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Abhandlungen / Original Papers

Money, Inflation and Growth in Germany

A Vector-Error-Correction-P-Star Model

Der Zusammenhang zwischen Geldmenge, Output und Preisen in Deutschland

Ein Vektorfehlerkorrektur-P-Star-Ansatz

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JEL C4, E4, E5

Deutsche Bundesbank, monetary policy, p-star, vector error correction model, inflation.

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Summary

The present paper uses the P-Star approach to analyze the real and price effects of German monetary policy on the basis of a multivariate vector-error-correction-model. One surprising result is that the Bundesbank does not cause the price effects of its monetary policy actions directly via (rational) expectations but only indirectly via influencing the output gap. The real effects of monetary policy are only of a temporary nature. In the long run money is neutral.

Zusammenfassung

Das vorliegende Papier untersucht die Preiswirkungen und die realen Effekte der Geldpolitik im Rahmen eines erweiterten P-Star-Ansatzes. Als ökonometrische Grundlage dient ein multivariates Vector-Error-Correction-Modell, in dem die Kointegrationsbeziehungen in theoriekonsistenter Weise restringiert werden. Im Ergebnis werden die Preiswirkungen der Geldpolitik nicht „direkt“ ausgelöst, sondern ausschließlich über die Beeinflussung des Output Gaps. Die realen-Effekte der Geldpolitik sind zudem nur kurzfristiger Natur. Langfristig bestätigt sich die Neutralitätshypothese.

I. Introduction

The present paper examines the price effects and the real effects of the German monetary policy using a modified P-Star-approach within a vector-error-correction-model

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(VECM). In the empirical analysis we impose restrictions on the VECM consistent with theoretical considerations and check whether the restrictions are compatible with the data set. The following questions are of main importance:

- What are the real effects of monetary policy? Is German monetary policy neutral?
- Via which mechanism does an expansive monetary policy lead to increasing prices? Is this process expectation driven or is the transmission process operating via the real economy?

The paper is organized as follows: After a short review of the literature concerning these questions (chapter II), the model is presented in chapter III. In chapter IV, the empirical part, the estimation results are presented and discussed. The paper ends with some tentative monetary policy conclusions and interpretations.

II. Empirical Results for Germany

The P-Star concept (P*) was developed by economists of the Federal Reserve System (Hallmann et al. 1989, 1991). It serves as a theoretical and empirical foundation of the money-price-nexus. The basic idea of the approach is conceivably simple: Additional money leads to higher prices in the long run provided that it is not absorbed by an increasing goods production or a higher money demand (lower velocity of circulation). Starting from the quantity equation the equilibrium price level (= P-Star) is defined as that level that is consistent with the current value of the money supply at full capacity and at the long run equilibrium value of velocity (see chapter III). A positive deviation of the current price level from the equilibrium price level, the so-called price gap, signals a future fall of inflation (and vice versa). This price gap consists of the output gap and the liquidity gap.[1]

A serious weakness of the original approach is the assumption of a constant velocity of circulation. This is equivalent to assuming an income elasticity of money demand of unity. But in a number of countries the velocity of circulation actually exhibits a trend. (Hoeller/Poret 1991, Toedter/Reimers 1994). In Germany, for instance, velocity with regard to M3, the target monetary aggregate of the Bundesbank until the end of 1998, showed a downward trend. For this reason, the equilibrium velocity in Germany is usually determined via a long-run money demand function (Issing/Toedter 1994).[2]

There are several papers dealing with such a revised P-Star model for Germany (Deutsche Bundesbank 1992, Groeneveld 1998, Hoeller/Poret 1991, Issing/Toedter 1994, Kole/Leahy 1991, Mayer/Fels 1993, Scharnagl 1996, Toedter/Reimers 1994).[3] Both before and after German unification these studies presented evidence of a stable long-run money-price-relationship (and a stable long run money demand). However, the choice of the monetary aggregate has a decisive role to play. One almost achieves the positive results exclusively in the case of M3, not in the case of narrowly defined monetary aggregates such as M1 (Scharnagl 1996, pp. 44 ff., Toedter/Reimers

[1] *Hess/Morris* (1995) choose an alternative procedure, the calculation of M*.

[2] Even for the USA *Pecchenino/Rasche* (1990) argue that the stability of the velocity of circulation concerning M2 is the result of special influences. They show that the P* model for the USA assuming a stationary velocity manifests a dynamic behavior inconsistent with the stylized facts. For a model for the USA with a time variant equilibrium velocity see *Orphanides/Porter* (1998).

