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Output, Money, and the Terms of Trade in Germany

An Empirical Test of the Real Business Cycle Hypothesis

By Joachim Scheide, Kiel*

I. Introduction

The idea that monetary policy has a significant influence on economic activity had been accepted for a long time. In recent years, however, this view was challenged by the theory of real business cycles; most models of this class set out to explain output fluctuations without assigning any important role for money.[1] On an empirical level, two lines of arguments can be described. The first states that changes in the money stock do not have any predictive power for output movements; *Sims* (1980), for example, arrives at this conclusion on the basis of an analysis with vector autoregressions.[2] The second argument runs as follows: Even if money appears to cause output in the *Granger* sense, it is only because of the endogenous response of money to changes in the production possibilities in the economy; however, actions by the central bank – i.e. changes in high-powered money – play no or only a minor role.[3] According to these findings, the money stock is not a true cause but only a leading indicator (though a good one, maybe) for economic activity.

While most of the influential empirical work focuses on U.S. data of various periods, the purpose of this paper is to shed light on the relevance of monetary policy for output in West Germany. In particular, it is investigated whether money in various definitions helps to predict output movements.

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[1] The benchmark model is *Kydland, Prescott* (1982). *McCallum* (1989) provides an overview of the models and the empirical implications of real business cycle theory.

[2] See *McCallum* (1986) for a criticism.

[3] See, for example, *Rush* (1985), *Manchester* (1989) and *Plosser* (1991). The theoretical background for this link between output and money is presented by *King, Plosser* (1984).

Additionally, the role of an important real factor, changes in the terms of trade, is analyzed for this open economy. It is of special interest to test whether this variable has a dominant impact on output in the sense that it substantially reduces the significance of the money-output relationship and is also contributing itself to changes in the "endogenous" components of money.

The structure of this paper is as follows. In the second section, the choice of the data and the method of investigation are briefly described. The analysis of vector autoregressions, in particular of variance decompositions, is generally regarded as useful to establish "stylized facts" about the relative explanatory power of different variables. The third section presents estimates for variance decomposition for the variables considered, starting with two-variable systems in the first part. In the second part, the information set is increased; it contains systems with three variables so that a judgment can be made concerning the relative importance of various measures related to money (e.g., high-powered money and endogenous money) and the terms of trade with respect to output. Finally, four-variable systems are considered in the third part where some restrictions which refer to the hypothesis of real business cycle theory are tested. The results are then summarized, and I will draw a few conclusions from the tests presented.

II. On the Data and the Method of Investigation

The output variable (Y) is real domestic expenditures (real GNP minus real net exports). One reason for this choice is that an external real shock affects investment and consumption and thus domestic expenditures. The effect on GNP may be ambiguous if imports are affected; therefore, I prefer using this variable instead of real GNP. Also, exports are influenced possibly more by policies abroad than by domestic policy.[4] The real factor which is analyzed with respect to its impact on output is the measure of the terms of trade (TT).[5] The use of changes in the terms of trade or in other variables of the external sector as a proxy for a real shock has been suggested in the literature on real business cycle theory.[6] According to this, terms-of-trade

[4] Nevertheless, if the tests presented here are run with real GNP, the results barely change.

[5] Defined as the ratio between the export deflator and the import deflator (NIA-basis).

[6] See, for example, *Stockman* (1988), *Plosser* (1989) und *McCallum* (1989). – Variables related to fiscal policy – such as government expenditures – are not considered in this paper since various studies have shown that the impact of government actions – at least, as far as broad aggregates such as expenditures, revenues or deficits are

shocks affect the production possibilities of the economy and the investment and consumption decisions of the private sector which will in turn lead to a change in the demand for money. In the real business cycle interpretation, the recessions in the middle of the 1970s and in the early 1980s were due to the sharp increase in import prices; also, another measure often used to define a supply shock, namely the *Solow* residual, shows large negative values for these periods (*Plosser,* 1989). For Germany, a country with a large external sector, terms-of-trade movements have been sizable in the past two decades; furthermore, earlier work on the German economy found a significant impact of the terms of trade or related variables (e.g. import prices) on economic activity.[7]

The monetary variables include the components of the money stock M1, i.e. currency (*CU*) and demand deposits (*DD*).[8] Two measures of the monetary base are available: One (*BB*) is published by the Deutsche Bundesbank in its monthly report, and it was the target variable for monetary policy for 14 years; the other (*BS*) is calculated by the Sachverständigenrat (German expert council). The latter is comparable to the extended monetary base (*Neumann,* 1986) since it takes account of effects due to changes in the required-reserve ratios,[9] while the former is calculated for fixed reserve ratios and a fixed structure of deposits. Furthermore, the money measures include the multipliers for M1 in terms of the two definitions of the monetary base (*MB, MS*). Finally, an important component of the multipliers is considered, namely the demand deposit-currency ratio (*DC*).

