an appreciating dollar and tend to "buy now" rather than wait. Even though, in an econometric sense, the capital flow will precede (Granger-cause) the rise in the exchange rate, it is actually the anticipation of a stronger dollar that is generating the increased capital flows. This is a potential problem in a majority of causality studies that contain such forward looking variables.

In this study, the variables most likely to fall into this category are interest rates, exchange rates and net foreign capital flows (as represented by *MTB*). To address this problem, in each instance where one of these (forward looking) variables Granger-causes another variable, the equation in which it appears is reestimated using OLS and an F-test is conducted to see whether *leads* of the variable in question significantly contribute to an equation with lags only. In only one instance was this a problem: future values of *MTB* significantly influenced budget deficits. This may suggest that policy makers base federal spending decisions on the anticipation of a future inflow of foreign capital to help with the purchase of new Treasury obligations. This result is not really surprising. Policy makers no doubt understand or have been told of the consequences that would result in domestic credit markets if the magnitude of federal borrowing continued without the additional foreign savings. It is quite likely, therefore, that the size of the budget deficit is indeed influenced by the anticipation of future foreign capital flows. This finding indicates a number of possibilities for future research in the area of federal spending behavioral relationships.

V. Summary and Conclusions

The open-economy VAR and variance decompositions have highlighted the importance of the domestic federal budget deficit during the period of the dollar's rise from 1979 to 1985. Deficits have a causal relationship with interest rates as well as money growth. Given the inconsistent results of previous studies, it is argued that the findings in this analysis are the result of controlling for appropriate international linkages in the model. For example, including foreign capital flows in the interest rate equation allows the effects of budget deficits to be shown more clearly. Also it was shown that the relationship of deficits and the dollar value is indirect rather than direct and is linked by interest rates and foreign capital flows.

Given the recent volatility of the stock market and the U.S. dollar, along with the sluggishness of trade deficit improvements, the evidence in this paper suggests that a reduction in the budget deficit might help to restore order to world markets. Asset markets may stabilize if only because of the calming effect a reduced deficit may generate. In addition, the international imbalances that our large deficit causes, forces policy makers away from normal decision making behavior. The Federal Reserve, for example, can not pursue traditional monetary policy targets as long as it is forced to participate in exchange rate management and to accomodate the deficit. Such concerns are why Paul Volcker [33] repeatedly asked Congress to trim the federal budget deficit. Given the focus in this country on free trade and minimal government intervention, a balanced budget would likely restore market order and a measure of confidence in international trade.

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