[3] However, critical arguments can be found in *Beyer* (1998).

1994, pp. 284 ff.). On the contrary, independent of the choice of the price variable, i. e. whether the CPI, the GDP deflator or the deflator of final demand is used, the results are nearly the same.

Funke/Hall (1994), Hansen/Kim (1996) and Funke et al. (1997) apply a multivariate P-Star approach. They also confirmed long run stability of German money demand M3. But, contrary to quantity theoretical suggestions, money supply is endogenous. Moreover these authors show that prices are not solely caused by monetary developments.

By means of simulations with the P-Star model Coenen (1998) showed that a strategy of monetary targeting is superior to direct inflation targeting in that it results in a lower volatility of the inflation rate. Furthermore, Seitz/Tödter (2001) argue that a strategy of monetary targeting can be rationalised within the P* framework. They demonstrate that money growth targeting is a special form of inflation forecast targeting based on a "limited" information set. In contrast to "full information" inflation forecast targeting, monetary growth targeting is likely to be more robust under changing conditions of the real world.[4]

The P-Star-concept has also been successfully applied to the countries of the European monetary union (Groeneveld et al. 1997, Groeneveld 1998, Gerlach/Svensson 1999). Gerlach/Svensson (1998) showed that the P-Star model had considerable empirical support in the EMU area from 1980 to 1998. Moreover, it was found that from the second third of the eighties a European price gap played a more and more important role for inflation in Germany. But, contrary to non-anchor countries in the former EMS (e. g. the Netherlands or France) domestic price gaps still exercised a significant effect on German inflation. Furthermore, Wesche's (1998) analysis revealed that a German price gap plays a decisive role for EU-wide price developments.

Except for Funke/Hall (1994), Hansen/Kim (1996), Funke et al. (1997) and Coenen (1998) all the above mentioned papers utilize a one-equation approach to estimate a price equation and/or the money price-relationship. In the following we present the P-Star approach on the basis of a multiple equation system. This allows us to quantify the price effects and the real effects of monetary policy via separating the different adjustment processes by which imbalances after monetary shocks were corrected. Moreover it gives an answer to the question whether the inflation process in Germany is more expectation driven or results from goods markets' disequilibria. As a consequence, a deeper analysis of the effects of monetary policy is opened and the transmission process of monetary policy becomes clearer. In addition this approach also allows the investigation of neutrality results stemming from the quantity theory.[5]

III. The Model

The starting point of the P-Star model for the determination of the equilibrium price level P* and the price gap, respectively, is the quantity equation. Expressed in logarithms and solved for p_t this yields:

$$p_t \equiv m_t + v_t - y_t, \text{ or } p_t \equiv m_t - k_t - y_t. \quad (1)$$

[4] In contrast to that view see *Svensson* (2000 and 2001).

[5] See for this *Moazzami/Gupta* (1995). These authors do not explicitly use the P-Star approach, but a closely related method. For Germany they cannot confirm the neutrality of money.

In (1) y_t stands for a transaction variable, v_t for the velocity of circulation and k_t is the money-to-income-ratio (both in logarithms), where $v_t = - k_t$.

With a given money stock m_t the actual price level is equal to its equilibrium value P-Star ($p_t = p_t{}^*$), if the money-to-income-ratio is in equilibrium ($k_t{}^* = k_t$) and the economy is operating at its potential output level ($y_t{}^* = y_t$).

$$p_t{}^* = m_t - k_t{}^* - y_t{}^* \tag{2}$$

The combination of equations (1) and (2) shows that the price gap ($p_t{}^* - p_t$) is the sum of two terms: the output gap ($y_t - y_t{}^*$) and the deviation of the equilibrium money-to-income-ratio from its actual value ($k_t - k_t{}^*$)

$$p_t{}^* - p_t = (k_t - k_t{}^*) + (y_t - y_t{}^*). \tag{3}$$

The disequilibrium in the money-to-income-ratio can be interpreted as the difference between actual and desired nominal money demand.[6] The latter are determined by a transactions variable y_t and an opportunity cost variable oc_t. Thus equation (3) may be transformed to

$$p_t{}^* - p_t = (m_t - p_t - \beta_y \cdot y_t + \beta_{oc} \cdot oc_t) + (y_t - y_t{}^*) \tag{4}$$

or

$$p_t{}^* - p_t = (m_t - m_t{}^*) + (y_t - y_t{}^*). \tag{4'}$$

Assuming stability, the actual values converge to their equilibrium values in the course of time and the different gaps are all stationary with zero mean, i.e. the cointegration relation between p^* and p may be indirectly expressed as two cointegration relations between y and y^* and m and m^*, respectively. If there exists a one-way causality from the output gap and the liquidity gap ($m - m^*$) to the price gap, then there are inflationary pressures if capacity is overutilized and/or if there is a liquidity overhang.

