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DOES IT MATTER HOW MONETARY POLICY IS IMPLEMENTED?

by

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Federal Reserve Bank of Dallas

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1. Introduction

The monetary base series is constructed as the simple sum of source base--a balance sheet measure--and the reserve adjustment magnitude (RAM). The source base captures actions that result in changes in the Federal Reserve's balance sheet, while RAM is a dollar measure of reserves freed (absorbed) through decreases (increases) in reserve requirement ratios. Thus, the monetary base directly reflects central bank monetary policy actions implemented through either open market operations, discount window borrowings, or changes in reserve requirement ratio structures.[1]

Friedman (1984) and McCallum (1988), among others, have recently argued that the monetary base should be the centerpiece of monetary policy. As it is calculated, the monetary base attempts to quantify all Federal Reserve actions in one measure. But this characteristic of the monetary base underscores a feature that may not be theoretically appealing. Plosser (1989) notes that "...monetary base numbers are peculiar mixtures of real and nominal elements of monetary policy. The practice of adjusting the base figures for reserve requirement changes confuses real and nominal disturbances" (p. 23). Are quite diverse monetary policy tools adequately summarized in one measure? If the answer to this question is yes, then the ends achieved by monetary policy are independent of the means used to implement policy.

Underlying the monetary base proposals of Friedman, McCallum and others is the fundamental presumption that a $1 increase in monetary base caused by reductions in reserve requirement ratios has the same monetary policy effect as a $1 increase in the monetary base achieved through, say, open market operations or discount window borrowing. To our knowledge, no one has developed a theoretical model where the macroeconomic effects due to changes in relative prices (e.g. reserve requirement ratio changes) are equal to those due to changes in nominal quantities (e.g. open market operations).[2] Yet, the monetary policy recommendations of Friedman, McCallum and others are premised on such a belief.

The purpose of this paper is to investigate whether the macroeconomic effects of changes in the Federal Reserve's balance sheet, and thus source base, are significantly different from the effects of changes in reserve requirement ratios. By using the monetary base measure as a policy indicator, one presumes the economic effects of the alternative policy tools are quantitatively similar. We test the validity of this restriction in a VAR setting considering the monetary policy effects on real GNP growth, inflation and nominal interest rates. In each case, the long-run multipliers provide evidence suggesting that the way in which monetary policy is implemented does not matter. Interestingly, the impulse response functions for the two policy tools are very similar for both output growth and inflation, and formal tests suggest that the direct effects of changes in these policy variables are not significantly different from each other for these two macroeconomic variables. Although the evidence suggests that the interest rate dynamics are different depending on whether policy is implemented through changes in reserve requirements or open market operations, the long-run effects of these policy changes on interest rates remain similar.

2. Data and Methodology

Simply summing source base and RAM, as is done in the Federal Reserve

Bank of St. Louis monetary base, presumes that a \$1 increase in monetary base achieved through reductions in reserve requirement ratios has the same effect as a \$1 increase in the monetary base achieved through, say, open market purchases. Likewise, a specification that uses the growth rate of the monetary base necessarily imposes the restriction that a one-percentage-point increase in the monetary base due to RAM growth has the same effect as a one-percentage-point increase in the monetary base due to source base growth. The validity of this restriction is directly testable.

The data used in this investigation are quarterly, span the period 1961:II to 1988:IV, and are seasonally adjusted. Following the definition of the monetary base, source base growth and RAM growth are defined in percentage-change form relative to the monetary base; that is, $\hat{SB}_t = \Delta SB/[(MB_t + MB_{t-1})/2]$ and $\hat{RAM}_t = \Delta RAM/[(MB_t + MB_{t-1})/2]$, respectively, where SB denotes the level of the source base, RAM is the level of the reserve adjustment magnitude, and MB is the monetary base. These two variables are used separately in explaining macroeconomic behavior in an unrestricted version of the estimated specifications, whereas a restricted version specifies monetary base growth (i.e., $\hat{MB}_t = \Delta MB/[(MB_t + MB_{t-1})/2]$) as the sole monetary explanatory variable. All monetary measures are constructed by the Federal Reserve Bank of St. Louis.[3]

