

Scheide, Joachim

Working Paper — Digitized Version

On real and monetary explanations of business cycles in West Germany

Kiel Working Paper, No. 356

Provided in Cooperation with:

Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

Suggested Citation: Scheide, Joachim (1989) : On real and monetary explanations of business cycles in West Germany, Kiel Working Paper, No. 356, Kiel Institute of World Economics (IfW), Kiel

This Version is available at:

<https://hdl.handle.net/10419/501>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Kieler Arbeitspapiere Kiel Working Papers

Working Paper No. 356
On Real and Monetary Explanations of
Business Cycles in West Germany

by

Joachim Scheide

Institut für Weltwirtschaft an der Universität Kiel
The Kiel Institute of World Economics

ISSN 0342-0787

Kiel Institute of World Economics
D-2300 Kiel, Düsternbrooker Weg 120

Working Paper No. 356
On Real and Monetary Explanations of
Business Cycles in West Germany

by

Joachim Scheide

Ag 805/89 ^{Weltwirtschaft}
Kiel

February 1989

Revised version of the paper presented at the seminar "Die siebziger Jahre - Der Weg in die Stagnation" at the Institut für Weltwirtschaft, Kiel, January 24-26, 1989.

The author himself, not the Kiel Institute of World Economics, is solely responsible for the contents and distribution of each Kiel Working Paper.

Since the series involves manuscripts in a preliminary form, interested readers are requested to direct criticisms and suggestions directly to the author and to clear any quotations with him.

ISSN 0342-0787

ON REAL AND MONETARY EXPLANATIONS OF BUSINESS CYCLES IN WEST GERMANY

<u>Contents</u>	Page
I. Introduction	1
II. On the Relevance of Real Business Cycle Theory	4
1. What Is a Trend?	4
2. Can Business Cycles Be Random?	8
III. Tests on the Importance of the Random Walk Component	12
1. The TS - versus DS-model	12
2. Random Walks in Macroeconomic Series	14
3. An Example: Unemployment	18
IV. Real and Monetary Causes for Business Cycles	20
1. The Data and the Method of Investigation	20
2. What Causes Output?	24
3. Do Interest Rates Dominate the Money Supply as a Causal Factor?	27
4. The Role of Real and Monetary Factors for Output	30
V. Focus on the Seventies	33
VI. Money Isn't Neutral After All	39
1. The Results in the Light of Other Studies	39
2. Growth Theory and Business Cycle Theory Are One	40
3. Some Problems With Real Business Cycle Theory	42
4. Some Doubts on the Long-run Neutrality of Money	43
Bibliography	45

Abstract

The view that fluctuations of economic activity can be attributed to real (or technology) shocks has received widespread attention in recent years. According to the real business cycle theory, output movements are not induced by monetary policy. This proposition is supported by several empirical investigations using two different types of tests: Firstly, macroeconomic time series can be characterized as following a random walk; secondly, in the analysis of vector autoregressions, the money supply does not cause output. In this paper, both tests are applied for data of the West German economy.

The hypothesis that macroeconomic time series behave like a random walk cannot be rejected with great power. Most of the 17 series under investigation show a unit coefficient if regressions for a variable are run on its own past value. Nevertheless, some of the statistical results, in particular the presence of autocorrelation, give rise to doubts about the correctness of the models. Above all, it is well known that such tests cannot conclusively discriminate between a value of 1.00 and, say, 0.96 for the coefficient, although the differences are substantial for the decomposition of a series into permanent and transitory components.

In the tests for Granger-causality, the importance of several candidates for explaining output is investigated. It turns out that in the bivariate case, real domestic expenditures are caused by the real money supply, real interest rates and the terms of trade, respectively. If systems with three variables are considered, the influence of the money supply dominates; neither interest rates nor terms of trade improve forecasts of domestic expenditures based on the knowledge of the money supply.

These latter results, while contradicting propositions of real business cycle theory, are in accordance with several other studies on the West German economy which show a strong impact of monetary policy on economic activity. In the final section, we therefore mention some doubts about the appropriateness of relying exclusively on real factors when explaining output fluctuations. Money seems to be non-neutral in the short run, and, furthermore, we have some evidence that money is not neutral even in the long run.

ON REAL AND MONETARY EXPLANATIONS OF BUSINESS CYCLES IN WEST GERMANY

I. Introduction

The past decade has seen a serious challenge to business cycle theory. It affected all conventional views, whether Keynesian or new classical, because the definition of the business cycle itself and the alleged size of the effects of macroeconomic policy, in particular monetary policy, on economic activity were questioned. According to the new real business cycle theory, the size and the persistence of cycles is much smaller than commonly thought and therefore much less of a problem for welfare and thus economic policy.

The new view was put forward by two distinct strands in the literature. Firstly, it could be shown that a well-articulated neo-classical model in which money has no role can mimic actual fluctuations of economic activity reasonably well¹; in that model, movements in real GNP and other variables are due to shocks in technology which have permanent effects. Secondly, it was claimed by economists analyzing economic time series that the behavior of those variables commonly associated with business cycles (GNP, employment, investment and so on) can be characterized by a random walk; this hypothesis, too, implies that the largest part of economic fluctuations can be attributed to real shocks which have, by definition, persistent effects on the level of activity². Thus, proponents of this view deny any major role for monetary policy in explaining movements of output,

¹ See, e.g., Kydland, Prescott (1982) and the discussion in Lucas (1987), who does not subscribe to this line of real business cycle proponents but uses this model as a benchmark and tries to incorporate money into it.

² Major impacts came from Nelson, Plosser (1982) whose article on macroeconomic time series of the United States was followed by many other investigations, also for other countries.

and the Phillips-curve in all its interpretations, i.e., including the expectations-augmented version or the Lucas supply curve, is regarded as an artifact. A further empirical challenge to the theory of monetary business cycles came from a somewhat different angle¹, namely the empirical work resting on vector autoregressions². On the basis of their findings, several authors rejected the view that money has any significant impact on output movements. It is this characteristic of the real business cycle theory that distinguishes it from the alternatives (McCallum, 1986, p. 398).

The influence of this new view has been substantial for it offers a theory based on strict neoclassical principles at a time when the attractiveness of the leading alternative of this school - the Barro-Lucas theory of monetary business cycles - seems to weaken. It induced a tremendous amount of research on a better specification of the role of monetary policy in a neoclassical model. Lucas discusses progress along this line, but states that an integration of monetary elements into the Kydland-Prescott model "... is, at present, slightly beyond the frontier of what is technically possible" (Lucas, 1987, p. 85).

The purpose of this paper is to discuss the relevance and some of the propositions of the real business cycle theory³ in the context of the West German economy. This approach seems to be, at least in part, appropriate for the explanation of economic activity in the 1970's. This was the period in which real disturban-

¹ Different in the sense that not all of those economists are proponents of the neoclassical real business cycle theory.

² Notably Sims (1980).

³ As the reader will have noticed, the term "real business cycle theory" is somewhat misleading since proponents of this school define the business cycle quite differently from the common use of the term. Actually, it is a theory to explain economic fluctuations, i.e., growth plus cycle. For a discussion, see also Section II. Nevertheless, we will continue to use the label to make things easier.

ces of great magnitude hit the economy; hardly any observer would deny that the oil price hikes, and possibly also the large changes of real exchange rates as well as the changes in fiscal policy, had an impact on the movement of output and employment. Furthermore, the development of average output growth since World War II shows a marked downturn over time¹, and several of the shifts in the growth rate seem to coincide with real shocks, in particular, again, in the middle and late 1970's, but probably also in the earlier periods. And the acceleration of economic activity in 1987/88 can possibly be viewed, in part, as a response to the favorable development of import prices. Nevertheless, it may be difficult to distinguish all the mentioned effects from the effects stemming from monetary policy. As a casual observation, it seems that favorable supply shocks coincided with (or led to) more monetary expansion, and, equivalently, real shocks with negative consequences were accompanied by monetary restrictions.

The paper is organized as follows: In Section II, the main arguments of the real business cycle view are summarized and contrasted with some criticisms. We will then present tests on the validity of some propositions and look at the stochastic behavior (random walk) of several economic time series in West Germany (Section III). The second approach of vector autoregressions will also be applied to West German data; we will test for Granger-causality (Section IV). We will then take a closer look at the business cycles in the 1970's (Section V). Finally, we will discuss the possible limits of the empirical investigations in general and elaborate a bit more on the notion of the neutrality of money.

¹ On average, real GNP increased by some eight percent in the 1950's, five percent in the 1960's, three percent in the 1970's and less than two percent in the 1980's.

II. On the Relevance of Real Business Cycle Theory

The arguments in favor of the real business cycle view are theoretical and empirical. The implication is that money is practically irrelevant; monetary policy can only produce some noise but not any kind of a Phillips-curve. This applies also, and this is a crucial difference between this theory and the new classical models, to monetary surprises; even unexpected money is neutral. This result turns out in some studies¹ when the time series of, e.g., output can be characterized as random walks.

1. What Is a Trend?

The way economic time series are described is therefore crucial when the force of real business cycle theory is assessed. Characteristically, most macroeconomic time series are not stationary but increase over time. The conventional procedure to define business cycles is to assume a deterministic time trend for variables such as real GNP; usually, this trend is taken to be linear or quadratic. The fluctuations around this trend are then, by definition, business cycles. These cycles are persistent, averaging, say, some five to seven years, and show quite large deviations from trend resulting in pronounced overheating or high unemployment. All conventional theories, then, set out to explain these movements, while normally the behavior of the trend is left for another "department" to explain - growth theory. But is this distinction appropriate when economic fluctuations are to be explained?