It should be obvious that the large number of monetary variables is not a bias against the real business cycle hypothesis because only three of them are measures of exogenous money while all others represent the – supposedly – much more important variables of endogenous money which might reflect the response of the public to supply shocks.

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concerned – on economic activity is negligible. For a test for German data, see *Scheide* (1989).

[7] Cf. *Dewald, Marchon* (1979), *Neumann* (1981), *Fratianni, Nabli* (1985), *Hansen* (1986), and *Scheide* (1989).

[8] The Kiel Institute adjusts the series of the monetary aggregates for structural breaks which are due to changes in the number of reporting banks etc. I also tested the importance of the money stock M2 and related measures, e.g. the time-deposit currency ratio. However, in accordance with other studies on the German economy, M2 does not show any clear-cut relationship with economic activity.

[9] For a discussion of the difference in the concepts, cf. Sachverständigenrat (1986). The data were kindly provided by the Sachverständigenrat. – In the real business cycle interpretation, changes in the reserve ratio represent a real disturbance. To isolate the possible impact of this policy measure, I tested whether the difference between the two base measures had any effect on output. However, this is not the case.

Table 1

Cross Correlation Between Output (Y) and 8 Other Variables[a] (1963.1 - 1988.2)

	− 6	− 5	− 4	− 3	− 2	− 1	0	+ 1	+ 2	+ 3	+ 4	+ 5	+ 6
TT	0.31	0.40	0.40	0.42	0.37	0.28	0.29	0.17	0.09	0.05	− 0.04	− 0.04	− 0.03
BS	− 0.17	− 0.02	0.15	0.31	0.45	0.52	0.53	0.48	0.38	0.31	0.23	0.16	0.14
BB	− 0.09	0.08	0.24	0.39	0.52	0.58	0.58	0.54	0.46	0.36	0.27	0.20	0.13
CU	− 0.22	− 0.07	0.08	0.20	0.30	0.35	0.36	0.32	0.27	0.20	0.13	0.09	0.02
DD	0.21	0.36	0.48	0.60	0.64	0.56	0.43	0.24	0.03	− 0.09	− 0.14	− 0.17	− 0.13
MS	0.36	0.44	0.46	0.49	0.42	0.28	0.11	− 0.09	− 0.26	− 0.37	− 0.36	− 0.34	− 0.30
MB	0.26	0.34	0.40	0.45	0.41	0.28	0.13	− 0.07	− 0.27	− 0.36	− 0.36	− 0.35	− 0.28
DC	0.45	0.53	0.55	0.61	0.57	0.43	0.25	0.05	− 0.18	− 0.28	− 0.27	− 0.27	− 0.18

[a] $X_{i,\,t+j}$ with j ranging from − 6 to + 6.

Variables (seasonal differences of the logs) are as defined in the text. Y: real domestic expenditures. TT: terms of trade. BS: corrected monetary base. BB: monetary base. CU: currency. DD: demand deposits. MB: M1-multiplier for BB. MS: M1-multiplier for BS. DC: ratio demand deposits-currency.

Quarterly data for Germany are available from 1960 onwards. They are usually published in the seasonally unadjusted form.[10] For all nine series, I use the seasonal difference in the logs of the variables, so that any variable X_{it} is in all tests defined as

$$X_{it} = (1 - L^4) \log x_{it} \qquad i = 1, 2, \ldots, 9$$

where x_{it} is the original series and L is the lag operator. Differencing seems appropriate since the time series are generally integrated of order one.[11]

As a first check of the data, the cross correlations of real domestic expenditures with all other 8 series – with lags running from −6 to +6 – are calculated (Table 1). Both measures of the monetary base (*BS* and *BB*) as well as currency (*CU*) have the maximum correlation with contemporaneous *Y*. Other money measures (*DD*, *DC* and the M1-multipliers) seem to have a lead of two or three quarters; the terms of trade also have the highest correlation with output at a lead of three quarters.

Correlation, however, does not say anything about causality. For that, more appropriate tests are necessary; they are reported in the next section.

III. Analysis of Variance Decomposition

1. *Two-variable Systems*

Variance decompositions can provide an important information by estimating the effects of shocks (innovations) on the „dependent" variable. The percentage of the explanation in the forecast error variance may vary substantially between the variables.