If the equilibrium process for prices is modeled within an error correction framework this yields

$$\Delta p_t = -\alpha_0^p \cdot (p_{t-1} - p_{t-1}{}^*) \tag{5}$$

or in view of (4′)

$$\Delta p_t = +\alpha_0^p \cdot (m_{t-1} - m_{t-1}{}^*) + \alpha_0^p \cdot (y_{t-1} - y_{t-1}{}^*). \tag{5'}$$

This price equation is not only influenced by the liquidity gap, but also by the output gap. This means (5) is a price equation extended with the Phillips curve.

For the empirical part of our analysis we further modify our model.

Up to now we assumed in (5) – in accordance with the traditional P-Star-model – that a disequilibrium in money holdings yields the same price response as a comparable out-

[6] For a connection between money demand and the money-to-income-ratio (the velocity of circulation) see *Issing/Toedter* (1994).

put gap. If different price reactions are allowed we have to modify (5) in the following way

$$\Delta p_t = +\alpha_1^p \cdot (m_{t-1} - m_{t-1}{}^*) + \alpha_2^p \cdot (y_{t-1} - y_{t-1}{}^*). \tag{6}$$

Equation (6) presents two competing views of how the rate of inflation adjusts to disequilibria. The first is the Phillips curve view ($\alpha_1^p = 0$), where the rate of inflation adjusts to the output gap (goods market disequilbrium). In the second case, which is a monetarist view ($\alpha_2^p = 0$), the inflation rate adjusts to the monetary disequilibrium.

IV. Empirical Analysis

Equation (6) and the five variables y, y*, p, m, oc are the basis of the whole system which will now be estimated with a VECM. The sample covers the period from the first quarter of 1973 to the fourth quarter of 1997. We use seasonally unadjusted quarterly data. The monetary aggregate is German M3 (= m), the target variable of the Bundesbank. The price level is measured by the GDP deflator (= p). Real GDP stands for y, y* indicates the production potential calculated by the Bundesbank (1995). Friedman's permanent income hypothesis states that long run money demand should depend on permanent income adjusted for transitory fluctuations. Therefore we use the production potential to approximate the transactions variable in the long run money demand function. Opportunity costs are calculated as the difference between the yield on German bearer bonds and the own rate of return of M3.[7] Until the second quarter of 1990 the data refer to West Germany, afterwards to unified Germany. The difference operator Δ relates to first differences. All variables except opportunity costs are in logarithms.

The following cointegration analysis is based on Johansen's (1988, 1991) multivariate methodology. The empirical analysis starts with an unrestricted VECM of the following form:

$$\Delta X_t = \sum_{i=1}^{q-1} \Gamma_i \Delta X_{t-i} + \Pi(1, X_{t-1}) + \varepsilon_t \text{ with } \varepsilon_t \sim NIID(0, \Sigma) \tag{7}$$

where X_t is the vector of the variables m_t, p_t, y_t, $y_t{}^*$and oc_t, and ε_t is the vector of the white-noise error terms.[8] According to the theoretical considerations the constant is only included in the cointegration equation. We further include three seasonal dummy variables because all variables except opportunity costs exhibit a clear seasonal pattern.[9] These are centered as suggested by Johansen (1995, p. 84).

[7] The own rate of return of M3 is a weighted average of the own rates of its components. We assume an own rate of zero for currency and sight deposits. For savings deposits at three months' (statutory) notice (weight 0.35) and time deposits with less than 4 years maturity (weight 0.25) we used the respective interest rates. The weights correspond to the average proportions in M3 during the sample.

[8] The inclusion of cost push variables or import prices did not alter the general results.

[9] The use of seasonal dummies prevents the test of seasonal unit roots. Therefore it may be possible that useful information is neglected. But, as *Brueggemann/Wolters* (1998) showed, the variables used in the present paper do not exhibit the same seasonal non-stationarities. This justifies the application of the traditional Johansen procedure.