Formally, the restricted version of a vector autoregression is represented as:

$$X_t = \sum_{j=1}^{n_1} \alpha_j X_{t-j} + u_t, \qquad (1)$$

where X_t = [$\hat{MB}_t$ $\hat{RPE}_t$ $\hat{GNP}_t$ r_t INF_t].[4] $\hat{MB}$ denotes monetary base growth, $\hat{RPE}$ is the growth rate of the relative price of energy, $\hat{GNP}$ is real GNP growth, r is the first-difference of the 3-month Treasury bill rate, INF is inflation measured by the fixed-weight deflator, n_1 stands for the lag length, α is the vector of estimated coefficients, and u_t is the vector of errors.[5] Substituting the two separate policy components of monetary base growth in equation (1) yields the following expression:

$$X_t = \sum_{j=1}^{n_1} \alpha_j X_{t-j} + u_t, \qquad (2)$$

where X_t = [$\hat{RAM}_t + \hat{SB}_t$ $\hat{RPE}_t$ $\hat{GNP}_t$ r_t INF_t]. It is clear from equation (2) that the restricted version imposes the prior that the coefficients on lagged values of the two monetary impulses (as well as the potential feedback effects from other variables on monetary base growth) are equal to one another. The effects due to changes in source base growth must equal the effects due to changes in RAM growth. The unrestricted version relaxes this assumption and estimates the following VAR:

$$Z_t = \sum_{j=1}^{n_2} b_j Z_{t-j} + e_t, \qquad (3)$$

where Z_t = [$\hat{RAM}_t$ $\hat{SB}_t$ $\hat{RPE}_t$ $\hat{GNP}_t$ r_t INF_t], n_2 is the lag length for the unrestricted version of the VAR, and e_t is the vector of residuals.[6]

3. Empirical Findings

Table 1 reports the sum of the coefficients obtained from estimating equation (3)--the unrestricted VAR system. In addition to the sums of the coefficients, we report two test statistics: the t-statistic is calculated under the null hypothesis that the sum of the coefficients is equal to zero, and the F-statistic is calculated under the null that the individual coefficients are jointly equal to zero.

With the exception of the two policy relationships represented in the first equations in Table 1, the summed coefficients on the two policy variables are similar across equations. For example, the results suggest that neither lagged values of RAM growth nor lagged values of source base growth are statistically significant in explaining either output growth or changes in nominal interest rates. Both source base growth and RAM growth developments are, however, significant in explaining inflation behavior, and the two summed coefficients are quite similar to one another in the inflation equation.[7] One exception occurs in the relative price of energy equation. Though the sums of lagged coefficients are positive for both policy variables, the F-statistic indicates that the coefficients on the lagged values of RAM growth are significantly different from zero, but the coefficients on lagged values of source base growth are not statistically significant.

In contrast to the similarity in the estimated effects of the two policy tools, Table 1 indicates that the two policy relationships are quite different. Lagged values of output growth are negatively associated with RAM growth, but are positively associated with source base growth. Interest rate changes are statistically significant in the RAM growth equation, but not in the source base equation. The sum of lagged values of inflation is statistically significant in the RAM growth equation, but not the source base equation. Furthermore, source base developments are not important in explaining RAM growth developments, but lagged RAM developments are marginally important in explaining source base developments.[8]

Using the estimates of (3), Figure 1 plots the impulse response function for real GNP growth given innovations in both RAM growth and source base growth.[9] In general, real GNP growth appears to follow a sinusoidal pattern that is dampening in response to innovations in RAM growth. On the other hand, innovations in source base do not establish a regular cycle. Rather, real output growth appears to generally decline in response to shocks in source base growth. Furthermore, the impulse response functions suggest that real GNP growth responds more strongly to innovations in RAM growth than to innovations in source base growth.

Figure 2 plots the response by nominal interest rate to innovations in RAM growth and source base growth. In Figure 2, the response of nominal interest rates to innovations in RAM growth seems juxtaposed with the response to innovations in source base growth. Generally, when interest rates are rising due to RAM growth innovations, they are falling in response to source base growth innovations. Again, policy effects appear to dampen significantly after twenty quarters.