Proponents of real business cycle theory state that the assumption of a deterministic trend² is ad hoc. This is certainly cor-

¹ A recent contribution is Wasserfallen (1988). Earlier studies are Wasserfallen (1985) and Stulz, Wasserfallen (1985).

² This may also be a moving average or a trend derived from the peaks in business cycles.

rect. Early theories and methodological studies go through great lengths to make a judgement on the trend¹, but there is no precise knowledge on the underlying growth rate of the economy and how it changes over time. This applies also to calculations of potential output. As the past has shown, these estimates had to be revised again and again, they show sudden shifts and so on. The difficulty lies in the fact that those factors that determine the underlying rate of growth are difficult to measure, e.g., the stock of technology. What is the alternative? Of course, we can always think of a way to decompose GNP into a trend and a cyclical component. But there is no satisfactory and widely accepted definition how this should be done, so "... one economist's 'trend' can be another's 'cycle'" (Stock, Watson, 1988, p. 150).

One way to proceed - and this is what is done in the works on real business cycle theory - is to look at the time series themselves. Here, the difference is made between two models that define the trend and deviations from it. The first describes the variable y_t (e.g., the log of GNP) as a series that, on average, is influenced by the time trend². It is therefore characterized

¹ See, for example, Mitchell (1928), who discusses various problems: "Unless it is possible to find trends which are satisfactory throughout long periods - long in comparison with business cycles - the distinction between secular and cyclical fluctuations is blurred and the whole analysis loses its point" (p. 214). And: "Is there a definite relation between secular trends and cyclical fluctuations? ... Can the trends of time series, after they have been measured, be discarded as of no further interest? Or must the trends themselves be brought into the explanations of cyclical fluctuations...?" (p. 233). - Haberler (1937) is less explicit in the discussion of the "secular trend" but he also stresses the difficulty of defining a trend: "... it is by no means necessary that the secular change should take place at a constant rate, or that it should always slope upward along a smooth curve which can confidently be extrapolated into the future. Nor is it excluded that the forces which create the trend may tend to operate spasmodically or cyclically" (p. 174).

² We use the simplest version of such a trend. Also, we neglect other aspects, e.g., seasonal factors.

as belonging to the trend-stationary class (TS):

$$(1) \quad y_t = a + bt + u_t$$

Here, the disturbance term is stationary with zero mean and variance σ_u^2 but is serially autocorrelated (with a positive sign). This means that for short-term forecasts of y , the existing autocorrelation can be exploited. Even for the distant future, there is only limited uncertainty concerning values of y . Apart from the disturbance term, the prediction can be very precise because the series y will always return to the trend.

This, however, is not true for the alternative, difference-stationary class (DS)¹:

$$(2) \quad y_t = \mu + y_{t-1} + v_t$$

In this case, y_t depends on the realized value of the previous period, with the coefficient being equal to one. If this model of a random walk with drift - the coefficient μ represents the average increase of y over time - is correct, future values cannot be predicted with precision. Firstly, the disturbance term is not autocorrelated and can thus not be exploited (i.e., v_t is white noise). Such a model is commonly used to describe the behavior of prices on financial markets (stock prices, interest rates, exchange rates) and implies that no information is available to improve the forecast for the next period - i.e., the best forecast is that today's price will also be tomorrow's price². Secondly, the forecast variance increases "without bound" because the deviations from trend are not stationary as in the TS-case but the series is an accumulation of stationary changes, and this sum is not stationary.

¹ Difference-stationary means that, in this case, the first difference has to be used to achieve stationarity.

² Possibly, as in this example, the drift term has to be considered.

One might argue that these statistical procedures do not in any way resemble economic theory and are therefore beside the point. What is there for the economist to explain if he knows that output follows a random walk? The answer is that these statistical methods help to determine what exactly is to be analyzed by the economist. And the implications of the correct choice of the method can be very important. If the true model is indeed of the DS-class - i.e., the series has to be differenced to be stationary - estimates with the other model can lead to spurious results.

This was demonstrated for the relationship between the money supply and nominal income¹. The quantity theory suggests a relationship with a coefficient of one. If an equation with just the trend variable is estimated, the coefficient may be significantly different from one. However, this equation is misspecified as is indicated by the presence of autocorrelation (as indicated by, e.g., a low Durbin-Watson statistic); the estimate for the coefficient is therefore biased. If first differences are used, this autocorrelation disappears and the coefficient becomes one. Such problems can, therefore, arise when the true model is indeed DS but the econometrician estimates a different model, e.g., one of the TS-class. Another important example concerns Friedman's permanent income hypothesis, according to which people consume exactly the permanent component of their disposable income; this part, however, follows a random walk. Therefore, observed consumption will also be a random walk. This implies for the testing procedure that current consumption cannot satisfactorily be explained by current observed income².

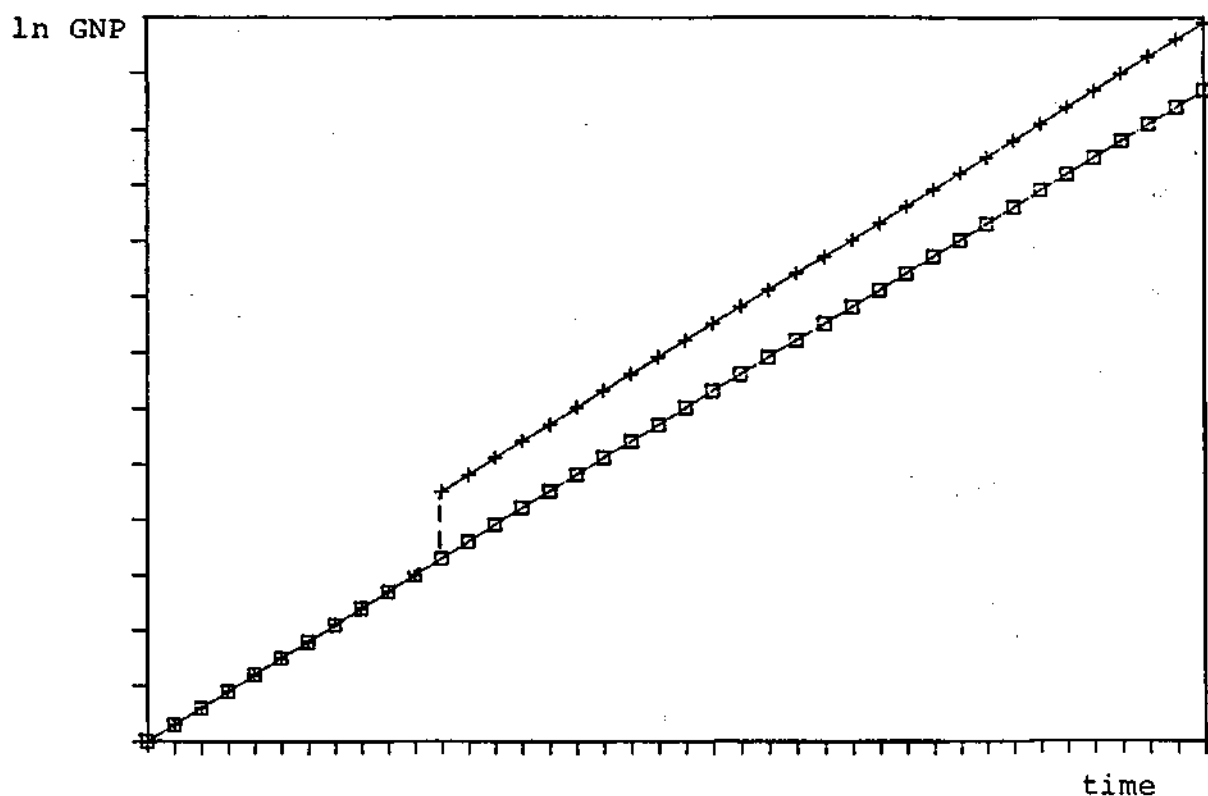
¹ See Plosser, Schwert (1978).

² On this distinction, see also the example in Stock, Watson (1988, p. 160 ff.), where one econometrician makes all the mistakes, because he does not distinguish correctly between levels and differences, whereas the second econometrician gets the correct results because she handles the time series, which are truly (i.e., by assumption of the authors providing the data) random walks, properly in her regressions.

2. Can Business Cycles Be Random?

What does this analysis mean for business cycle analysis? In effect, the question of TS- and DS-models amounts to asking: If the current level of, e.g., real GNP is one percent higher than expected, how does this affect our forecast of the future level of GNP? The answer given by someone using a TS-model would be: not at all. Since GNP is, by assumption, trend returning, the deviation from trend is only transitory; it will vanish, more or less quickly, over the next periods. Someone using a DS-model would instead revise his forecast by one percent, thus taking into account the random-walk character of real GNP¹. The difference is described in Figure 1. After the unexpected jump of GNP (in this case, the log of real GNP), the trend line now is on a

Figure 1: A Permanent Shift of the Level of a Time Series



¹ These two reactions described are extreme. It is, of course, possible that the change of the forecast may lie between zero and one, implying that part of the change is seen as permanent. A way to estimate such decomposition between permanent and transitory changes in time series is described by Cochrane (1988).

higher level (upper line) but still, of course, runs parallel to the old one. This, however, remains the path the economist believing in a TS-model will use for his forecast¹.