In a first step we tested for the number of lags q to be included in the model. We used the information criteria of Akaike, Schwarz and Hannan-Quinn. Unfortunately, these criteria give no clear cut answer (see Table 1). The Akaike-criterion suggests a lag length of 2, while the Schwarz- and Hannan-Quinn-criterion prefer an optimal lag length of 1. We decided to include a lag length of 2 because otherwise the residuals showed signs of autocorrelation.

The traditional and the Reimers-corrected[10] Trace-test suggest three cointegration relations (see Table 2a). This result is not surprising although our theoretical considerations (see equation (6)) would indicate only two cointegration relations. According to the unit root tests (see Table 3) the opportunity cost variable is stationary in levels while all other variables are difference stationary.[11] Therefore we get a so-called "trivial"

Table 1: Test of lag length in the VECM

LAG (= q)	AKAIKE	HANNAN-QUINN	SCHWARZ
1	– 47.534	– 47.037	– 46.301
2	– 47.747	– 46.973	– 45.828
3	– 47.529	– 46.478	– 44.925
4	– 47.334	– 46.007	– 44.045
5	– 47.449	– 45.844	– 43.474
6	– 47.442	– 45.562	– 42.783
7	– 47.452	– 45.295	– 42.107
8	– 47.547	– 45.113	– 41.516

Table 2a: The number of cointegration relations in the VECM (with oc)

Null	Trace	Trace (corr.)
r = 0	164,64***	144,48***
r < 2	88,29***	77,48***
r < 3	40,68***	35,70**
r < 4	15,93	13,98
r < 5	5,87	5,15

***(**,*): significance level < 1 % (5 %, 10 %).

[10] *Reimers* (1992) makes the point that the critical values of the trace-statistic depend on the data generating process and the sample size. He proposes a correction which takes account of the number of endogenous variables (n) and the lag length (q). This modified test statistic compared to the traditional one reads as

$$\text{Traditional trace-test:} \quad LR = -T \sum_{i=r+1}^{n} \log(1 - \lambda_i)$$

$$\text{Reimers-corrected trace-test:} \quad LR = -(T - nq) \sum_{i=r+1}^{n} \log(1 - \lambda_i)$$

[11] Theoretical considerations are also in favor of the stationarity of opportunity costs, see Seitz (1998). *Serletis/Koustas* (1998) show that the time series properties of the used variables are very important for tests of neutrality hypotheses. With a proper specification they could confirm monetary neutrality for Germany.

Table 2b: The number of cointegration relations in the VECM (without *oc*)

Null	Trace	Trace (corr.)
r = 0	117,06***	105,12***
r < 2	44,87***	40,29**
r < 3	21,52*	19,32
r < 4	6,86	6,16

***(**,*): significance level < 1 % (5 %, 10 %).

Table 3: Unit-Root-ADF-Tests[12]

Variable	Specifikation[1]	t-value[2]	Conclusion
m3	t,4	– 2,44	(trend insignificant)
m3	c,4	– 0,90	unit root w. drift
p	t,4	– 1,17	(trend insignificant)
p	c,4	– 1,24	(const. insignificant)
p	n,4	– 0,89	unit root wo. drift
y	t,4	– 2,11	(trend insignificant)
y	c,4	– 0,63	(const. insignificant)
y	n,4	2,67	unit root wo. drift
y*	t,4	– 2,26	(trend insignificant)
y*	c,4	– 0,14	unit root w. drift
oc	t,3	– 3,85**	(trend insignificant)
oc	c,3	– 3,66***	stationary
d(m3)	t,3	–4,38***	(trend insignificant)
d(m3)	c,3	– 4,33***	stationary
d(p)	t,3	– 2,79	(trend insignificant)
d(p)	c,3	– 2,57	(const. insignificant)
d(p)	n,3	– 1,98**	stationary
d(y)	t,3	– 3,78**	(trend insignificant)
d(y)	c,3	– 3,84***	stationary
d(y*)	t,4	– 2,88	(trend insignificant)
d(y*)	c,4	– 2,90**	stationary

[1] t = with constant and trend; c = with constant; n = without constant and trend
[2] ***(**,*): significance level < 1 % (5 %, 10 %).

cointegration equation and the cointegration rank is augmented by one. This result is also confirmed from another perspective. If we estimate the number of cointegration relations without opportunity costs (see Table 2b) the number of cointegration relations is reduced to two according to the Reimers-corrected test.