Finally, Figure 3 plots the two impulse response functions for inflation behavior. The figure shows a similar pattern in response to innovations in either source base or RAM. One minor difference emerges in Figure 3, however; the inflation response to source base growth shocks appears stronger than to RAM growth shocks for the first eight quarters. The influence of both shocks then appears to decline at about the same pace.

But are the policy coefficients reported in Table 1 and the impulse responses in Figures 1 through 3 significantly different for the two different policy measures? Table 2 reports results of formal statistical tests on the coefficients on lagged values of RAM growth and source base growth in the three major macroeconomic equations: real GNP growth, changes in nominal interest rates, and inflation. The top half of Table 2 reports test statistics calculated under the null hypothesis that coefficients on lagged values of source base growth are jointly equal to coefficients on lagged values of RAM growth. In the output and inflation equations, the F-statistics are 0.78 and 0.47, respectively. The critical value is 2.76. Thus, there is no evidence of a differential response to the policy variables in these two cases, even on a short-term basis. In the nominal interest rate equation, however, the F-statistic is 3.11. Here the evidence suggests that the dynamic path of nominal interest rates illustrated in Figure 2 is significantly different given a one-percentage-point increase in source base growth as compared to a one-percentage-point increase in RAM growth.[10]

Another critical issue is whether the long-run effects of changes in source base growth are significantly different from changes in RAM growth. In a VAR system, the direct total effect is captured by the final multipliers. The bottom half of Table 2 reports a t-statistic calculated under the null hypothesis that the sum of the coefficients on RAM growth equal the sum of the coefficients on lagged values of source base growth, which is equivalent to testing whether the final multipliers are equal. The t-test statistics are 1.22, 0.33, and 0.2 for the GNP growth, nominal interest rate, and inflation equations, respectively. In each case, the t-statistic is less than the 5% critical value of 2.0. Therefore, the econometric restriction imposed when one uses the monetary base is not rejected in the long run.[11]

4. Conclusion

Movements in the monetary base reflect changes in source base, changes in reserve requirements ratios, or both. The use of the monetary base measure in empirical work implicitly restricts the effects of these seemingly disparate policy actions to be equal. We test the equality of the two effects in the case of three macroeconomic variables: output growth, inflation, and nominal interest rates. In each case, the evidence presented in this paper suggests that the long-run effects of changes in the monetary base due to source base developments and changes in the monetary base due to RAM developments are not significantly different from one another. Quite surprisingly, the evidence is consistent with the hypothesis that source base developments and RAM developments have the same direct influence on the dynamic paths for both output growth and inflation. Insofar as the aim of monetary policy is to influence the long-run behavior of macroeconomic variables, the evidence is consistent with notion that the outcome of monetary policy is independent of the means used to implement it. In the nominal interest rate specification, however, the evidence suggests that the direct short-run influence on the dynamic path for interest rates is dependent on whether the policymaker elects to change the reserve requirement structure or to use open market operations to conduct monetary policy.

Footnotes

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1. See Haslag and Hein (1989) for a more detailed discussion of the monetary base.

2. See Romer (1985) for a general equilibrium model suggesting differential effects.

3. The monetary base adjusted for changes in reserve requirements is calculated by the Board of Governors of the Federal Reserve System. We also estimated the VAR system substituting this measure for the monetary base calculated by the St. Louis Federal Reserve Bank. The main findings reported in this paper are not affected.

4. The growth rate of the relative price of energy is included in our VAR system following Tatom (1981). Changes in the growth rate of the relative price of energy are hypothesized as positively correlated to movements in the overall inflation rate. Furthermore, energy price movements are highly correlated with the major supply shocks that are postulated to have influenced real economic activity in the 1970s. Omitting this variable from the system does not alter the main

conclusions reported in this paper.

5. We conducted unit root tests to determine if the variables in the VAR system were stationary. In each case, we can reject the null hypothesis that the variables in equation (3) are nonstationary.

6. A likelihood ratio test (with Sims' (1980) correction) is used to select $n_2 = 7$. Under the null hypothesis that the lag length is 7 (with the alternative that the lag-length is eight), the test statistic indicates that the null is not rejected. We tested whether shorter lag lengths (1 through 6) could be accepted when the alternative hypothesis is that the lag length is seven. In each case, the null hypothesis is rejected.