For the two-variable systems (*X*, *Z*), the estimates are based on the following type of equations:[12]

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[10] The exception is the monetary base in the definition of the Bundesbank which is published only on a seasonally adjusted basis.

[11] For a test of various series, cf. *Scheide* (1990).

[12] In another paper (*Scheide*, 1991), I also ran *Granger*-causality tests for all the systems under consideration here. They served as a preliminary test for the choice of variables and also for the length of the lags. This analysis in general confirms the results presented in this paper on the basis of the variance decomposition method. Given the results for these causality tests, the choice of four lags can be justified since the optimal lag length in those systems is often smaller than or at least close to four. Therefore, the use of, e.g., eight lags might be inappropriate in many of the systems considered here and might unduly reduce the degrees of freedom. While *Manchester* (1989) estimates systems with eight lags for each variable, *Plosser* (1991) also uses four lags in his vector autoregressions.

$$X_t = c + bt + \sum_{i=1}^{4} a_i X_{t-i} + \sum_{i=1}^{4} d_i Z_{t-i} + u_t \quad (1a)$$

$$Z_t = c + bt + \sum_{i=1}^{4} e_i X_{t-i} + \sum_{i=1}^{4} g_i Z_{t-i} + v_t \quad (1b)$$

Table 2a summarizes the variance decomposition results for the forecast error in the systems analyzing the relationship with real domestic expenditures.[13] In all the tables reported here, a 12-quarter forecast horizon is used which is quite common in investigations of business cycle phenomena.[14] It appears that most series have a strong influence on real domestic expenditures, i.e. the impact of innovations of these series (X) on the variance of Y is quite high. In particular, *DD* and *DC* (with values of 30.4 and 26.9, respectively) perform better in this regard than *TT* (18.7). The monetary base has a contribution which is at least as high as that of the terms of trade, while the impact of currency seems to be somewhat lower. The effect of a different ordering can be seen in the right part of Table 2a. In all cases, the innova-

Table 2a

Variance Decomposition in Two-variable Systems with Output (Y) and 8 Other Variables (X) – 12 steps ahead[a]

Series X	[Y X] Innovation in X, effect on Y	[Y X] Innovation in Y, effect on X	[X Y] Innovation in X, effect on Y	[X Y] Innovation in Y, effect on X
TT	18.7	11.4	30.5	1.1
BS	19.7	5.0	28.8	3.1
BB	25.1	2.8	31.9	1.0
CU	14.7	1.3	21.1	0.5
DD	30.4	6.0	50.0	4.6
MS	24.5	6.0	35.5	6.1
MB	20.9	8.0	37.6	8.2
DC	26.9	20.1	45.5	16.8

[a] Ordering in brackets. – For definition of the variables, see Table 1.

[13] The results may depend on the ordering of the variables; the information concerning the ordering is therefore always given in the tables. The numbers in Tables 2a and 2b refer to the portion of the forecast error variance explained by the respective other variable. Each variable itself explains the difference between the values given and 100.

[14] For example, *Plosser* (1991) also relies on a 3-year forecast horizon. Of course, I checked many other possibilities as well. In general, it can be said that the values stabilize at the 12-step ahead forecast.

tions in the series X now account for a much larger share of the forecast error variance of Y, while innovations in Y mostly explain only a smaller share of the variance in X. It is worth noting that as to the effects in the opposite direction, real domestic expenditures seem to affect only the deposit currency ratio while the impact on all other variables is trivial.

Since the role of the real disturbance is of interest, I also tested the causal link between this variable and each of the other measures. The variance decomposition results for the systems including the terms of trade (TT) show that several of the monetary aggregates and other money measures explain a large part of the forecast error variance in TT (up to 29.1 percent in the case of currency), while the multiplier MS shows the smallest impact (Table 2b). In the opposite direction, the terms of trade explain only a small fraction of the forecast error variance of the monetary variables under consideration. The impact on the deposit currency ratio is the highest with a value of slightly over 10 percent, and there is a comparable influence on demand deposits (DD).

Table 2b

Variance Decomposition in Two-variable Systems with Terms of Trade (TT) and 7 Money Measures (X) – 12 steps ahead[a]

Series X	[TT X] Innovation in X, effect on TT	[TT X] Innovation in TT, effect on X	[X TT] Innovation in X, effect on TT	[X TT] Innovation in TT, effect on X
BS	28.9	8.1	30.7	8.5
BB	16.6	9.9	20.6	7.4
CU	29.1	4.2	34.1	5.1
DD	20.2	11.0	25.2	9.8
MS	9.3	4.3	13.9	2.4
MB	16.7	4.5	20.2	4.6
DC	13.8	11.7	18.9	9.3

[a] Ordering in brackets. – For definition of the variables, see Table 1.