But if the random walk hypothesis is correct, can we still observe fluctuations which resemble the actual behavior of output? To answer this question, we have run a simulation with a model (for annual data) of the type

$$(3) \quad y_t = 0.043 + 1.0y_{t-1} + v_t$$

The values were chosen to match the actual development of real GNP in West Germany, i.e., the average growth rate of real GNP (equivalent to 4.3 percent²) between 1950 and 1987 and the variance of v_t (which equals 0.00038). Drawing random values for v_t and using equation (3) we get a simulated series for real GNP which shows ups and downs over time which are similar to those of the real-world series³. That there are movements similar to cycles can best be described in terms annual growth rates. Here, the deviations from the long-term trend show persistence even though the disturbances are random (Figure 2).

If business cycles are only real, the consequences for economic policy are drastic. If the observed movements of output merely reflect market adjustments to unavoidable shocks (e.g., harvest failures, economic developments in foreign countries), there is no role for the government to counter these movements. The ups and downs "... do not necessarily harm society, but simply represent the adjustments of markets to changes in tastes or con-

¹ Or put differently, the TS-model implies a lower than average growth rate for at least one period, thus allowing the series to return to the trend line, whereas in the DS-case, the expected growth rate is not changed.

² This value is only a rough approximation because the trend growth, as mentioned above, declined over time. However, the simulation is used only for the purpose of demonstration.

³ Of course, the timing is different.

accept the conclusions reached by Nelson, Plosser (1982) and many others, do we all believe in real business cycles now? Unfortunately, the issue cannot be settled easily because the empirical tests are not conclusive, their power is not strong enough¹. While many aspects of the tests seem to be in favor of the random walk hypothesis², the crucial factor is that the true coefficient of the lagged variable should be precisely one. If it is less than one (even slightly so, e.g., 0.98), the result would not invalidate the arguments of proponents of real business cycles, but it would change the decomposition of a series into a permanent and transitory component significantly³.

Other counter-arguments are concerned with the shocks to technology. Are they really big enough (and occur with high enough frequency) to account for most or even all economic fluctuations? Many authors have doubts concerning the procedure used by Kydland, Prescott (1982), because they just choose the technological shocks to match the behavior of economic variables: "... if someone believes that the variance of actual technology shocks is only (say) one-tenth as large as the value implied by the Kydland-Prescott model, he will find nothing in the Kydland-Prescott results that would require him to alter his belief" (McCallum, 1986, p. 400). This criticism is widely accepted⁴. What would be necessary, then, is to define technological shocks more precisely, i.e., find variables whose changes would affect output in a way that would be compatible with estimates of the parameters in a production function.

¹ Of course, the authors mention this fact.

² For example, the values of the autocorrelation function in Nelson, Plosser (1982) which are practically the same as for a random walk model. However, as McCallum (1986, p. 405 f.) points out, inspection of the autocorrelations alone cannot be conclusive; the function is not unique but can also belong to classes of an ARMA-model which are trend stationary.

³ This point is extensively discussed by McCallum (1986, p. 405 ff.).

⁴ See, e.g., Dotsey, King (1988, p. 12).

III. Tests on the Importance of the Random Walk Component

1. The TS - versus DS-model

It was mentioned before that standard regression results can be misleading if the stochastic character of time series is not correctly taken into account. If, for example, real GNP does follow a random walk, the usual detrending - based on the assumption of a deterministic trend - can lead to spurious interpretations. To demonstrate the difference, we estimated two regressions, one of the TS-class (4), one of the DS-class (5):

$$(4) \quad y_t = \alpha_1 + \alpha_2 t + \alpha_3 t^2 + u_t$$

$$(5) \quad y_t = \beta_1 + \beta_2 y_{t-1} + v_t$$

In the TS-model, we used a quadratic trend also to improve the fit of (the log of) real GNP¹.

The estimates for the period 1952-1987 (annual data) are as follows²:

$$(4') \quad y_t = 5.975 + 0.073t - 0.001t^2 + \hat{u}_t$$

(473.6) (46.7) (23.3)

$$\bar{R}^2 = 0.997 \quad \text{D.W.} = 0.805$$

¹ A linear trend makes no sense because the growth rates of GNP declined over time. Therefore, in a regression with just t we get negative residuals for the first years, positive ones for the interim period, and negative residuals again for the last couple of years.

² \bar{R}^2 is the adjusted correlation coefficient, D.W. the Durbin Watson statistic. The t -values are given in parentheses; they indicate that all estimated coefficients are highly significant.

$$(5') \quad y_t = 0.394 + 0.949y_{t-1} + \hat{v}_t$$

(7.40) (122.4)

$$\bar{R}^2 = 0.998 \quad \text{D.W.} = 1.796$$

Now, which model is better? Judging from the statistical criteria of goodness of fit, they are equal. Also, all coefficients are highly significant. However, the second model is preferable if we consider the statistics on autocorrelation. While model (4') reveals highly autocorrelated residuals (at lag one), the second model (5') looks better in this respect. In general, this implies at least, that the behavior of residuals has to be checked in the diagnosis of regressions. And for certain hypotheses such as the quantity theory it is better to use first differences rather than detrended series¹.

¹ See Section II, where this was mentioned. Two further remarks should be made: Firstly "highly correlated residuals... (indicate)... strong persistence in the cyclical component... these are exactly the characteristics one would expect if the time series under investigation contain unit roots" (Wasserfallen, 1988, p. 310). This means that if a series is truly a random walk, the detrended series is likely to exhibit spurious periodicity (Stock, Watson, 1988, p. 168). Secondly, detrending can lead to misleading results because the variable under investigation and the time trend are not cointegrated. Cointegration means that the investigated stochastic time series have the same trend. Real GNP and the time trend, as in this example, are not cointegrated by definition, because the time trend is not itself an integrated stochastic process (Stock, Watson, 1988, p. 168).

2. Random Walks in Macroeconomic Series

We now turn to our investigation of macroeconomic time series in West Germany. Many statistical procedures can be found in the literature; we confine ourselves to very simple tests with annual data. Unfortunately, the time series available are not as long as for the United States¹ since most series for West Germany start only in 1950. This will perhaps limit the power of the tests. The variables used are 17 nominal and real variables with the standard definitions². The first test concerns the random-walk hypothesis in its simplest form:

$$(6) \quad y_t = \alpha + \beta y_{t-1} + u_t$$

We used natural logs for all the variables. What we want to test is whether $\beta = 1$. The second procedure is to test a joint hypothesis according to the equation:

$$(7) \quad y_t = \alpha + \beta y_{t-1} + \gamma (y_{t-1} - y_{t-2}) + \delta t + v_t$$

Our null-hypothesis is, again, that $\beta = 1$. Furthermore, we test whether γ and δ are zero, i.e., whether there is any influence of further variables on the development of y_t or whether there is still a trend (time trend = t).

The test results are reported in Tables 1a and 1b. We can see that almost all coefficients for the lagged variable are close to one. The exceptions in Table 1a are employment and velocity, in Table 1b the number of variables with coefficients below 0.9 is 11 out of 17. If we apply the usual procedure of allowing two

¹ Nelson, Plosser (1982), for example, can use up to 111 observations.

² It should be noted, however, that we did consider the structural break in 1960 (inclusion of the Saarland and West Berlin) in all the series. Furthermore, we made the adjustments for the money supply M1 which are necessary in the light of various statistical and institutional changes.

standard errors, the value of 1.0 is included in five cases (Table 1a) and eight cases (Table 1b), respectively. However, this interpretation based on the normal distribution is not quite correct, because it has been shown that in regressions like these the estimates for the coefficients β are biased downwards. For example, as Nelson and Plosser¹ show in an example of simulated random walks, estimates for β are about 0.9. A special statistical table has been developed for these hypotheses by Fuller (1976) and others. For example, Wasserfallen (1988, p. 309 f.) gets coefficients even much lower than most of the ones reported in Table 1a and 1b and concludes - on the basis of these tables - that he cannot reject the hypothesis of a coefficient of one. Using the table in Fuller (1976), we are not able to reject the hypothesis of a coefficient of one in eight cases (Table 1a) and 16 cases (Table 1b), respectively.

However, there are some caveats to be made. Firstly, the estimated slope coefficients are sometimes quite high even if we allow for two standard errors. Ideally, they should represent the drift part of the random walk. Secondly, as Table 1b reveals, the null hypothesis concerning γ and δ must be rejected in several cases (although both these results can also be modified since there may be a bias which is not in favor of the tested hypothesis). Finally, in many regressions there is still autocorrelation left in the residuals. This implies that we may not yet have found the appropriate model.

All these factors indicate that other classes of models may also be appropriate, and among them are even those which are, in effect, trend-stationary. For no matter how good a model is, it must be kept in mind that it is not possible to distinguish conclusively between models with contain a coefficient of one or, say, 0.96 for the autoregressive part². This is certainly not

¹ Nelson, Plosser (1982, p. 144 ff.).

² See Section II.

