Estimating Monetary Policy Rules for South Africa

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Contents

Page

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1. Introduction

Aim of this paper is to combine the estimation of the Monetary Conditions Index (MCI) with the theoretic modelling of monetary policy rules for open and emerging market economies using the example of South Africa. The idea that monetary policy is not only interested in optimal monetary conditions but also in external stability, builds the basis for the analysis. This idea emerged from studying currency crises, which are caused by inadequate monetary policy and in particular from the experience of the Asian crisis of 1997/98 and their world-wide spread also to South Africa. The Monetary Conditions Index is a potentially useful tool for the development of monetary policy rules.

The MCI will be introduced in section 2 and will be estimated for the South African case in section 3. Section 4 briefly recapitulates monetary policy rules derived from economic theory, while section 5 combines estimations of section 3 and theoretical rules from section 4 to specify monetary policy rules for South Africa. Section 6 concludes.

2. The Monetary Conditions Index

Frequently we are confronted with announcements of decisions of central bank governors on interest rate changes. The successive discussion of these decisions is often centred on the expected inflation rate and the appropriate interest rate needed to reach certain inflation targets. What are much less discussed are changes in exchange rates. In case of floating exchange rates, these rates are subject of frequent and sudden changes. Knowing that interest rates as well as exchange rates may have an influence on monetary conditions and thus on inflation targets, the question arises whether a rise in interest rates may be compensated by a depreciation of the exchange rate. A further question is whether a one percent increase of the repo rate has the same effect on monetary conditions as a one percent decline of the exchange rate would have.

An answer to this kind of questions is provided by the MCI. The index is a combination of changes in real interest rates and changes in real exchange rates. The weights of the two measures depend on the influence that interest rates and exchange rates have on real measures such as the output gap and, finally, on inflation. Therefore, the MCI provides on the one hand an information tool for the public and on the other hand an early indicator for the monetary authorities. The MCI is currently used by several central banks all over the world, e.g. Canada, New Zealand, Norway and Sweden. The MCI also was in use as a target variable of the central banks in Canada and New Zealand.

The MCI in its simplest form can be formulated as:[1]

1) $MCI = b_1 \Delta r_t - b_2 \Delta e_t$

Equation (1) illustrates that the MCI is the combination of changes in real interest rates[2] and changes in real exchange[3] rates. Thereby, an increase in real interest rates as well as a decrease in real effective exchange rates[4] indicates a higher MCI and, therefore, tighter monetary conditions. The estimation of weights in the MCI is of greatest interest for the estimation of the MCI. Table I provides an overview of MCI estimations for different countries all over the world.

Other current studies estimate further MCI weights, e.g. for Thailand: 3.3:1, Hong Kong: 4.3:1, Nigeria: 0.2:1, Mexico: 1:1, Czech Republic: 2.7:1, and Poland: 0.3:1.[5] It is remarkable that the weight of the exchange rate measure in the MCI for smaller countries is sometimes larger than the weight of the interest rate measure. This is shown in the estimates above. The weight of the interest rate measure is so high that the exchange rate is kind of negligible to describe monetary conditions for rather large and more closed economies such as the USA. The following section attempts to identify the relevant data and to estimate the MCI for South Africa.

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1 For the economic derivation of the MCI see Burger & Knedlik (2004).

2 Real interest rate in the current period minus real interest rate in the base period.

3 The level of the real effective exchange rate minus the real effective exchange rate in the base period divided by the level of the base period.

4 A decrease in the exchange rate is usually referred to as appreciation of domestic currency.

5 See Hataiseree (1998: 10) for Thailand, Hong Kong Monetary Authority (2000: 64), Olekah & Masha (2003: 12) for Nigeria, Feliz & Welch (2004) for Mexico and Korhonen (2002: 9) for the Czech Republic and Poland.