To summarize, the analysis so far contradicts the view that monetary impulses play no or only a minor role in explaining output movements. Most measures related to M1 seem to have a bigger impact than the terms of trade; the latter variable does not explain more than the two measures of the monetary base and performs only slightly better than currency. Furthermore, money causes the real variable terms of trade. In contrast, most monetary variables appear to be exogenous with respect to output and the terms

of trade in the respective two-variable systems; a notable exception is the deposit currency ratio (*DC*).

However, the tests are not yet complete. Analyzing whether the impact of money on real variables is due to the overriding importance of the public's response to real shocks rather than actions by the central bank and whether the terms of trade play a dominating role in explaining output – directly or via measures of money – requires larger systems to which I will turn next.

2. *Systems with Three Variables*

It is now analyzed how the addition of a third-variable changes the contribution of the various innovations to the changes in output. For 13 systems the forecast error variance decomposition is estimated (Table 3).[15] These tests not only reveal the impact of shocks in the variables on output but also give a clue as to the interaction of all variables in a system. The comparison between effects of demand deposits (*DD*) on the one hand and the monetary base (*BS* and *BB*) and currency (*CU*) on the other shows – again – a dominance of *DD*. This is obvious for both orderings chosen; the contribution varies substantially only in the case of *BB* (system (2)): Innovations in the monetary base seem to have a significant impact on output (14.6) in the first but only a negligible effect in the second ordering (1.9). The relative importance of the measures of the monetary base and the respective multipliers or the multiplier component *DC* changes with the ordering (systems (4) to (7)); nevertheless, there is no evidence that would reject the hypothesis of an influence of the monetary base in addition to that of the respective other variables. Currency, however, seems to be unimportant in connection with *DC* (system (8)).

The innovations in the monetary base contribute more to the reduction in the forecast error variance of output than the terms of trade. This is even the case for currency (system (11)). The reason may be that the terms of trade are not exogenous with respect to the various money measures;[16] in the variance decomposition results, therefore, innovations in the monetary base or in cur-

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[15] The estimates are based on equations like (1 a) and (1 b); the systems now include three (and later four) variables. Note that in the tables of the variance decomposition the numbers in each row add up to 100. – The decompositions were computed for forecast errors up to 16 quarters. Of course, the values change considerably; but as mentioned before, they tend to stabilize at the 12-step ahead forecast. Additionally, the relative importance of the variables in the analysis is not strongly affected if it is compared to the errors of, say, the 6- or 8-step ahead forecast. Thus, no further results are reported here.

[16] See also Table 2 b.

Table 3

Variance Decomposition in Three-variable Systems with Output (*Y*) and 8 Other Variables – 12 steps ahead[a]

		Innovation in:					
Effect on:	(1)	[*Y*	*BS*	*DD*]	[*Y*	*DD*	*BS*]
Y		68.4	6.0	25.6	68.4	26.8	4.8
BS		2.6	51.1	46.3	2.6	68.6	28.8
DD		4.6	21.5	73.9	4.6	84.4	11.0
	(2)	[*Y*	*BB*	*DD*]	[*Y*	*DD*	*BB*]
Y		67.8	14.6	17.7	67.8	30.4	1.9
BB		2.0	68.7	29.3	2.0	73.5	24.5
DD		4.9	34.3	60.8	4.9	92.2	3.0
	(3)	[*Y*	*CU*	*DD*]	[*Y*	*DD*	*CU*]
Y		69.9	5.4	24.7	69.9	28.4	1.6
CU		1.1	86.9	12.0	1.1	36.8	61.1
DD		7.2	40.9	51.9	7.2	72.5	20.3
	(4)	[*Y*	*BS*	*MS*]	[*Y*	*MS*	*BS*]
Y		70.9	4.7	24.5	70.9	20.3	8.8
BS		2.9	39.9	57.1	2.9	51.9	45.2
MS		3.7	15.3	81.1	3.7	82.3	12.3
	(5)	[*Y*	*BB*	*MB*]	[*Y*	*MB*	*BB*]
Y		68.7	14.4	16.9	68.7	20.7	10.6
BB		2.9	65.2	31.9	2.9	42.2	54.9
MB		5.7	8.4	85.8	5.7	89.1	5.2
	(6)	[*Y*	*BS*	*DC*]	[*Y*	*DC*	*BS*]
Y		73.6	13.9	12.5	73.6	17.5	8.9
BS		4.8	89.9	5.3	4.8	17.2	78.0
DC		11.6	41.8	46.5	11.6	53.3	31.0
	(7)	[*Y*	*BB*	*DC*]	[*Y*	*DC*	*BB*]
Y		70.8	17.6	11.7	70.8	18.0	11.3
BB		1.8	88.9	9.3	1.8	22.7	25.5
DC		10.5	40.8	48.7	10.5	60.5	29.0
	(8)	[*Y*	*CU*	*DC*]	[*Y*	*DC*	*CU*]
Y		69.9	5.4	24.7	69.9	18.8	11.2
CU		1.1	86.9	12.0	1.1	3.8	95.2
DC		12.1	21.3	66.5	12.1	63.0	25.0