Therefore we treat opportunity costs as an exogenous I(0)-variable in the VECM which is included in levels with a lag length of 0 to 2 in the estimation and restrict the number of cointegration relations to two. We have to include a further impulse dummy for

[12] We applied the sequential testing procedure according to *Dolado* et al. (1990) for the unit root tests. The number of lags was determined with the Akaike criterion beginning with a maximum lag number of 4.

German unification. Residual analysis indicates an outlier in the third quarter of 1990 which is due to the over expansion of the money stock relative to GDP in the course of the unification process. The dummy variable is one in this quarter and zero otherwise.

The coefficients of the two cointegration relations were now restricted according to the theoretical considerations. In particular this means assuming a price elasticity of one in the cointegration equation identified as a long run money demand function. In the other cointegration equation which describes the deviation of GDP from its long run equilibrium we assume the proportionality of GDP and production potential. The χ^2-test statistic indicates that these long run restrictions are compatible with the data ($\chi^2(4) = 3.98$, significance level $< 10\,\%$). Moreover the hypothesis that the production potential is weakly exogenous in our model cannot be rejected ($\chi^2(6) = 10.56$, significance level $< 10\,\%$). This result is consistent with the quantity theory according to which the production potential is solely determined by real factors. This also implies that money is neutral in the long run. Because the hypothesis of weak exogeneity of the production potential cannot be rejected we reduce the whole system to three endogenous variables (m, p, y). The following equations show the estimation results (the absolute t-values are in brackets below the coefficients):[13]

$$\begin{aligned}\Delta m_t = & -\underset{(6.13)}{0.18}\cdot(m_{t-1} - p_{t-1} - \underset{(67.84)}{1.29}\cdot y_{t-1}{}^{*} + \underset{(6.62)}{0.91}) + \underset{(3.66)}{0.10}\cdot(y_{t-1} - y_{t-1}{}^{*}) \\ & + \underset{(3.04}{0.25}\cdot\Delta m_{t-1} + \underset{(0.08)}{0.01}\cdot\Delta p_{t-1} - \underset{(1.98)}{0.10}\cdot\Delta y_{t-1} - \underset{(0.30)}{0.03}\cdot\Delta y_t{}^{*} - \underset{(0.56)}{0.05}\cdot\Delta y_{t-1}{}^{*} \\ & + \underset{(0.70)}{0.13}\cdot oc_t - \underset{(2.59)}{0.72}\cdot oc_{t-1} - \underset{(0.01)}{0.00}\cdot oc_{t-2}\end{aligned} \tag{8}$$

$$\begin{aligned}\Delta p_t = & +\underset{(0.19)}{0.00}\cdot(m_{t-1} - p_{t-1} - \underset{(67.84)}{1.29}\cdot y_{t-1}{}^{*} + \underset{(6.62)}{0.91}) + \underset{(4.67)}{0.10}\cdot(y_{t-1} - y_{t-1}{}^{*}) \\ & + \underset{(0.03)}{0.00}\cdot\Delta m_{t-1} - \underset{(0.33)}{0.03}\cdot\Delta p_{t-1} - \underset{(2.73)}{0.10}\cdot\Delta y_{t-1} + \underset{(0.22)}{0.02}\cdot\Delta y_t{}^{*} + \underset{(2.05)}{0.15}\cdot y_{t-1}{}^{*} \\ & + \underset{(0.50)}{0.07}\cdot oc_t + \underset{(0.19)}{0.04}\cdot oc_{t-1} + \underset{(0.58)}{0.10}\cdot oc_{t-2}\end{aligned} \tag{9}$$

$$\begin{aligned}\Delta y_t = & +\underset{(2.11)}{0.12}\cdot(m_{t-1} - p_{t-1} - \underset{(67.84)}{1.29}\cdot y_{t-1}{}^{*} + \underset{(6.62)}{0.91}) - \underset{(3.11)}{0.16}\cdot(y_{t-1} - y_{t-1}{}^{*}) \\ & + \underset{(3.10)}{0.49}\cdot\Delta m_{t-1} + \underset{(0.32)}{0.08}\cdot\Delta p_{t-1} - \underset{(2.16)}{0.21}\cdot\Delta y_{t-1} + \underset{(0.86)}{0.16}\cdot\Delta y_t{}^{*} + \underset{(1.73}{0.31}\cdot\Delta y_{t-1}{}^{*} \\ & + \underset{(1.32)}{0.46}\cdot oc_t - \underset{(0.40)}{0.21}\cdot oc_{t-1} + \underset{(0.44)}{0.18}\cdot oc_{t-2}\end{aligned} \tag{10}$$

In combination with the significant coefficients of the error correction terms, the loadings – the corresponding t-values are 6.13 (first term in equation (8)) and 3.11 (second term in equation (10)), respectively, – these equations show that the two cointegration relations are indeed a nominal (price homogenous) money demand function and an equation determining real GDP, because deviations from long run equilibrium are corrected via changes in money demand and GDP. The two cointegration equations ex-

[13] The coefficients and t-values of the dummy variables are not shown.