Country	Source							
	Central banks	IMF	OECD	Deutsche Bank	Goldman Sachs	JP Morgan	Merrill Lynch	Dornbusch et al.
Australia			2.3			4.3	4	
Austria				3.3				
Belgium						0.4		
Canada	2; 3	4; 3	2.3		4.3	2.7	3	
Denmark						1.9		
EMU								2.17
Finland						2.5		
France		3	4	3.4	2.1	3.5		2.1
Germany		2.5; 4	4	2.6	4.2	2.3	4	1.39
Italy		3	4	6.6	6	4.1		2.89
Japan		10	4		8.8	7.9	10	
Netherlands				3.7		0.8		
NZ	2							
Norway	3					1.4		
Spain			1.5	2.5		4.2		1.46
Sweden	3-4		1.5	0.5		2.1		8.13
Switzerland				6.4		1.7		
UK		3	4	14.4	5	2.9	3	
USA		10	9		39	10.1	10	

Table I: The weights of the MCI in selected OECD countries (weight of the interest rate parameter relative to the exchange rate parameter), source: Ericsson et al. (1999: 36). Please note that the different institutions issue MCI with different positions after the decimal point, some issue intervals (-) while others issue more than one estimation (;).

3. The Monetary Conditions Index in South Africa

Different methodologies are used throughout the literature in order to estimate the weights of the MCI. Here, the methodology used by Korhonen (2002) is explained as an example, since the paper will follow the approach of Korhonen. The estimation equation of the least square approach of Korhonen consists of interest rate and exchange rate measures as independent variables and the output gap as dependent variable. The output gap variable is calculated by using a Hodrick-Prescott-Filter.[6] The estimation starts with a lag length of four quarters, which is reduced until the longest lagged variable becomes significant. The methodology of

[6] Hodrick-Prescott filters are used to identify the smooth component of a time series in the research on business cycles. The identification of the smooth component is achieved by solving the optimisation problem between minimal trend deviation and maximal smoothness (minimisation of the sum of second differences of the smooth component). The smoothness parameter is chosen as a weight of the two optimisation targets. A parameter of 1600, as used in the present estimation, is commonly used for quarterly data. For details on the formal methodology see Rinne & Specht (2002: 115-6).

Korhonen provides a simple technique, which is adequate to estimate the MCI. However, in some cases the methodology used in this paper departs from the approach to overcome some shortcomings.

Other authors, e.g. de Wet (2002) who estimated the MCI for South Africa use inflation rates as dependent variables. In case of South Africa this may not be a great difference since inflation and output gap show strong cross correlations as figure I indicates.[7]

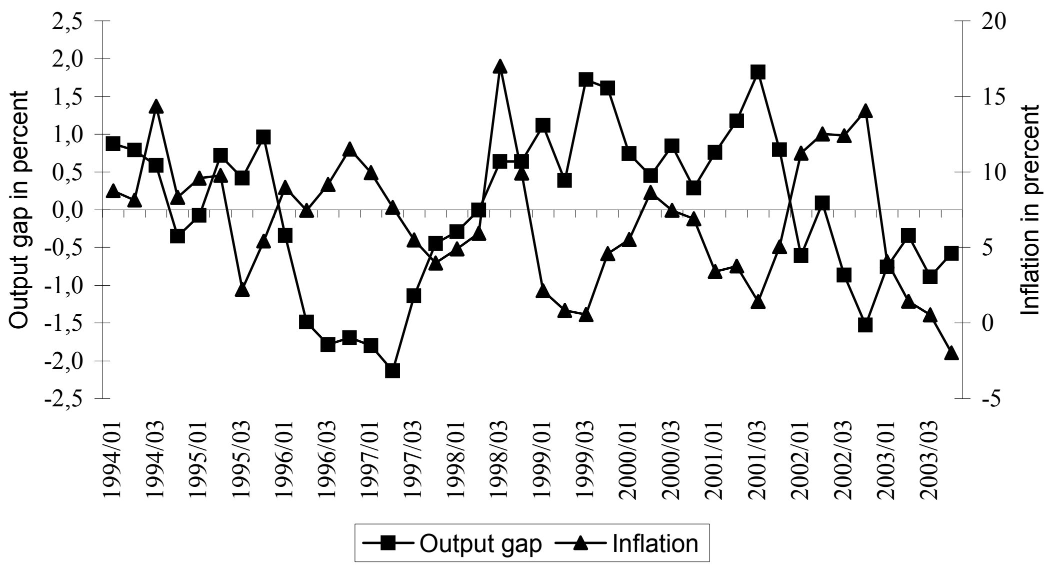

Figure I: Inflation and output gap in South Africa, Source: own calculations based on SARB-data.

Quarterly data derived from the online statistics of the South African Reserve Bank (SARB) is used in the present analysis. The sample period stretches from the first quarter of 1994 to the fourth quarter of 2003.