7. Thus, the evidence suggests that monetary base does not directly affect output growth. This evidence concurs with the King and Plosser (1984) hypothesis that "outside" money--the monetary base--is not significantly correlated with output growth, but is highly correlated with inflation. The evidence is also consistent with Horrigan's (1988) hypothesis that changes in reserve requirement ratios are not important for stabilization purposes.

The evidence is also consistent with monetary base growth having significant effects on nominal GNP growth as McCallum (1988) has emphasized. When we test for differential response in a nominal GNP growth setting, we again find no evidence suggesting that RAM developments have differential effects from those of source base.

8. Haslag and Hein (1989) provide evidence of a negative contemporaneous correlation between RAM growth and source base growth that is statistically significant.

9. The order used by the Choleski decomposition is RAM growth, source base growth, growth of the relative price of energy, output growth, nominal interest rates, and inflation. It is well known that the results may change when we alter the order used in the decomposition. In our case, however, the results did not change substantially when we altered the order.

10. Interestingly, when we exclude the interest rate from the VAR system, there is evidence that the effects of RAM growth and source base growth on output growth are statistically different, with only the former having a significant effect.

11. Slovin, Sushka, and Bendeck (1990) also find interest rates are unaffected by the announcement of changes in reserve requirements.

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Table 1

Summary of Summed Lagged VAR Coefficients

Model [$\widehat{SB}_t$ $\widehat{RAM}_t$ $\widehat{RPE}_t$ $\widehat{GNP}_t$ r_t INF_t]

Equation	$\widehat{RAM}$	$\widehat{SB}$	$\widehat{RPE}$	$\widehat{GNP}$	r	INF	$\bar{R}^2$
$\widehat{RAM}$	0.152	0.01	0.071	-0.119	-0.007	-0.061	
t-stat[1]	(0.41)	(0.04)	(1.94)	(0.55)	(0.20)	(2.02)*	
F-stat[2]	(2.16)*	(0.43)	(1.82)	(2.38)*	(2.15)*	(0.30)	0.36
$\widehat{SB}$	0.116	0.635	-0.098	0.439	-0.001	0.586	
	(0.28)	(1.38)	(2.39)*	(1.80)	(1.76)	(0.32)	
	(1.91)	(2.47)*	(1.56)	(2.41)*	(0.47)	(0.69)	0.39
$\widehat{RPE}$	3.008	1.162	0.448	-1.472	0.031	-0.452	
	(1.27)	(0.73)	(1.92)	(1.05)	(0.24)	(1.53)	
	(2.23)*	(1.60)	(4.97)	(1.41)	(0.63)	(0.67)	0.48
$\widehat{GNP}$	0.708	0.193	0.191	0.128	-0.009	-0.744	
	(1.00)	(0.41)	(1.24)	(0.31)	(1.32)	(1.53)	
	(0.45)	(0.4)	(1.67)	(0.61)	(1.41)	(1.09)	0.23
r	-75.3	-65.5	-2.27	78.49	-0.86	85.36	
	(1.37)	(1.75)	(0.42)	(2.43)*	(1.95)	(1.82)	
	(1.65)	(1.50)	(1.70)	(2.13)*	(4.22)*	(3.79)*	0.49
INF	0.339	0.312	-0.011	0.098	0.004	0.733	
	(1.58)	(2.17)*	(0.54)	(0.77)	(4.23)*	(2.40)*	
	(2.83)*	(2.88)*	(1.45)	(0.48)	(1.12)	(3.24)*	0.82

* Indicates that the null hypothesis is rejected at the 5% level.

[1] The t-statistic reported is calculated under the null hypothesis that sum of the lagged coefficients on the lagged variables equal zero.

[2] The F-statistic reported is calculated under the null hypothesis that the coefficients on the lagged variables are jointly equal to zero.