Table 1a) - Regression Results - Test for Random Walk, 1953-1987
(annual data)

Equation (6) $y_t = \alpha + \beta y_{t-1} + u_t$

$H_0: \beta = 1; u_t$ white noise

Series	$\hat{\alpha}$	$\hat{\beta}$	Significance level residual ^a
Nominal GNP	0.183 (0.033)	0.983* (0.005)	0.304
Real GNP	0.398 (0.058)	0.948 (0.008)	0.043
Real GNP per capita	0.498 (0.098)	0.952 (0.010)	0.090
Nominal domestic demand (DD)	0.203 (0.040)	0.980* (0.006)	0.082
Real domestic demand	0.430 (0.071)	0.943 (0.010)	0.004
Real private consumption	0.336 (0.043)	0.953 (0.007)	0.018
Real fixed investment	0.547 (0.126)	0.906 (0.023)	0.002
Real exports	0.265 (0.051)	0.963 (0.009)	0.624
Real imports	0.391 (0.048)	0.940 (0.009)	0.004
Employment	0.436 (0.068)	0.860 (0.022)	0.000
Unemployment rate	0.071 (0.088)	0.928* (0.064)	0.354
GNP-Deflator	-0.013 (0.032)	1.012* (0.008)	0.013
DD-Deflator	-0.006 (0.035)	1.010* (0.008)	0.002
Money supply M1	0.147 (0.028)	0.985* (0.006)	0.065
Real money supply (M1/DD-Deflator)	0.296 (0.071)	0.950 (0.014)	0.331
Velocity (M1/nominal DD)	0.392 (0.260)	0.781* (0.144)	0.402
Stock prices	0.466 (0.229)	0.911* (0.052)	0.221

All variables are natural logs. Standard errors in parantheses.

*: The null-hypothesis that the coefficient equals one cannot be rejected at the 5%-level (based on the test in Fuller, 1976).

^aThe significance level for the rejection of the hypothesis of white noise in the residuals (according to the estimates of the Q-statistic with 15 autocorrelations).

Table 1b) - Regressions Results - Test for Random Walk, 1953-1987
(annual data)

$$\text{Equation (7)} \quad y_t = \alpha + \beta y_{t-1} + \gamma (y_{t-1} - y_{t-2}) + \delta t + v_t$$

$$H_0: \beta = 1; \gamma = \delta = 0; v_t \text{ white noise}$$

Series	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\delta}$	Significance level residual ^a
Nominal GNP	0.058 (0.308)	1.004* (0.065)	0.253 (0.181)	-0.001 (0.005)	0.341
Real GNP	0.528 (0.232)	0.925* (0.038)	0.011 (0.169)	0.001 (0.001)	0.075
Real GNP per capita	1.168 (0.461)	0.878* (0.051)	0.099 (0.163)	0.003 (0.002)	0.080
Nominal domestic demand (DD)	0.179 (0.324)	0.978* (0.069)	0.328 (0.185)	0.001 (0.006)	0.090
Real domestic demand	0.507 (0.236)	0.927* (0.039)	0.239 (0.167)	0.001 (0.002)	0.060
Real private consumption	0.336 (0.169)	0.947* (0.031)	0.349 (0.166)	0.001 (0.001)	0.481
Real fixed investment	0.617 (0.250)	0.884* (0.052)	0.327 (0.158)	0.002 (0.002)	0.308
Real exports	0.535 (0.266)	0.899* (0.067)	-0.148 (0.171)	0.004 (0.005)	0.675
Real imports	0.446 (0.145)	0.914* (0.037)	0.207 (0.163)	0.003 (0.003)	0.020
Employment	0.368 (0.109)	0.879* (0.037)	0.407 (0.140)	0.000 (0.000)	0.027
Unemployment rate	-0.106 (0.132)	0.881* (0.060)	0.264 (0.166)	0.011 (0.006)	0.396
GNP-Deflator	0.512 (0.139)	0.849 (0.042)	0.509 (0.127)	0.006 (0.002)	0.597
DD-Deflator	0.444 (0.133)	0.869* (0.040)	0.626 (0.123)	0.005 (0.002)	0.289
Money supply M1	0.432 (0.210)	0.877* (0.072)	0.323 (0.169)	0.009 (0.006)	0.070
Real money supply (M1/DD-Deflator)	0.708 (0.229)	0.847* (0.053)	0.259 (0.160)	0.005 (0.002)	0.298
Velocity (M1/nominal DD)	0.727 (0.287)	0.603* (0.158)	0.387 (0.188)	-0.001 (0.001)	0.685
Stock prices	0.815 (0.293)	0.779* (0.086)	0.337 (0.161)	0.010 (0.005)	0.260

Explanations see Table 1a).

satisfactory because everybody can interpret the results the way he likes¹. What we can say, however, on the basis of these results is that the permanent component of the changes in trend is probably high. This means that, for example, with a coefficient slightly less than one (e.g. 0.96) it will take many years until, after a real shock, the series returns to its trend.

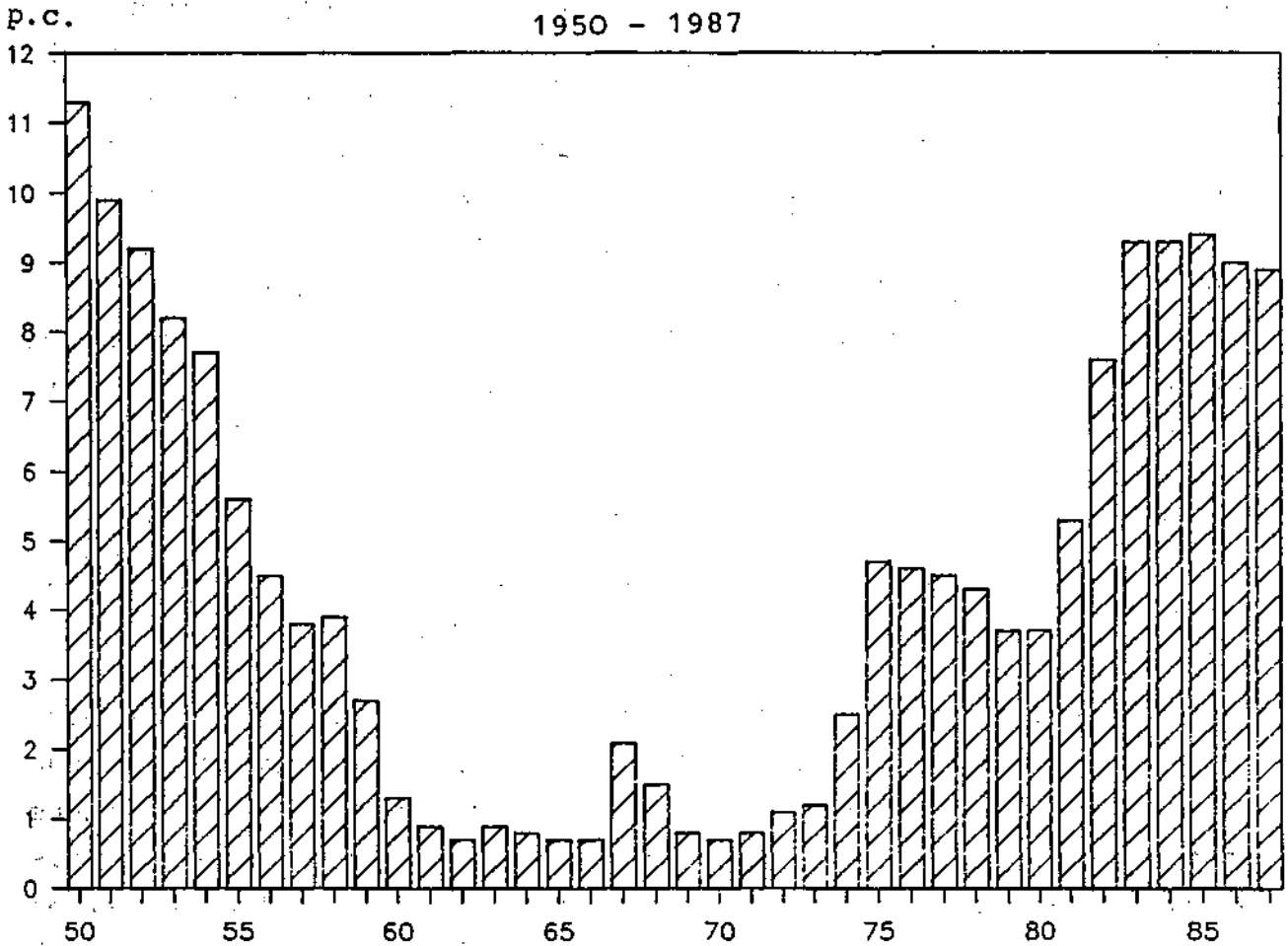
3. An Example: Unemployment

Interestingly, the series which comes very close to a random walk is the unemployment rate since the coefficient is not significantly different from one even if the t-statistic is applied; also, all other test statistics are satisfactory. This is also confirmed in a regression in which the coefficient of the lagged endogenous variable is restricted to one. Our result differs from the one in Nelson, Plosser (1982) about the United States where the unemployment rate is the only series which does not seem to follow a random walk. In the case of West Germany, the random walk character seems obvious from Figure 3, because the rate does not follow a pronounced cyclical pattern but instead shows shifts which are persistent. This is particularly true for the 1970's and early 1980's when unemployment increased to a new level and stayed there. This was the time of substantial real shocks, especially the oil price increases. These developments are a clear indication that the economist still has to explain real world phenomena even if the stochastic properties of a time series are as in this case². Of course, there are several explanations for the shifts in the unemployment rate, e.g., the hysteresis hypothesis. However, as one example shows it is not necessary to give

¹ That is, a proponent of real business cycle theory would see them as another bit of evidence in his favor while others would not need to change their minds.