Table 4: Test statistics for equations 8–10

Test statistics	Equation (8)	Equation (9)	Equation (10)
Adj. R-squared	0,88	0,93	0,90
standard error (in %)	0,68	0,52	1,33
LM(1)	0,71	0,80	2,72
LM(4)	0,34	3,60***	2,84**
ARCH(1)	1,72	0,59	0,58
ARCH(4)	1,46	0,62	0,40
Jarque-Bera	1,38	1,04	0,25

***(**,*): significance level < 1 % (5 %, 10 %).

hibit satisfactory statistical results (see Table 4). In connection with the significant error correction terms this may be interpreted as a sign of stability. On the other hand, the adjustment to long run equilibrium is relatively slow. Each quarter a maximum of only 18 % of the disequilibria are corrected.[14]

The long run money demand function in normalized form reads as

$$(m_t - p_t) = -0.91 + 1.29 \cdot y_t{}^* \tag{11}$$

The income elasticity is above unity pointing to the downward trend in velocity for M3 (Hubrich 1999). This should mainly be due to the interest bearing wealth components included in M3 (Gerdesmeier 1996).

Moreover, the equations demonstrate that money demand rises during economic booms. This can be seen from the money demand equation (8) in which the coefficient of the output gap has a significant positive sign (+ 0.10). The business cycle effects of monetary policy may be incorporated in equation (10). The coefficient of the error correction term of the money demand equation is positive (+ 0,12) suggesting an expansion in the money stock stimulates economic activity. It is surprising, however, that – contrary to the monetarist view – a monetary overhang does not directly affect prices. The coefficient of the liquidity gap is highly insignificant in the price equation (9). Price responses are only generated indirectly via influencing the output gap.[15] Inflation in Germany is therefore caused by disequilibria in the goods market, i. e. inflation expectations are not formed rationally (future oriented) but adaptively.[16] This is in line with the evidence presented in Funke et al. (1997, p. 256 f.) that the success of the Bundesbank in stabilizing prices is not solely due to money supply. Nevertheless this result is at odds with the annual announcement of money supply targets. Inherent in theses targets is an implicit inflation target called the price norm. In the case of a credible monetary policy this would suggest that economic agents build their price expectations according to this inflation target.

[14] *Roeger/Herz* (1997), p. 146 argue that this slow adjustment is due to measurement errors in the equilibrium velocity and in equilibrium transactions volume; see also *Brueggemann/Wolters* (1998), p. 206.

[15] *Hoeller/Poret* (1991) already stressed the point that the output gap is a better indicator for inflationary trends than the liquidity gap.

[16] This result is at odds with theoretical work in *Frenkel* (1994). *Reckwerth* (1997) shows that expectation formation in Germany is best modeled with a return-to-normality-approach.

Table 5: Correlation matrix of the residuals of the estimated equations

	m	p	y
m	1.000	–	–
p	0.173	1.000	–
y	0.058	– 0.104	1.000

To get a better understanding of the system's dynamics, especially the effects of money, price and income shocks we further present some impulse responses. As Table 5 shows the residuals of the three equation system are uncorrelated, i. e. the covariance matrix of the error terms is nearly diagonal. Thus the conclusions are independent of the ordering of the variables. For theoretical reasons we choose the following ordering for the impulse responses: p, y, m3. This ordering may be motivated by the fact that goods prices are sticky in the short run and money demand as a financial variable adjusts quickly to shocks.

The resulting impulse responses are depicted in Figures 1 to 6. They are in line with the conclusions drawn up to now. While in the short run the real effects of monetary policy are dominating, the long run is characterized by the price effects. Figure 1 shows that the real effects end at about four years (= 16 quarters). In the first six quarters a monetary shock does not change prices (see Fig. 3). But even after 10 years the price effects did not disappear completely. Price and output shocks have an immediate effect on money balances (see Fig. 5 and 6). Furthermore, economic activity mainly determines prices (Fig. 4). But price shocks do not cause any real effects (Fig. 2).