Table 3: Continuation

	(9)	[*Y*	*BS*	*TT*]	[*Y*	*TT*	*BS*]
Y		69.8	20.4	9.7	69.8	9.3	20.9
BS		3.4	90.9	5.6	3.4	5.4	91.2
TT		9.9	36.5	53.6	9.9	54.2	35.9
	(10)	[*Y*	*BB*	*TT*]	[*Y*	*TT*	*BB*]
Y		67.7	21.8	10.5	67.7	10.3	22.0
BB		2.0	92.4	5.5	2.0	7.5	90.4
TT		11.1	24.0	64.9	11.1	68.1	20.8
	(11)	[*Y*	*CU*	*TT*]	[*Y*	*TT*	*CU*]
Y		74.2	16.1	9.7	74.2	10.2	15.6
CU		0.7	95.0	4.3	0.7	4.2	95.1
TT		9.1	34.5	56.4	9.1	59.2	31.6
	(12)	[*Y*	*DD*	*TT*]	[*Y*	*TT*	*DD*]
Y		65.6	22.2	12.2	65.6	12.7	21.7
DD		6.3	83.4	10.3	6.3	12.9	80.8
TT		18.2	26.6	55.2	18.2	60.1	21.8
	(13)	[*Y*	*DC*	*TT*]	[*Y*	*TT*	*DC*]
Y		67.8	17.6	14.6	67.8	16.6	15.6
DC		15.1	68.0	16.9	15.1	20.3	64.6
TT		7.5	24.7	67.7	7.5	75.9	16.6

[a] Ordering in brackets. – For definition of the variables, see Table 1.

rency explain up to 36.5 percent (*BS* in system (9)) of the forecast error variance of the terms of trade. Finally, in connection with *DD* and *DC* (systems (12) and (13)), the impact of the terms of trade on output seems to be somewhat stronger.

In general, these results indicate that only a small role can be attributed to the real disturbance for explaining output fluctuations. While the focus has so far been on the explanation of the forecast error variance of output, the figures in Table 3 also give some interesting information as to the interaction of the other variables in the respective systems. In particular, the impact of the monetary base or currency on the measures of endogenous money is often substantial. In the case of the deposit currency ratio (i.e. systems (6) to (8)), up to about 40 percent of the forecast error variance is explained by exogenous money. The effects on demand deposits (system (1) to (3)) are almost as high, whereas the effect on the two multipliers is smaller (systems (4) to (5)). In the systems which include the terms of trade it is obvi-

ous that the indirect impact on the measures of endogenous money is much smaller, reaching some 20 percent in the case of the deposit currency ratio (system (13)).[17]

3. *Tests of Restricted and Unrestricted Four-variable Systems*

Finally, a strong version of the real-business cycle theory is tested in systems which include four variables: output, the money multiplier (or other measures of endogenous money), the terms of trade, and the monetary base. The hypothesis is that the monetary base plays no role in explaining any of the other three variables under consideration. For that purpose, the four equations which contain four lags of each variable (plus constant and time trend) are estimated simultaneously[18] with and without the restriction that the coefficients of the monetary base are zero (i.e. there are 12 restrictions). For the estimates of the unrestricted and restricted systems the likelihood ratio is calculated which follows a chi-square distribution.[19]

Table 4 summarizes the results for the six systems. The null-hypothesis (i.e. the coefficients of the monetary base are zero) can be rejected in three cases at the 5 % level of significance. As could be expected from the results

Table 4

Likelihood-ratio Tests for Unrestricted and Restricted Four-variable Systems[a]

	System	Calculated value of likelihood-ratio	Conclusion for H_0
(1)	[*Y MS BS TT*]	41.66	rejected
(2)	[*Y MB BB TT*]	16.70	not rejected
(3)	[*Y DC BS TT*]	31.22	rejected
(4)	[*Y DC BB TT*]	24.36	rejected
(5)	[*Y DD BS TT*]	12.14	not rejected
(6)	[*Y DD BB TT*]	4.48	not rejected

[a] For definition of the variables, see Table 1.