² Equivalently, economists use theories to explain exchange rates or other prices on financial markets even though it is widely held that these prices follow a random walk.

Figure 3: Variable Trends of Unemployment



up neoclassical principles when these developments are explained¹.

Anyway, it is worth analyzing the aspect of real business cycle theory a little further by looking at the importance of real disturbances for economic activity. This is what we turn to next.

¹ See Soltwedel, Trapp (1988), who consider these shifts as reflecting changes in the natural rate of unemployment.

IV. Real and Monetary Causes for Business Cycles

The question whether monetary policy can have any influence on economic fluctuations has been answered to the negative in the works on real business cycle theory. In part, these arguments are based on empirical tests with vector autoregressions in which, under certain circumstances, money fails to cause changes in output. We want to investigate whether such conclusions hold up for West Germany. In particular, we want to analyze the effects of both monetary policy and real variables on the development of output to see which group performs better or whether both are important. By "performing" we simply mean whether Granger-causality is present¹.

1. The Data and the Method of Investigation

The variable to be explained is real domestic demand². This measure is preferred over real GNP because of the relatively large external sector in West Germany; as has been shown in various studies, the causal link between, e.g., monetary policy and domestic demand is closer than that between money and GNP³. After all, we also want to look at the possible impact of external influences (e.g., exports), so it does not make so much sense to use GNP which includes exports.

Quarterly data are available from 1960 onwards. Given real domestic demand as the variable to be explained, the role of six candidates for explaining cycles is investigated. As far as monetary factors are concerned, the influence of the real money supply M1 is tested. We also analyze the role of real interest ra-

¹ See, for example, the discussion in Granger (1980).

² Real GNP minus real net exports.

³ See, for example, Scheide (1984).

tes¹. The real variables are those which are commonly mentioned when business cycle movements are explained. Not all of them are supply-side shocks or "shocks to technology" as mentioned in the real business cycle theory, but they nevertheless reflect influences from the real side. The variables under investigation are: terms of trade, real exports, real government expenditures, and real wages². Therefore, we can test the importance of

- the oil price shocks, which led to a sharp decline of the terms of trade in the 1970's and a strong increase in the 1980's;
- the economic performance in other countries, which is, at least to a large extent, exogenous to the West German economy;
- government activity³, which, supposedly, played a major role for the economic performance especially in the late 1960's and in the 1970's; and
- the behavior of labor unions, which has been called aggressive in the 1970's and thus is held to have had an impact on

¹ The money supply M1 is deflated with the price index of nominal domestic demand; the real interest rate is approximated by the current nominal rate (3-months-money market rate) minus the percentage change of the deflator over the previous year.

² The terms of trade are defined as the ratio between the export and import deflator (NIA-basis). We further weighted this measure in order to take account of the growing importance of the external sector; this means, since the sum of exports and imports has grown over time relative to GNP, a one percent change of the terms of trade is more important in, say, 1985 than it was in 1965. Real exports are taken from the NIA. Real government expenditures are outlays of total government divided by the GNP-deflator. Real wages are wages and salaries according to NIA, also divided by the GNP-deflator.

³ The measure of expenditures is - as far as the impact on output is concerned - less disputed than taxes or budget deficits. See Barro (1987).

economic activity¹.

In the tests, only real variables are used. Although it is true that vector autoregressions can be viewed as reduced forms of, possibly, a variety of structural models, they are not immune to the Lucas-critique. In using the real money supply and real interest rates, we come relatively close to shocks of monetary policy.

In order to achieve stationarity of the series, we transformed the data by taking the seasonal differences² of the logs (except for the interest rate). Since some of the original series exhibit a quadratic trend, we also used a linear trend for the growth rates.

To test for Granger-causality, we will use the procedure which has been proposed by several authors and which is, for the case of West Germany, applied by Scheide (1984). This means that the lag length in the vector autoregressions will be chosen according to Akaike's FPE-criterion (final prediction error) which can be preferred over the usual practice of ad-hoc lags³. The search procedure for the minimum FPE in a system of equations can be described as follows:

1. We will first run univariate autoregressions for a variable y and choose the lag length according to the minimum FPE (optimum is N_1).

¹ Wage increases were very high then, a fact which is often said to have contributed to the end of the Brandt-government.

² Differencing is done also in the light of the criticism with respect to detrending (see Section II).

³ It is common practice to set the lag length ad hoc; usually, lags of 4, 6, or 8 quarters are used. The results, however, can be biased: existing causality may not be detected, or there may be a spurious causality. For examples of the defects, see Scheide (1984, p. 79 ff.).

2. We will then add the second variable x testing all lags. Causality runs from x to y if for any number of lags the FPE is smaller than in the univariate case for y with lag length N_1 ; the optimal system is y, x (N_1, N_2).
3. Steps 1 and 2 will be taken to test for reversed causality, i.e., whether y causes x .
4. A third variable z will be added to the optimal system of y and x to see whether z causes y , or, in the other case, causes x .

This procedure is a shortcut for testing all possible lag lengths¹, but it seems fairly powerful².

The FPE is defined as follows:

$$(8) \quad FPE = 1/T \cdot (T+q)/(T-q) \cdot SSR$$

where T is the number of observations, q is the number of estimated coefficients, and the sum of squared residuals is SSR . In other words, the reduction of the SSR in the regression has to be sufficiently large to outweigh the "penalty" of an increase in q by the addition of another lag.

The tests will be performed for the period 1964:1 to 1987:4³, i.e., there are 96 observations for each equation. The univariate autoregression will be run for the variable y (seasonal difference of the log) according to:

$$(9) \quad y_t = c + bt + \sum_{i=1}^N a_i \cdot y_{t-i} + u_t; \quad N = 1, 2, \dots, 8.$$

¹ As an example, in a system of three variables, 512 equations would have to be estimated if we test up to 8 lags.

² For examples supporting this view, see Hsiao (1981) and Scheide (1984).

³ This allows us to check relatively long lags.

where c is a constant and t takes account of the fact that a trend is present in the some of the variables. Lags up to eight quarters will be tested. With the optimal lag length being $N1$, we will then test whether x causes y :

$$(10) \quad y_t = c + bt + \sum_{i=1}^{N1} a_i \cdot y_{t-i} + \sum_{j=1}^N d_j \cdot x_{t-j} + v_t ; N = 1, 2, \dots, 8$$

Causality is present if the minimum of the FPE for any of the equations (10) will be lower than the minimum in the univariate case (9). Reversed causality (does y cause x ?) and the influence of other variables (e.g., does z cause x or y ?) will be tested accordingly.

2. What Causes Output?

As a first step, we analyze the impact of the variables mentioned on real domestic demand - and vice versa - in the bivariate system (Table 2a and 2b). Given the optimal lag in the univariate regression for real domestic demand (with lag 4), the six variables mentioned were each added to this equation. It turns out that our output measure is caused by real M1, real interest rate, terms of trade and - with the smallest reduction of the FPE - real exports. For the latter, however, the sum of the coefficients is negative which seems implausible¹. The other results are roughly in line with previous studies on West Germany. Somewhat surprisingly, though, no causal role can be attributed to real government expenditures and real wages.

In the tests for causality in the opposite direction we find that real domestic demand causes the real money supply, although the reduction of the FPE is only minimal (Table 2b). While there is no impact on other variables, real domestic demand is causal with

¹ One might expect a positive sign because a good export performance is supposed to boost investment spending. However, the result is not a variance with other investigations; for example, it appears also in Scheide (1987, p. 39), where a different method is used.

Table 2a) - Causality Tests¹ for Real Domestic Demand and Six Other Variables

Variable	Optimal lag length for variable	FPE ²	Significance level residuals ³	Causality (yes/no)
Real M1	1	0.265	0.728	yes
Real interest rate	1	0.282	0.793	yes
Terms of trade	2	0.291	0.701	yes
Government expenditures	1	0.310	0.737	no
Real exports	5	0.298	0.658	yes
Real wages	1	0.304	0.826	no

¹Given the optimal lag length of 4 for the univariate regression of real domestic demand. The FPE is 0.304×10^{-3} .

²Multiplied by 10^3 .

³The significance level for the rejection of the null hypothesis of white-noise residuals (based on the estimates of the Q-statistic with 27 autocorrelations).

Table 2b) - Causality Tests for Six Variables and Real Domestic Demand

Variable	Optimal lag length for the uni-variate case (FPE ¹)	Optimal lag length for domestic demand (FPE ¹)	Significance level residual ²	Causality (yes/no)
Real M1	6 (0.304)	5 (0.303)	0.245	yes
Real interest rate	1 (1490)	1 (1520)	0.561	no
Terms of trade	7 (0.0227)	1 (0.0230)	0.738	no
Real government expenditures	2 (0.365)	1 (0.373)	0.143	no
Real exports	8 (1.26)	1 (1.30)	0.838	no
Real wages	7 (0.144)	3 (0.128)	0.778	yes

¹FPE multiplied by 10³.