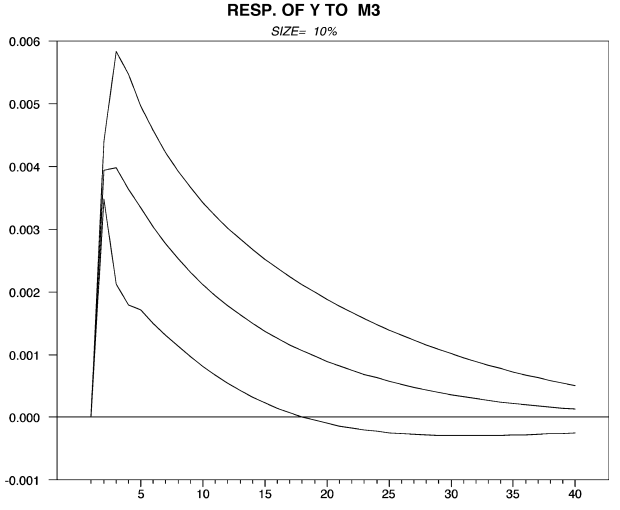

Figure 1[17]

[17] The 90 %-confidence bands were calculated on the basis of Monte-Carlo-simulations with the software MALCOLM for RATS. The own responses of shocks are not presented.

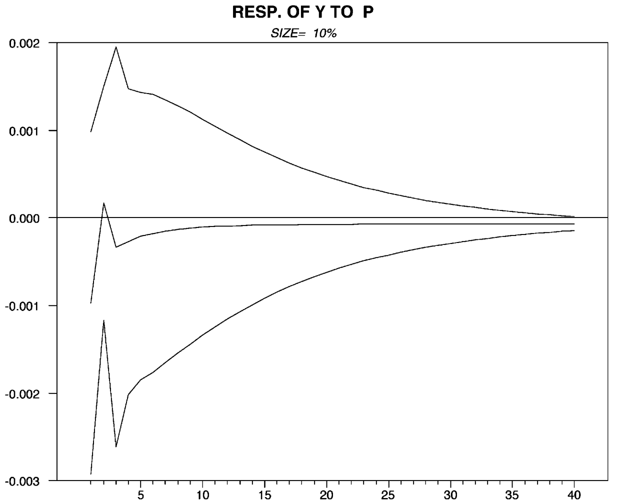

Figure 2

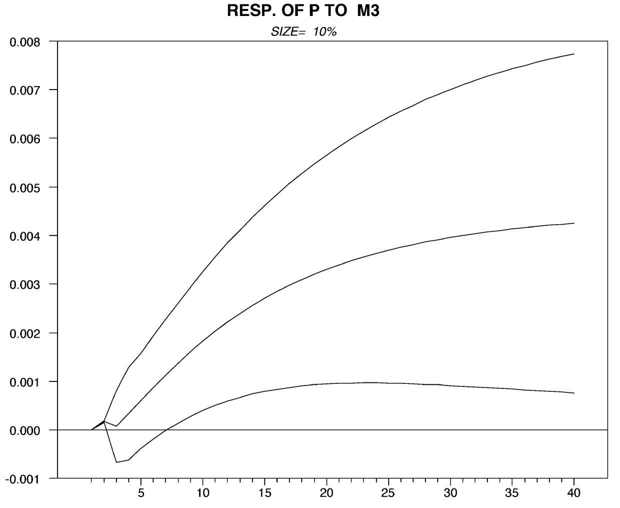

Figure 3

V. Summary and Monetary Policy Interpretation

The present paper analyzes the price and quantity effects of monetary policy in Germany. For this reason we specified a multivariate VECM. It was established that it is important to consider the system interdependencies of the model. Only then can different adjustment processes of market disequilibria and especially of monetary policy