[17] This is confirmed by an analysis not reported here which – in systems with three variables – compares the effects of innovations in exogenous money with those of the terms of trade on the measures of endogenous money. For more details, see *Scheide* (1991).

[18] The equations in the systems mentioned above are estimated simultaneously to take account of the fact that the residuals of the equations may be correlated (method of "seemingly unrelated equations").

[19] The critical values for the chi-square distribution (for 12 degrees of freedom) are 18.55, 21.03 and 26.22 for the 10 %, 5 % and 1 % level of significance, respectively.

in the previous tests, in those systems which include demand deposits (*DD*) the null-hypothesis (H_0) cannot be rejected which again suggests that this variable plays a strong role in explaining output.

While these results seem somewhat inconclusive, it has to be remembered that in those systems the monetary base had to "compete" against two other measures which are supposedly much more important for explaining output, i.e. the tests definitely do not have a bias against the real business cycle hypothesis. The ambiguity of the results is also revealed in the results for the variance decomposition for the same systems (Table 5). Here, the output variable of domestic expenditures (*Y*) always appears first in the ordering of variables. The motive behind changing the ordering for the remaining variables is to give the monetary base a "chance" equal to that of the terms of trade, so *TT* appears either in fourth or in second place (the multipliers, the deposit currency ratio and demand deposits are always ordered in third place).

Given that the variable of real domestic expenditures accounts for 65 to 70 percent of its own forecast error variance and that the other variables have to explain the rest, a value of well above 10 percent would indicate a substantial impact, while a value of well below 10 percent would mean that the innovations in that respective variable are of minor importance. By this definition, the multipliers (*MB* and *MS*) and demand deposits (*DD*) are the most important variables for explaining output fluctuations. The deposit currency ratio (*DC*), however, plays only a small role in systems including any measure of the monetary base. In most systems, innovations in the monetary base explain at least as much of the forecast error variance of *Y* as the terms of trade. In general, *BB* seems to perform better than *BS* indicating that changes in reserve requirements do not play a major role in explaining output.

Also in these systems, the impact of the terms of trade on measures which represent endogenous money is small; *TT* explains more than 10 percent only in the case of the forecast error variance in *DC*. However, it is important to note that the measures of the monetary base explain not only a large portion of the variance in the terms of trade but – as shown in the previous tests – also have a substantial impact on endogenous money; the values for the effect on demand deposits and the deposit currency ratio range between 18.6 (system (5)) and 39.9 percent (system (3)), when the first ordering is considered.

Table 5

Variance Decomposition in Four-variable Systems with Output (*Y*), the Terms of Trade and Various Money Measures – 12 steps ahead[a]

		Innovation in:							
Effect on:	(1)	[*Y*	*BS*	*MS*	*TT*]	[*Y*	*TT*	*MS*	*BS*]
Y		66.6	2.3	20.5	10.6	66.6	10.2	16.3	7.0
BS		4.8	37.6	51.0	6.6	4.8	8.9	37.5	48.8
MS		2.9	11.8	79.7	5.7	2.9	6.2	80.7	10.3
TT		15.4	13.0	24.9	46.7	15.4	52.5	15.2	16.9
	(2)	[*Y*	*BB*	*MB*	*TT*]	[*Y*	*TT*	*MB*	*BB*]
Y		64.4	11.2	13.9	10.6	64.4	10.4	16.6	8.6
BB		3.7	63.4	28.1	4.8	3.7	7.2	35.5	53.6
MB		5.7	6.0	81.4	6.8	5.7	6.9	82.6	4.8
TT		15.7	10.7	23.1	50.5	15.7	55.0	23.9	5.4
	(3)	[*Y*	*BS*	*DC*	*TT*]	[*Y*	*TT*	*DC*	*BS*]
Y		70.0	14.0	5.8	10.1	70.0	9.1	9.5	11.4
BS		4.8	88.5	1.9	4.8	4.8	4.5	9.3	81.4
DC		8.1	39.9	38.2	13.7	8.1	11.8	46.5	33.6
TT		12.7	34.0	1.5	51.8	12.7	53.4	5.1	28.7
	(4)	[*Y*	*BB*	*DC*	*TT*]	[*Y*	*TT*	*DC*	*BB*]
Y		68.3	15.4	6.2	10.1	68.3	10.4	10.2	11.1
BB		2.2	88.0	7.1	2.8	2.2	6.7	17.7	73.5
DC		8.5	37.3	42.4	11.8	8.5	10.8	51.7	29.0
TT		14.4	19.9	7.0	58.7	14.4	64.2	9.2	12.1
	(5)	[*Y*	*BS*	*DD*	*TT*]	[*Y*	*TT*	*DD*	*BS*]
Y		66.3	4.4	19.2	10.1	66.3	9.1	22.3	2.3
BS		4.7	50.8	39.2	5.3	4.7	6.3	62.8	26.2
DD		5.7	18.6	67.9	7.8	5.7	8.2	79.0	7.1
TT		16.6	18.2	17.5	47.8	16.6	52.3	27.1	4.0
	(6)	[*Y*	*BB*	*DD*	*TT*]	[*Y*	*TT*	*DD*	*BB*]
Y		65.0	12.0	12.4	10.6	65.0	10.5	23.1	1.4
BB		3.3	68.5	24.1	4.2	3.3	7.1	65.7	23.9
DD		6.0	30.8	54.5	8.8	6.0	10.5	81.9	1.7
TT		17.4	13.8	16.4	52.5	17.4	57.4	24.7	0.5