²See Table 2a.

respect to real wages (with a positive sign). This result is compatible with the hypothesis of a procyclical behavior of real wages¹. In all equations, the tests for autocorrelation in the residuals (calculated from the Q-statistic) are favorable, i.e., the hypothesis of white noise in the residuals cannot be rejected. This is, by the way, also the case for all the systems reported in the following parts.

After this more or less preliminary search procedure we will continue with a more detailed analysis in order to find out whether monetary policy does have an effect on output even if other hypotheses are tested or other variables included. For this, we will use those variables which were found to have a significant impact on real domestic demand, namely real M1, the real interest rate and the terms of trade.

3. Do Interest Rates Dominate the Money Supply as a Causal Factor?

An important contribution in the debate on real versus monetary business cycle theory was the empirical study by Sims (1980) in which it is shown that the explanatory power of the money supply vanishes if the interest rate is included in the system of vector autoregressions². While this is viewed by some as evidence against monetarism - at least in its rational expectations version -, the result does in no way imply that actions of the central bank have no impact on production. For this to be true "...

¹ See, e.g., Scheide (1984, pp. 101 ff.), where the same result is obtained.

² The result for the United States is based on the estimates on the decomposition of variance of the variables under consideration. In Sims' paper, the contribution of innovations in the money stock is substantially reduced (from 37 to 4 percent in the postwar period) if the interest rate is added to the system. In other words, the money supply is not Granger causal anymore in the extended system.

it would have to be shown that neither money stock nor interest rate innovations had appreciable explanatory power for output" (McCallum, 1986, p. 401). Since the US-Fed, as well as many other central banks including the Deutsche Bundesbank, pursued an interest rate policy, actions of the monetary authority may show up in the interest rate in addition or instead of the money supply.

Starting from our results for the bivariate systems where both the real money supply and the real interest rate are causal for real domestic demand, we now test whether one of the two variables of monetary policy dominates the other. Given the optimal lag structure (see Table 2a) for domestic demand/money supply (4,1) and domestic demand/interest rate (4,1) we add the respective third variable, again testing all lags up to eight quarters (Table 3a). It turns out that in the first case the interest rate does not improve the result in the output/money-system; the FPE does not decline, the interest rate is no longer causal. For the second case, we can say that the money supply is again causal, and, as the optimal three-variable system happens to be the same¹, the impact of the interest rate disappears. Since we can assume to have found the optimal system² we can conclude that, if anything, the causal role of the money supply for output is stronger than that of the interest rate.

To complete the test, we also have to investigate all other possible directions of causality. For the bivariate case of the money supply and the interest rate, it turns out that the interest rate causes money; in fact, according to the reduction of the FPE, the influence is very strong, and the sign is, as to be expected, negative (Table 3b). There is no causality in the opposite direction. When domestic demand is added to both optimal

¹ The lags are (4,1,1) for the system of three variables in both cases, so the equations are identical.

² Of the possible 512 equations in the three-variable system with up to eight lags.

Table 3a) - Causality Tests for Real Domestic Demand, Real Money Supply and Real Interest Rates

Bivariate system ¹ (FPE ²)	Added variable (optimal Lag)	FPE ² of three-variable system	Significance level residual ³	Causality of added variable (yes/no)
Domestic demand/ money supply (0.264)	Interest rate (1)	0.266	0.793	no
Domestic demand/ interest rate (0.282)	Money supply (1)	0.266	0.793	yes

¹Optimal system according to Table 2a.- ^{2,3}See Table 2a.

Table 3b - Causality Tests for Real Money Supply and Real Interest Rates

Variable (Lag ¹)	Added variable (optimal lag)	FPE ²	Significance level residual ³	Causality (yes/no)
Money supply (6)	Interest rate (2)	0.198	0.777	yes
Interest rate (1)	Money supply (2)	1500	0.878	no

¹Optimal lag for univariate case. See Table 2b.- ^{2,3}See Table 2a.

Table 3c - Causality Tests for Real Money Supply, Real Interest Rates and Real Domestic Demand

Bivariate System ¹ (FPE ²)	Added variable (optimal lag)	FPE ²	Significance level residual ³	Causality of added variable (yes/no)
Money supply/ interest rate (0.198)	Domestic demand (1)	0.198	0.791	no
Interest rate/ money supply (1500)	Domestic demand (1)	1530	0.858	no

¹Optimal system according to Table 3b.- ^{2,3}See Table 2a.

bivariate systems, no additional explanatory power can be detected, domestic demand is not causal for either the money supply or the interest rate (Table 3c)¹.

While the latter result is not surprising in the light of our previous findings (especially Table 2b), the causality structures found in Tables 3a and 3b need interpretation. First of all, it cannot be said that money plays no role in explaining output movements. Even if the significance of money vanished² as the interest rate is added to the system, we could not conclude that monetary policy has no effect. It is true, according to neoclassical theory, that real interest rates do react after a real disturbance³; however, they do not only reflect changes in the real economy but also actions of the central bank. Although the results concerning the link between the real interest rate and the real money supply are surprising⁴ and will need further empirical study, we can also say that actions of the central bank, via changes in interest rates or in the money supply, obviously affect output. This result contradicts the notion that money does not matter.

4. The Role of Real and Monetary Factors for Output

In Section IV.2 we found that both the real money supply and the terms of trade were causal for real domestic demand if a two-variable system is considered. We now test the joint hypothesis by adding a third variable to the optimal two-variable system. If the influence of the terms of trade variable is analyzed, we find

¹ We get the same results as in Table 3c if we change the order of the added variables, i.e., if we add the money supply to the interest rate/domestic demand system and the interest rate to the money supply/domestic demand system.

² Table 3a says it does not.

³ See Barro (1987) for several examples.

⁴ One would expect causality also in the other direction, i.e., money to cause interest rates.

that this relative price does not improve the system of domestic demand/money supply (Table 4a), i.e., it is not causal in the three-variable system. This means that the effects of the money supply dominate, which is also revealed by the second result: real M1 is causal for domestic demand in the three-variable system¹. It seems, therefore, that even when real shocks are considered, the impulses from the money supply variable (real M1) are more important.

Turning to the analysis of causality in the opposite direction, we find causality running from the terms of trade to the money supply but not vice versa (Table 4b). While the latter result may be surprising, the former shows that there may either be a reaction of the central bank after a change in the terms of trade (e.g., more monetary expansion in the case of a revaluation of the D-Mark, which is in accordance with casual observations) or that a terms of trade improvement raises real M1 simply by reducing the price level.

If real domestic demand is included, there is hardly any change in these results; it is - as before - only slightly causal with respect to real M1 and not causal for the terms of trade.

To sum up, the results of this section are in favor of the view of monetary business cycles, because the money supply shows a strong causal link with output. Interest rates and terms of trade are, by themselves, also important; their relevance, however, is sharply reduced or even vanishes if the money supply is taken into account.

¹ We left out the real interest rate in this analysis. Similar tests, however, were also run for the three-variable system including domestic demand, interest rate and terms of trade. It turns out that in this case, both variables are causal with respect to domestic demand.

Table 4a) - Causality Tests for Real Domestic Demand, Real Money Supply and Terms of Trade

Bivariate System ¹ (FPE ²)	Added variable (optimal Lag)	FPE ² for the added variable	Significance level residual ³	Causality of added variable (yes/no)
Domestic demand/ money supply (0.264)	Terms of trade (2)	0.266	0.587	no
Domestic demand/ terms of trade (0.291)	Money supply (1)	0.266	0.587	yes

¹Optimal system according to Table 2a.- ^{2,3}See Table 2a.

Table 4b - Causality Tests for Real Money Supply and Terms of Trade

Variable (Lag ¹)	Added variable (optimal lag)	FPE ²	Significance level residual ³	Causality (yes/no)
Money supply(6)	Terms of trade(1)	0.296	0.645	yes
Terms of trade(7)	Money supply(5)	0.0227	0.771	no

¹Optimal lag for univariate case. See Table 2b.- ^{2,3}See Table 2a.

Table 4c - Causality Tests for Real Money Supply, Terms of Trade and Real Domestic Demand

Bivariate System ¹ (FPE ²)	Added variable (optimal lag)	FPE ²	Significance level residual ³	Causality of added variable (yes/no)
Money supply/ terms of trade (6,1)	Domestic demand(5)	0.295	0.235	yes
Terms of trade/ money supply (7,5)	Domestic demand(1)	0.0232	0.772	no

¹Optimal system according to Table 4b.- ^{2,3}See Table 2a.

V. Focus on the Seventies

The period of the 1970's can be characterized as a time with substantial shocks to the West German economy. We could observe sharp ups and downs of monetary expansion, oil price increases of unprecedented magnitude, plus other changes which challenged the adjustment capacity of the economy, in particular, the transition to a system of flexible exchange rates.

We want to analyze whether the results reported in Section IV have to be modified if we concentrate on the 1970's. It seems appropriate to extend the estimation period somewhat in order to have a sensible number of degrees of freedom; therefore, the period 1968 to 1983 will be analyzed (i.e. 64 observations). Furthermore, the method used is similar to the one in the previous section; however, we do not again go through the search procedure of testing many of the possible lag lengths. For the purpose at hand, it seems sufficient to test various vector autoregression systems with a fixed number of lags. Following conventional procedures, we use four lags in all equations; in the light of the lag lengths we found to be optimal in the previous section, this choice does not seem to be extremely wrong. The variables used are real domestic demand, real M1, real interest rates and terms of trade¹.