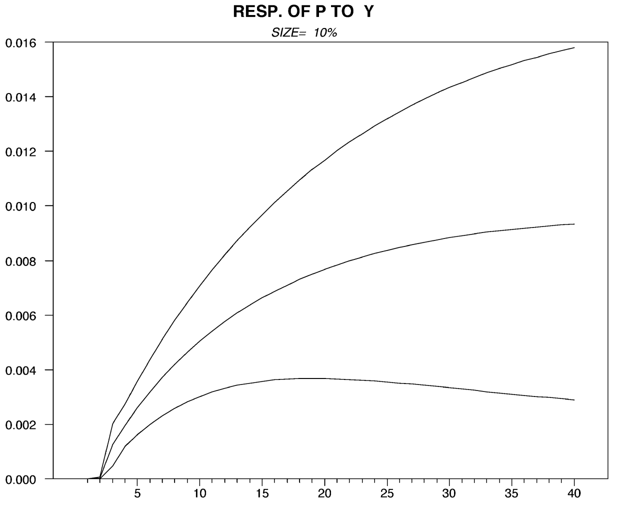

Figure 4

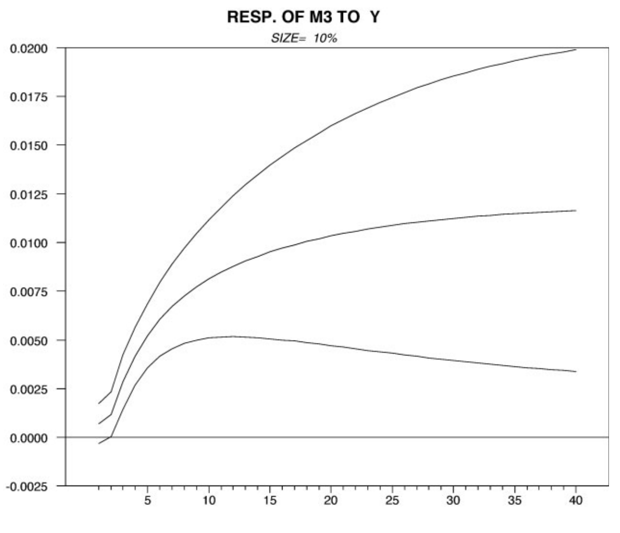

Figure 5

effects be captured appropriately. Within this model we showed that money is endogenous and that it is essential to consider the feedbacks.

The real effects of monetary policy within the model are predominantly short to medium-term in nature. However, this short period of time can last some years as the impulse responses indicated. In the long run monetary policy is neutral.

Furthermore there is clear evidence of a money-price-relation. But an expansionary monetary policy only increases inflation via stronger capacity utilization. However,

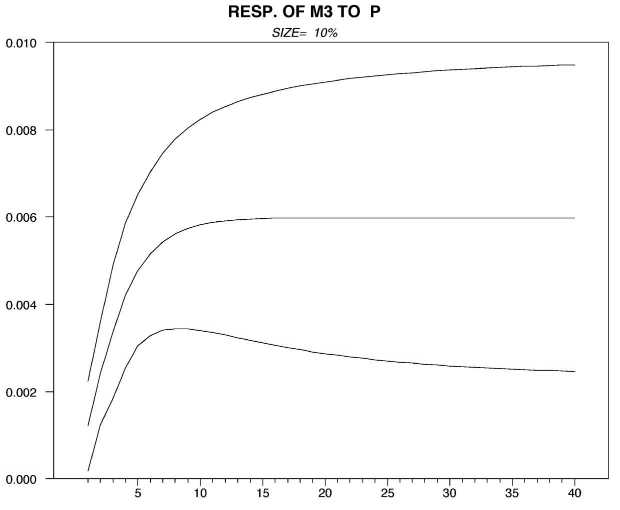

Figure 6

this result is not surprising in the light of the monetary strategy of the Bundesbank: This was characterized by a high degree of credibility and reputation. The more stability oriented monetary policy is and the less it attempts to systematically deceive the economic agents and to stimulate the economic activity by time inconsistent and short-run behavior, the more pronounced are the real effects of a given monetary policy stance and the smaller are the primary price effects of too expansionary or too restrictive policies. In such an environment it is reasonable to base price forecasts on the past.

Although there are good reasons for the existence of adaptive inflation expectations in Germany, this empirical result remains a puzzle. The inflation target of the Bundesbank was an inflation rate of 0 % to 2 %. The announcement of this (implicit) target should help the markets to avoid systematic expectation errors. This should have caused the inflation process in Germany to also include a "rational" component (besides the "adaptive" part) that is realized without goods market frictions. While an adaptive inflation process results from unexpected shocks, the inflation originating from rational expectations and resulting in a permanent inflation process should have been the normal situation in Germany.

Although monetary policy seems to have real effects, the empirical results should not be interpreted as to direct monetary policy more towards the business cycle. The long lags in the transmission process of monetary policy detected in the paper are more in favor of a steady and cautious monetary policy. Therefore monetary policy recommendations should be made with caution.

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