Table 2

Tests of Coefficient Equality for
RAM Growth and Source Base Growth

<u>Null Hypothesis</u>:

$\hat{RAM}_{t-j} = \hat{SB}_{t-j}$

$j = 1, 2, \ldots, 7$

<u>Equation</u>	<u>F-statistic</u>
$\hat{GNP}$	0.78
r	3.11
INF	0.47

<u>Null Hypothesis</u>:

$$\sum_{j=1}^{7} \hat{RAM}_{t-j} = \sum_{j=1}^{7} \hat{SB}_{t-j}$$

<u>Equation</u>:	<u>t-statistic</u>
$\hat{GNP}$	1.22
r	0.33
INF	0.2

Figure 1
Impulse Response Functions for GNP Growth Given Innovations in RAM Growth and Source Base Growth

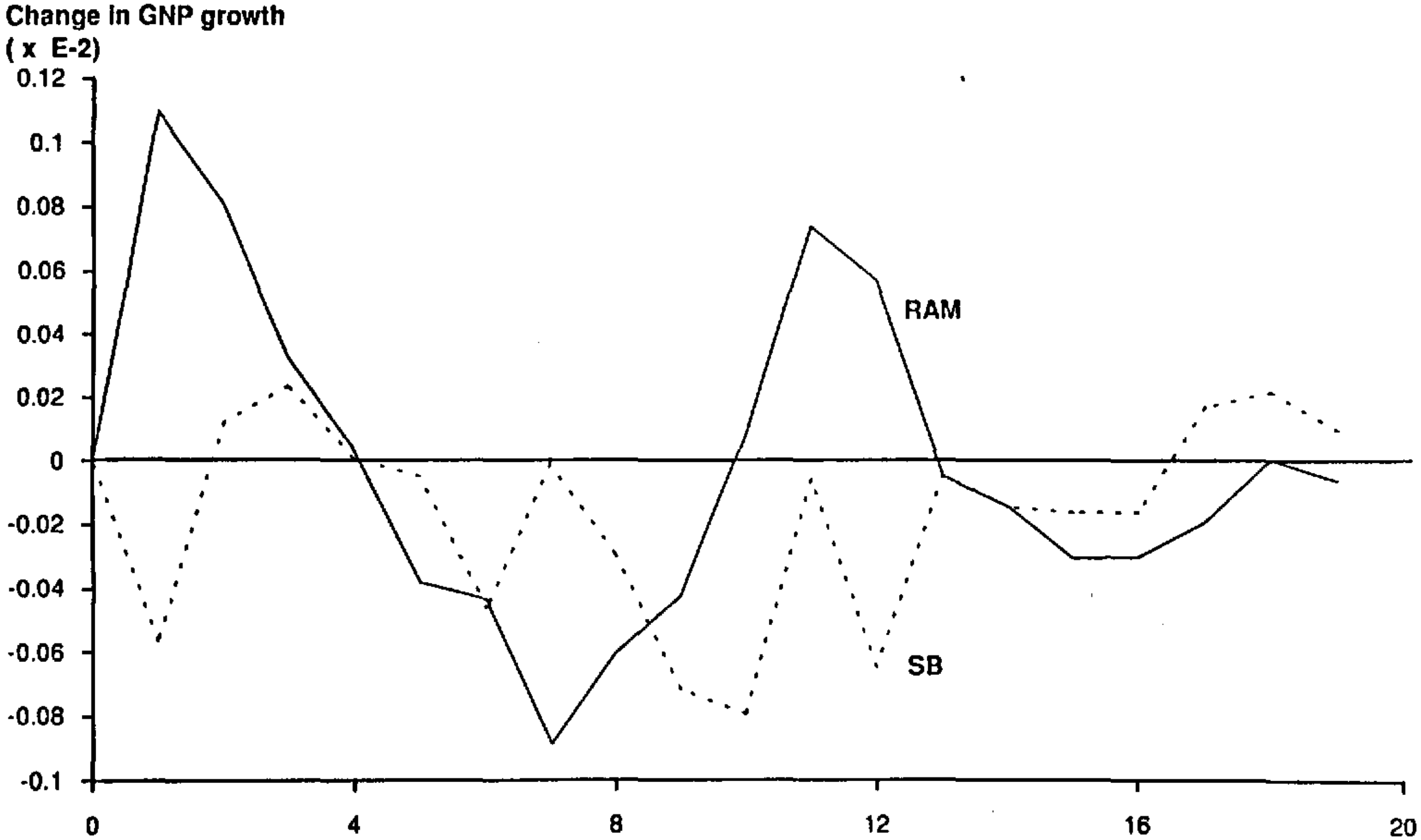


Figure 2
Impulse Response Functions for Nominal Interest Rate
Given Innovations in RAM Growth and Source Base Growth