As a first step, we estimated vector autoregressions with two variables. The results for the six systems are reported in Table 5; the figures are the significance levels of the block of the right-hand side ("explanatory") variables². It turns out that our

¹ The other variables mentioned in Section IV.2 were also tested, but, as before, they were not causal for real domestic demand.

² A low level implies that the null hypothesis (= the coefficients of the explanatory variables are zero) can be rejected at a low significance level; conventional levels are 0.05 or 0.01. - In the tables, we do not report the significance levels for the lagged values of the left-hand side variable, which are extremely low in all cases. Also, the results for the tests for autocorrelation of the residuals are not reported; as before, we cannot reject the hypothesis that the residuals are white noise.

Table 5) - Significance Level of Variables in a Two-Variable
Vector Autoregression System¹
(Estimation Period 1968:1 to 1983:4)

Influence of	Influence on			
	Real domestic demand	Real money supply	Real interest rate	Terms of trade
Real domestic demand	x	0.4627	0.1806	0.2288
Real money supply	0.0018	x	0.5480	0.3399
Real interest rate	0.0129	0.0000	x	0.0236
Terms of trade	0.0293	0.6254	0.6814	x

¹Significance levels of the block of the right-hand side variables in the regressions are reported.

previous results are more or less confirmed:

- Real domestic demand is strongly influenced by all other three variables, and the lowest significance level is again found for real M1. On the other hand, domestic demand is not causal for any of the other variables; i.e., money supply, interest rates and terms of trade are causally prior (or exogenous) in the two variable system.
- Real M1 is, again, strongly caused (=significance level close to zero) by real interest rates; there is no causality in the opposite direction. Also, the money supply does not significantly affect the terms of trade.
- The real interest rate is causal (at the standard significance level of 0.05) for all other three variables but is not influenced by any of them.
- The terms of trade have a significant influence on domestic demand only, and is itself caused by the interest rate.

As before, we are also interested in whether the results change if three instead of two variables are analyzed in a system. The four variables mentioned make up four possible systems of this order; the results are reported in Tables 6a to 6d. In the first system (domestic demand, money supply, interest rate) we find that real domestic demand is caused by real M1 and real interest rates; however, the significance of the latter is strongly reduced compared to the two-variable case (Table 6a). The other relationships are not changed in principle, the interest rate still has a strong impact on the money supply.

In the second system the variable "terms of trade" is included instead of the interest rate (Table 6b). The terms of trade, however, do no longer significantly influence domestic demand; only the money supply is causal. Both other variables have an impact on the terms of trade.

Table 6a) - Significance Level of Variables in a Three-Variable Vector Autoregression System¹

Influence of	Influence on		
	Real domestic demand	Real money supply	Real interest rates
Real domestic demand	x	0.5274	0.8020
Real money supply	0.0155	x	0.4342
Real interest rate	0.0861	0.0000	x

¹See Table 5.

Table 6b) - Significance Level of Variables in a Three-Variable Vector Autoregression System¹

Influence of	Influence on		
	Real domestic demand	Real money supply	Terms of trade
Real domestic demand	x	0.4455	0.0448
Real money supply	0.0448	x	0.0683
Terms of trade	0.4233	0.5922	x

¹See Table 5.

Table 6c) - Significance Level of Variables in a Three-Variable Vector Autoregression System¹

Influence of	Influence on		
	Real domestic demand	Real interest rate	Terms of trade
Real domestic demand	x	0.7929	0.1071
Real interest rate	0.0113	x	0.0121
Terms of trade	0.0243	0.5347	x

¹See Table 5.

Table 6d) - Significance Level of Variables in a Three-Variable Vector Autoregression System¹

Influence of	Influence on		
	Real money supply	Real interest rate	Terms of trade
Real money supply	x	0.4249	0.5212
Real interest rate	0.0000	x	0.0500
Terms of trade	0.0954	0.5321	x

¹See Table 5.

In the third system, too, we get similar results as before; both interest rates and terms of trade are causal for domestic demand (Table 6c). And also in the last system (money supply, interest rates and terms of trade), the results concerning the causal ordering are practically identical to what was found before.

Therefore, the results of the vector autoregressions in this section support the previous findings that monetary policy - or more precisely: changes in the money supply - has a relatively strong influence on output and that it seems to dominate other factors. This is true even for the 1970's when real shocks of unusual magnitude hit the economy.

"... the nonneutrality of money...
is surely the hardest problem
in macroeconomics".
Barro (1984, p. 179).

VI. Money Isn't Neutral After All

1. The Results in the Light of Other Studies

In the preceding three sections, the arguments of the real business cycle theory were subjected to empirical tests. We used random walk tests and vector autoregressions in order to account for the different evidence usually put forward by those who stress the dominance of real factors for fluctuations of economic activity. As expected, the results are not conclusive. The hypothesis that macroeconomic time series follow a random walk found some support, at least, it could not be rejected with much power. However, the results in the vector autoregression analysis suggest that monetary policy still plays a major role for explaining output movements.

The money supply was strongly causal with respect to domestic demand, and it dominates the other variables (interest rates, terms of trade). The role of interest rates is interesting since they are a causal prior for the money supply. At least in part, this can be attributed to the way monetary policy has been pursued in West Germany. During most of the time of the estimation period, the Deutsche Bundesbank used interest rates as the instrument for monetary policy; therefore, the response of the money supply is not surprising. Real interest rates also react after a real shocks. But in the vector autoregressions, we could not make out any influence from that side. Certainly, more work on these relationships is necessary.

In the light of other studies on West Germany, these results concerning the strong effects of monetary policy are not surprising¹. After all, the seven business cycles of the postwar

¹ See, for example, Trapp (1976) and Scheide (1984).

period - beginning in 1950¹ - were closely connected with changes in monetary policy. Without oversimplification it can be said that there was no recession without a marked deceleration of monetary expansion, and no boom without rapid monetary expansion.

While the strong view that money plays no role can thus not be supported by empirical analysis, the real business cycle theory cannot be dismissed in principle. Not only do the random walk tests suggest a substantial weight of the permanent component; but also the behavior of the trend of output suggests that in the case of West Germany, too, a great part of the fluctuations in economic activity must be attributed to real changes. Real shocks were important in those phases when the growth rate declined markedly, in particular after the oil price hikes of the 1970's.

2. Growth Theory and Business Cycle Theory Are One

In general, then, it does not seem appropriate to rely exclusively on real or monetary variables when explaining economic activity². It is, therefore, also not appropriate to make a distinction between growth theory and business cycle theory³. What needs to be done, then, is to incorporate monetary factors into a theoretical model, possibly of the Kydland/Prescott type in order to overcome the present state of neoclassical business cycle theory which can be characterized as: "... there is currently no compelling evidence for any particular description of cycles..." (Dotsey, King, 1988, p. 12)⁴.

¹ One can leave out the period before 1950 that was characterized by the reconstruction.

² For an empirical study on the decomposition of trend and cyclical developments, see Cochrane (1988).

³ This is also the tendency in the work of Lucas.

⁴ On these problems, see also the book of Lucas (1987) on the frontiers of business cycle theory.

The policy implications of the neoclassical real business cycle theory are radical for stabilization policies derived from the Keynesian paradigm¹; this, however, is not surprising or new. However, since the view that monetary policy plays no role could not be validated, the idea of monetarist prescriptions cannot be dismissed. In particular, a rule for monetary policy would help to stabilize the development of output²; this is disputed by real business cycle theory. No doubt, it cannot be a sensible target (definitively no a feasible one anyhow) of economic policy to eliminate all fluctuations. But how much such rules for monetary and also fiscal policy would help has recently been subject to controversy. Lucas (1987) comes up with a surprisingly low estimate of the variability of consumption that could possibly be reduced by the most stable policies³. This implies that the welfare losses even from "bad" stabilization policies are minor. It is true that most negative effects from cyclical fluctuations in the postwar period are dwarfed in the light of substantial changes in underlying growth rates we can observe in some countries⁴. However, the order of magnitude mentioned above seems to be extremely low if the substantial misallocations induced by monetary instability are considered⁵.

1 See Section II.

2 For a simple example of a rule for West Germany, see Scheide (1988a).

3 For the postwar period in the United States Lucas calculated: "Eliminating aggregate consumption variability ... would ... be equivalent in utility terms of an increase in average consumption of something less than one tenth of a percentage point ..." (Lucas, 1987, p. 26/27).

4 See Lucas (1988).

5 For example, think of the investments that were taken solely for the purpose of hedging against inflation. For a discussion, see also Scheide (1988b).

3. Some Problems With Real Business Cycle Theory

Many reservations have been made with respect to real business cycle theory¹. One concerns the timing of some variables in relation to output movements. For example, a favorable supply shock should raise the profitability of investment (Brunner, Meltzer, 1986, p. 4). Therefore, one would expect investment activity to accelerate early in the cycle. This, however, is not a regularity of business cycles.

Furthermore, we can very often observe changes in real variables which are closely related to changes in monetary policy. The large ups and downs of (real) exchange rates are one example. It would be hard to explain, say, the sharp trend changes of the US-dollar solely as a response to real shocks. Instead, these changes coincided with changes in the course (or regime) of monetary policy.