[a] Ordering in brackets. – For definition of the variables, see Table 1.

IV. Conclusions

The estimates of the variance decomposition have the purpose to find causes of output fluctuations. The variables under consideration reflect actions of the central bank, a real disturbance and responses of the public. One object is to test the relative importance of the different variables. Many regressions were run for the period 1964 - 1989 in order to take account of the fact that results and interpretations may depend on the information set chosen. The reason for considering several variables of exogenous and endogenous money was to avoid the possible criticism that the results may depend on the particular choice of variables. Indeed, one could pick results in such a way as to either support the real business cycle view or to subscribe to conventional theories.

It can be concluded that the strong hypothesis of real business cycle theory finds no or only limited support. For this theory to be correct it would have to be shown that first, the monetary base – or, as *Plosser* (1991) mentions, currency – has no impact on output, and second, that measures of endogenous money are not only the dominant explanatory monetary variables for output but are also influenced exclusively by supply shocks.[20] As to the first hypothesis, the results of the empirical tests do not allow a rejection of the view that actions of the central bank matter. Both measures of the monetary base – and even currency – explain some of the movements of output. Furthermore, the monetary base *BB* seems to perform better in many cases than *BS*; the real business cycle interpretation would imply the opposite because *BS* takes account of changes in reserve requirements. As far as the second hypothesis is concerned, it is indeed obvious that the stronger impact on output stems from the multipliers or demand deposits. But these measures of endogenous money are themselves not dominantly explained by movements of the terms of trade; in fact, they are at least as much influenced by monetary policy, i.e. changes in the monetary base or currency. So in the tests presented here, the response of the public does not necessarily mean a response to supply shocks.[21]

The tests reveal that real disturbances, measured as changes in the terms of trade, are not the dominant source of output fluctuations although there is certainly a causal role. In principle, the variable of the terms of trade

[20] "It seems inadequate to conclude that whatever is not monetary ... must be real in the sense of real disturbances that appear in RBC theories" (*Barro*, 1986, p. 136).

[21] In a theoretical and empirical analysis, *Garfinkel, Thornton* (1991) show that monetary policy does indeed have an effect on the deposit currency ratio and, consequently, on the money multiplier.

could be an appropriate measure of real shocks: It is observable, it also has fluctuated substantially and could therefore account for major ups and downs in economic activity.[22] It would, of course, be ideal to use a real disturbance which is truly exogenous. The variable of the terms of trade is not since – as the tests also show – it is influenced by domestic monetary policy and – one may assume – by foreign monetary policy as well. Even changes in, say, raw material prices which may have a dominant impact on the terms of trade cannot be viewed as exogenous since they are also affected by monetary policy in industrial countries (*Langfeldt, Scheide, Trapp* 1989).

To summarize, the German experience does not support the real business cycle interpretation in its strong version which denies any importance of central bank actions. There is a role for the monetary base in explaining output movements although the effects stemming from responses of the public seem to be stronger. But a satisfactory interpretation along the lines of the real business cycle theory would require more empirical research to test what the possible causes of these responses are. In this regard, the variable of the terms of trade is obviously not the best choice.

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[22] If measured in relation to output, it accounted for a 2.5 percent decline before the 1974/75 recession; before the 1980/82 downturn, the respective value was 2 percent. However, prior to the recession in 1966/67 (which was about as severe as the other two) no major change could be observed.