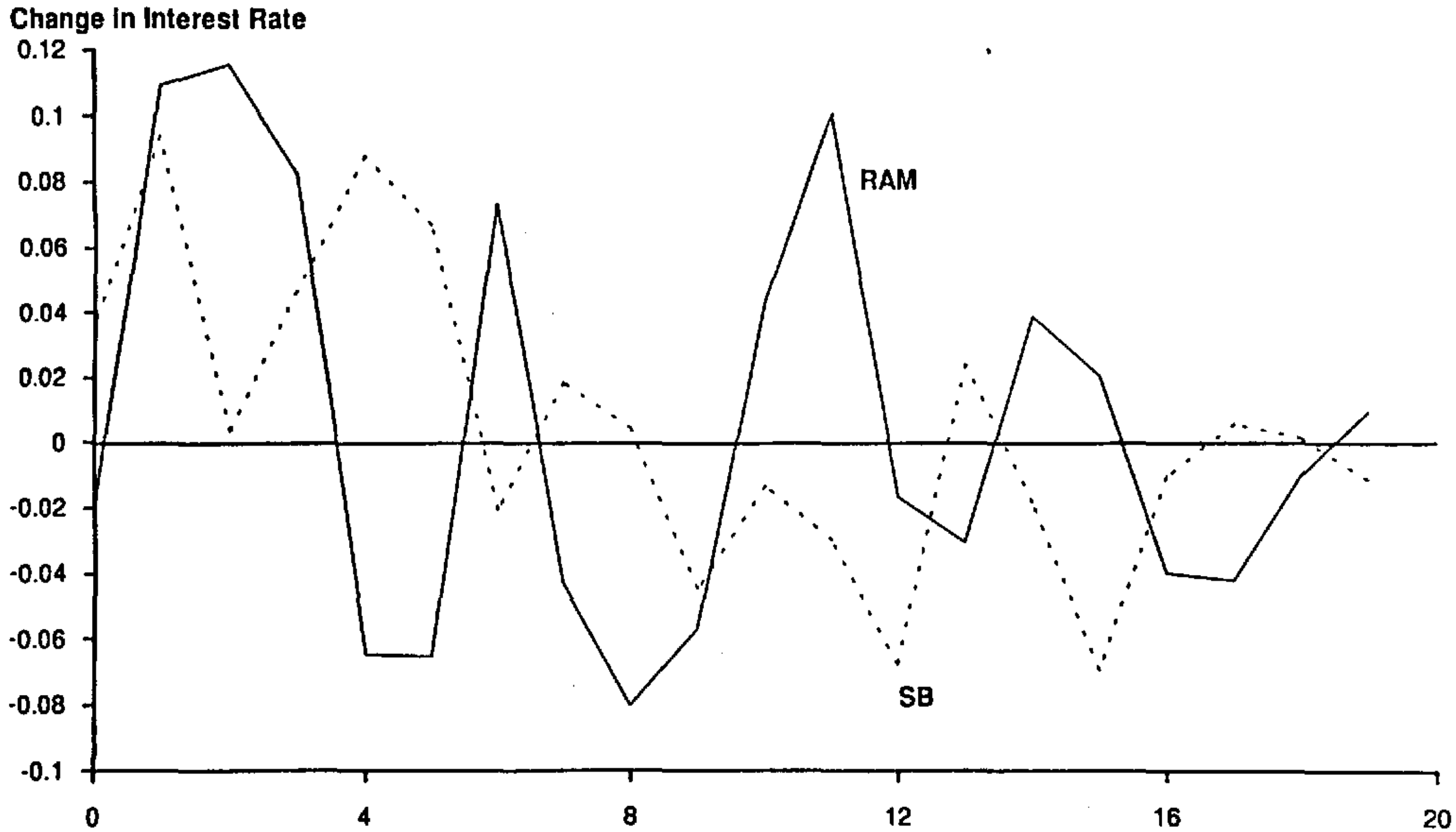
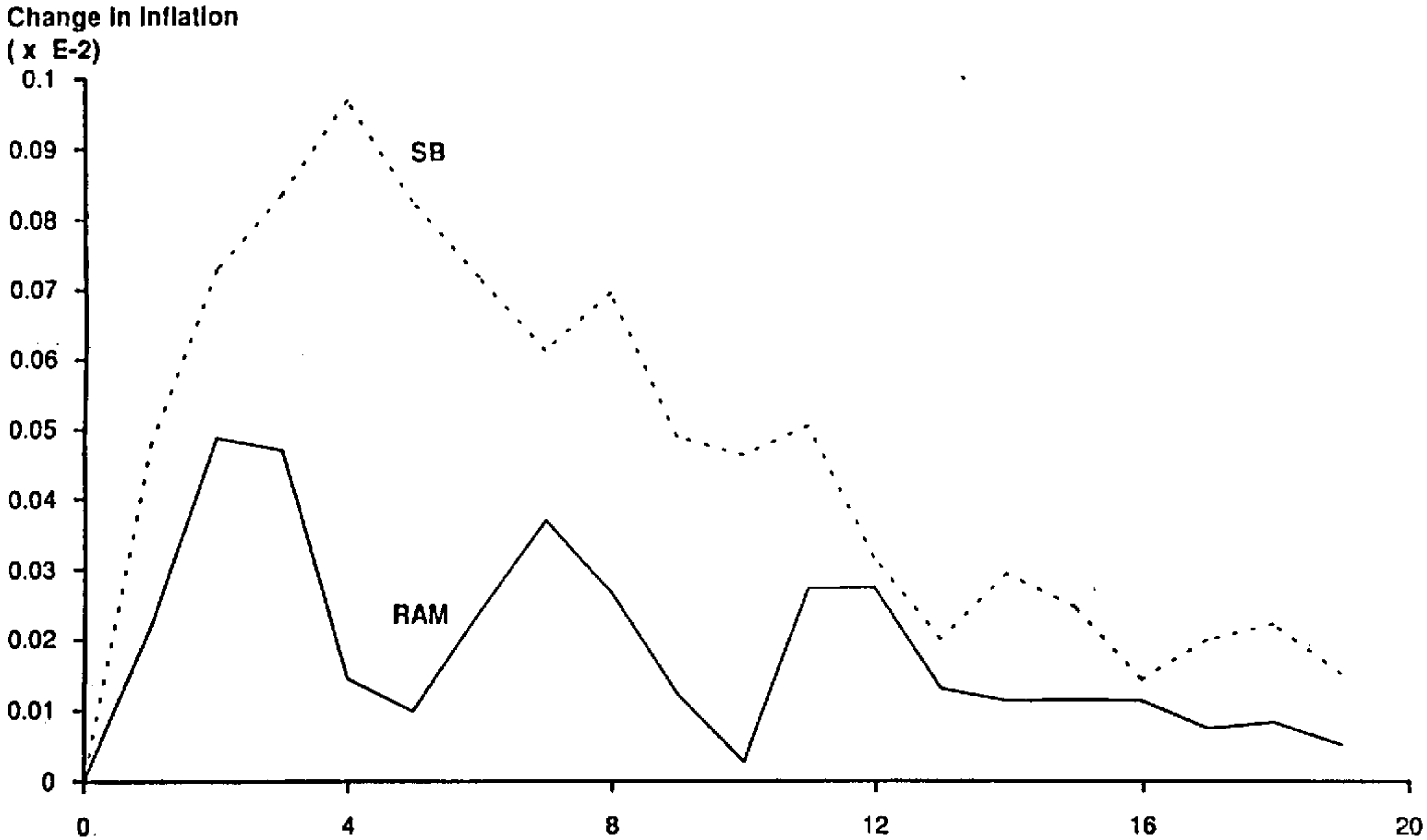


Figure 3
Impulse Response Functions for Inflation Given Innovations in RAM Growth and Source Base Growth



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