It is true, supply shocks have at times been substantial. The oil price increases of the seventies and the decline since late 1985 implied large changes in the "oil bill", adding up to some one to two percent of GNP in the case of West Germany. But we experienced much sharper downturns of economic activity in 1974/75 and 1980/82 so there must have been an extremely large "multiplier". And above all, real shocks of this magnitude could not be observed in earlier periods. For example, in the course of the recession of 1966/67, such real shocks were not present at all, although that recession was about as severe as the downturns in 1974/75 and 1980/82. So it seems that it is difficult to make out real shocks of the magnitude and frequency which would be sufficient to exclusively account for all economic fluctuations.

If proponents of real business cycle theory see a connection between output and money, it is one of reversed causality². The empirical tests in this paper could not at all support this view.

¹ See, for example, McCallum (1986) and Brunner, Meltzer (1986).

² On this point, see, again, McCallum (1986, p. 398).

Furthermore, other studies on West Germany show that money (at least, the aggregate M1) runs ahead of output movements by several quarters¹. While it may be true that this does not necessarily mean a causality running from money to output, the reversed-causality argument would have to rely on a case of "ante hoc ergo propter hoc".

4. Some Doubts on the Long-run Neutrality of Money

Most models of monetary business cycle theory are based on the natural rate theory and the long-run neutrality of money. While this is certainly a sensible axiom for abstract models, we should ask whether these tenets also hold in the light of other theoretical (and empirical) considerations. If we want to describe the long-run neutrality strictly, we would come up with a definition like: In the long run, say, twenty years from now, the level of real output will be the same no matter how monetary policy behaves in the meantime². Such a definition can be questioned on various grounds. And we do not have to rely on pre-monetarist theories³.

One is the (now almost popular) notion of Friedman on the positively sloped Phillips-curve (Friedman, 1977).. The second concerns the possible effects of monetary instability on economic growth. Since uncertainty about the future course of monetary policy raises the risk premium in interest rates (and thereby the observed real interest rate), investment may be dampened (Masca-ro, Meltzer, 1983). Monetary instability was found to have a

¹ Trapp (1976) and Scheide (1987).

² If this was true, the gains from rules for monetary (and fiscal) policy might be small indeed.

³ Certainly, Austrians would not subscribe to such a description of neutrality.

negative impact on growth in many industrial countries (Kormendi, Meguire, 1985)¹. A basic microeconomic contribution explaining these phenomena was the demonstration how inflation can weaken the signalling function and thereby the allocative efficiency of the price system (Cukierman, 1982).

All these factors suggest that money is not neutral even in the long run; the way policy is pursued, the level and variability of inflation can also have permanent effects on the level of output. Admittedly, this does not make the decomposition of economic fluctuations into permanent and cyclical components easier. But it is nevertheless suggestive for a comprehensive theory of growth and business cycles.

¹ The instability and rapid inflation in many developing countries is, one can imagine, also detrimental to growth in these countries.

Bibliography

- Barro, Robert J., *Macroeconomics* (2nd ed.), New York 1987.
- , "Rational Expectations and Macroeconomics in 1984". *The American Economic Review*, Papers and Proceedings, May 1984, pp. 179-182.
- Brunner, Karl, Allan H. Meltzer (Eds.), "Real Business Cycles, Real Exchange Rates, and Actual Policies". *Carnegie-Rochester Conference Series on Public Policy*, Vol. 25, Amsterdam 1986.
- Cochrane, John H., "How Big Is the Random Walk in GNP?" *Journal of Political Economy*, Vol. 96, 1988, pp. 893-920.
- Cukierman, Alex, "Relative Price Variability, Inflation and the Allocative Efficiency of the Price System". *Journal of Monetary Economics*, Vol. 9, 1982, pp. 131-162.
- Doan, Thomas A., *RATS*, Version 3.00. Evanston 1988.
- Dotsey, Michael, Robert G. King, "Rational Expectations Business Cycle Models: A Survey". *Federal Reserve Bank of Richmond, Economic Review*, Vol. 74/2, 1988, pp. 3-15.
- Friedman, Milton, "Nobel Lecture: Inflation and Unemployment". *Journal of Political Economy*, Vol. 85, 1977, pp. 451-472.
- Fuller, Wayne A., *Introduction to Statistical Time Series*. New York 1976.
- Granger, Clive W.J., "Testing for Causality. A Personal Viewpoint". *Journal of Economic Dynamics and Control*, Vol. 2, 1980, pp. 329-352.
- von Haberler, Gottfried, *Prosperity and Depression*. Geneva 1937.
- Hall, Bronwyn H., Rebecca Schnake, Clint Cummins, *TSP*, Version 4.1. Palo Alto 1987.
- Hsiao, Cheng, "Autoregressive Modelling and Money-Income Causality Detection". *Journal of Monetary Economics*, Vol. 7, 1981, pp. 85-106.
- Kormendi, Roger C., Phillip G. Meguire, "Macroeconomic Determinants of Growth - Cross-Country Evidence". *Journal of Monetary Economics*, Vol. 16, 1985, pp. 141-163.
- Kydland, Finn E., Edward C. Prescott, "Rules Rather than Discretion: The Inconsistency of Optimal Plans". *Journal of Political Economy*, Vol. 85, 1977, pp. 473-491.

- , - , "Time to Build and Aggregate Fluctuations". *Econometrica*, Vol. 50, 1982, pp. 1345-1370.
- Lucas, Robert E., "Principles of Fiscal and Monetary Policy". *Journal of Monetary Economics*, Vol. 17, 1986, pp. 117-134.
- , *Models of Business Cycles*. Oxford 1987.
- , "On the Mechanics of Economic Development". *Journal of Monetary Economics*, Vol. 22, 1988, pp. 3-42.
- Mascaro, Angelo, Allan H. Meltzer, "Long- and Short-term Interest Rates in a Risky World". *Journal of Monetary Economics*, Vol. 12, 1983, pp. 485-518.
- McCallum, Bennett T., "On 'Real' and 'Sticky-Price' Theories of the Business Cycle". *Journal of Money, Credit, and Banking*, Vol. 18, 1986, pp. 397-414.
- Mitchell, Wesley C., *Business Cycles - The Problem and Its Setting*. New York 1928.
- Nelson, Charles R., Charles I. Plosser, "Trends and Random Walks in Macroeconomic Time Series". *Journal of Monetary Economics*, Vol. 10, 1982, pp. 139-162.
- Pindyck, Robert S., Daniel L. Rubinfeld, *Econometric Models and Economic Forecasts* (2nd ed.). Singapore 1987.
- Plosser, Charles I., William G. Schwert, "Money, Income, and Sunspots: Measuring Economic Relationships and Effects of Differencing". *Journal of Monetary Economics*, Vol. 4, 1978, pp. 637-660.
- Rush, Mark, "Real Business Cycles". Federal Reserve Bank of Kansas City, *Economic Review*, February 1987, pp. 20-32.
- Scheide, Joachim, *Geldpolitik, Konjunktur und rationale Erwartungen*. Kieler Studien, 188, Tübingen 1984.
- , "Zur aktuellen konjunkturpolitischen Debatte in der Bundesrepublik Deutschland". *Die Weltwirtschaft*, 1987, H.1, pp. 33-45.
- (1988a), A K-Percent Rule for Monetary Policy in West Germany. *Kiel Working Papers*, 337, October 1988.
- (1988b), "Book Review on: Robert E. Lucas Jr., *Models of Business Cycles*". *Weltwirtschaftliches Archiv*, Vol. 124, 1988, pp. 797-799.
- Sims, Christopher H., "Comparison of Interwar and Postwar Business Cycles: Monetarism Reconsidered". *The American Economic Review*, Vol. 70, 1980, pp. 250-257.

- , "Is There a Monetary Business Cycle?" The American Economic Review, Vol. 73, 1983, pp. 228-233.
- Soltwedel, Rüdiger, Peter Trapp, "Labor Market Barriers to More Employment: Causes for an Increase of the Natural Rate. The Case of West Germany". In: Herbert Giersch (Ed.), Macro and Micro Policies for More Growth and Employment, Symposium 1987, Tübingen 1988, pp. 181-225.
- Stock, James H., Mark W. Watson, "Variable Trends in Economic Time Series". Journal of Economic Perspectives, Vol. 2, 1988, pp. 147-174.
- Stulz, René M., Walter Wasserfallen, "Macroeconomic Time-Series, Business Cycles, and Macroeconomic Policies". In: Karl Brunner, Allan H. Meltzer (Eds.), Understanding Monetary Regimes. Carnegie-Rochester Conference Series on Public Policy, Vol. 22, Amsterdam 1985.
- Trapp, Peter, Geldmenge, Ausgaben und Preisanstieg in der Bundesrepublik Deutschland. Kieler Studien, 138, Tübingen 1976.
- Wasserfallen, Walter, "Forecasting, Rational Expectations and the Phillips-Curve". Journal of Monetary Economics, Vol. 15, 1985, pp. 7-27.
- , "Trends, Random Walks, and the Expectations-Augmented Phillips Curve - Evidence from Six Countries". Journal of Money, Credit, and Banking, Vol. 20, No. 3 (Part 1), 1988, pp. 306-318.