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Zusammenfassung

Output, Geld und Terms-of-Trade in Deutschland – ein empirischer Test der realwirtschaftlichen Konjunkturzyklen

Gemäß der Theorie der realwirtschaftlich bedingten Konjunkturzyklen (RBC) ist der oft gefundene Zusammenhang zwischen Geldmenge und Produktion Indiz für eine umgekehrte Kausalität: So scheint die Geldmenge M1 nur deshalb kausal im Sinne von Granger für die wirtschaftliche Aktivität zu sein, weil die endogene Komponente auf reale Störungen reagiert; dagegen ist das exogene, von der Notenbank gesteuerte Geld neutral. Mit Quartalsdaten für die Zeit 1964 - 1989 wird die RBC-Hypothese für die Bundesrepublik Deutschland untersucht. Die Varianzzerlegungen verschiedener vektorautoregressiver Systeme zeigen erstens, daß die Geldbasis und auch das Bargeld einen Einfluß auf die Produktion haben; Innovationen in diesen Größen vermindern die Varianz des Prognosefehlers der Produktion. Dieser Effekt ist mindestens so bedeutend wie derjenige, der von dem realen Schock, gemessen an Änderungen der Terms-of-Trade, ausgeht. Zweitens hat zwar das endogene Geld wie z.B. die Geldmengenmultiplikatoren oder die Sichtdeposition den stärksten Einfluß auf die Produktion, sie werden jedoch selbst nicht vorwiegend von realen Faktoren bestimmt. Vielmehr geht von Änderungen der Geldbasis ein erheblicher Einfluß auf diese Größen aus; daher kann man die Bewegungen des endogenen Geldes nicht so interpretieren, als seien sie allein die Reaktion des Nichtbankensektors auf reale Schocks. Diese Ergebnisse stehen im Widerspruch zur RBC-Hypothese.

Summary

Output, money, and the terms of trade in Germany – an empirical test of the real business cycle hypothesis

The theory of real business cycles (RBC) interprets the often found link between money and output as one of reversed causality: A broad monetary aggregate such as M1 Granger-causes output only because of the response of endogenous money to changes in the production possibilities in the economy while exogenous money is neutral. Quarterly data for the period 1964 - 1989 are used to investigate the validity of the RBC hypothesis for Germany. On the basis of variance decomposition results for various vector autoregressive systems, it is shown that first, the monetary base and even currency have an impact on output, i.e. their innovations reduce the forecast error variance of output. This effect is at least as strong as the one stemming from the real shock, i.e. changes in the terms of trade. Secondly, while the variables of endogenous money, such as the money multiplier and demand deposits, seem to have the strongest effect on output, they are themselves not dominantly influenced by real factors. In fact, monetary policy, e.g. a change in the monetary base, has a substantial impact, so the movements of endogenous money cannot be viewed as being solely a response of the public to real shocks. These findings are at variance with the RBC interpretation.

Résumé

Output, argent, et les Terms-of-Trade en l'Allemagne – un test empirique des cycles conjoncturelles économiques réelles

Selon la théorie sur les cycles conjoncturelles économiques réelles (l'hypothèse RBC) la cohésion souvent trouvée entre la quantité de monnaie en circulation et la production est un indice pour une causalité inversée: Donc la quantité de monnaie M1 semble être causale pour l'activité économique dans le sense de Granger seul, parceque la composante endogène réagit aux pertubations réelles. Au contraire, la monnaie exogène, contrôlée par la banque d'emission est neutre. Au moyen des données trimestrielles our la période de 1964 allant jusqu'à 1989 on analyse l'hypothèse RBC pour l'Allemagne Fédérale. L'analyse des variances des différents systèmes vecteur-autoaggressifs indique premièrement, que la base de monnaie ainsi que l'argent liquide influencent la production; innovations dans ces dimensions réduisent la variance du faute de la prévision productive. Cet effet est au moins aussi important que celui, qui résulte du choc réel dû au changements du Terms-of-Trade. Il est vrai que deuxièmement la monnaie endogène – comme par example les multiplicateurs de la quantité de monnaie en circulation ou bien les dépôts à vue – influence la production le plus, cependant en majorité ces facteurs ne sont pas déterminés par des conditions réelles. Plutôt des changement de la base de monnaie influencent considérablement ces facteurs. C'est pourquoi il ne faut pas interpréter les mouvements de la monnaie endogène comme réaction du secteur non-bancaire sur des chocs réels. Ces résultats sont en contradiction avec l'hypothèse RBC.