In order to estimate the output gap quarterly data of the GDP is used. The output gap is defined as the difference between potential output and current output. It is assumed that the potential output equals the smoothed time series of the current output since the potential output is not observable. To identify the potential output a Hodrick-Prescott filter with a smoothness parameter of 1600 is used. The logarithms of the potential output series as well as the time series GDP are calculated to yield growth rates. The time series "output gap" is calculated by

[7] The cross correlation coefficient is -0.38.

the difference of the logged time series of potential output and GDP (see figure II). To yield percent point changes the time series is multiplied by 100. The identified time series "output gap" is stationary.[8]

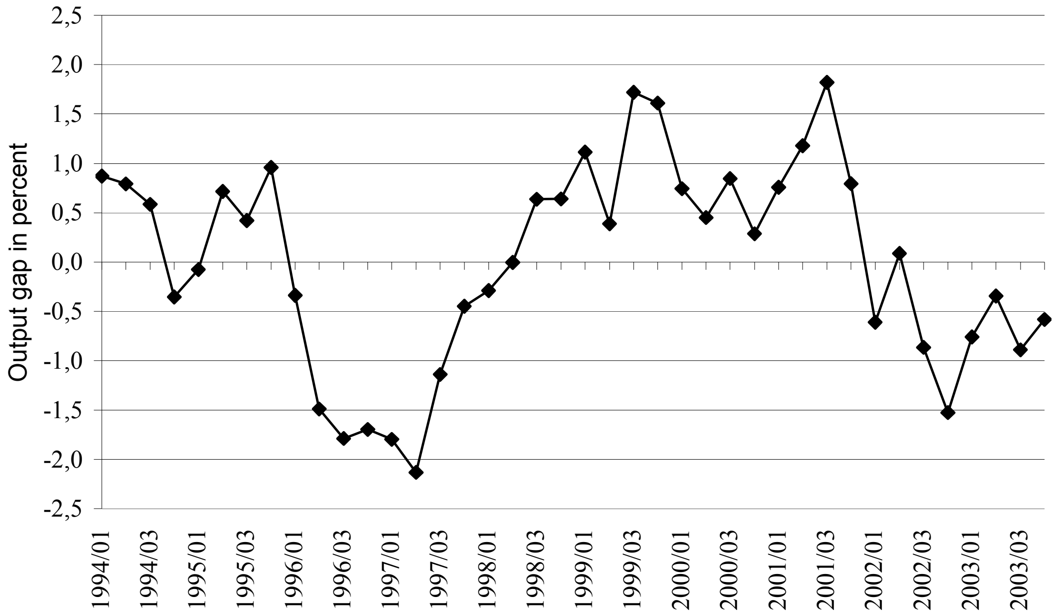

Figure II: The output gap in South Africa, Source: own calculations based on SARB online statistics.

The time series "real interest rate" (see figure III) is derived from SARB online statistics. The basis of derivation of the time series is the rate for six months money on money markets. This rate was chosen, since the maturity is assumed to be short enough to be under a sufficient influence of the SARB and to be long-ranging enough to influence the real sphere of the economy.[9] The monthly data of the SARB was converted into quarterly data by averaging the monthly data of one quarter of the year. To derive the real interest rate the quarterly inflation rate was subtracted from the quarterly money market interest rate.[10] To calculate deviations of the interest rate from a base period, the Hodrick-Prescott-filter technique was use to smooth

[8] The Dickey-Fuller test with intercept and a maximum lag length of nine shows that the null hypothesis, that the time series would show a unit root, can be rejected accepting a probability error of five per cent. For details on the Dickey-Fuller test see Poddig et al. (2001: 352ff).

[9] In the decision on what interest rate to choose one important dilemma of the MCI is reflected. In order to use the MCI as an information tool on monetary conditions, which influence real conditions and finally inflation rates, one would choose a long maturing interest rate. For the use of the MCI as a guideline for monetary policy one would rather choose a short maturing interest rate to ensure the influence of the central bank on the operating target. The decision to choose one interest rate is, therefore, always a compromise between the two requirements.

[10] It is thereby assumed that the nominal interest rate consists of two elements: the real component and the inflation rate. For more details on the so-called Fisher decomposition of the nominal interest rate see Jarchow (1998: 245).

the time series. Differences between the actual real interest rate and the base rate were generated to gain a percent point change to derive the time series "Real Interest Rate". This time series is stationary.[11]

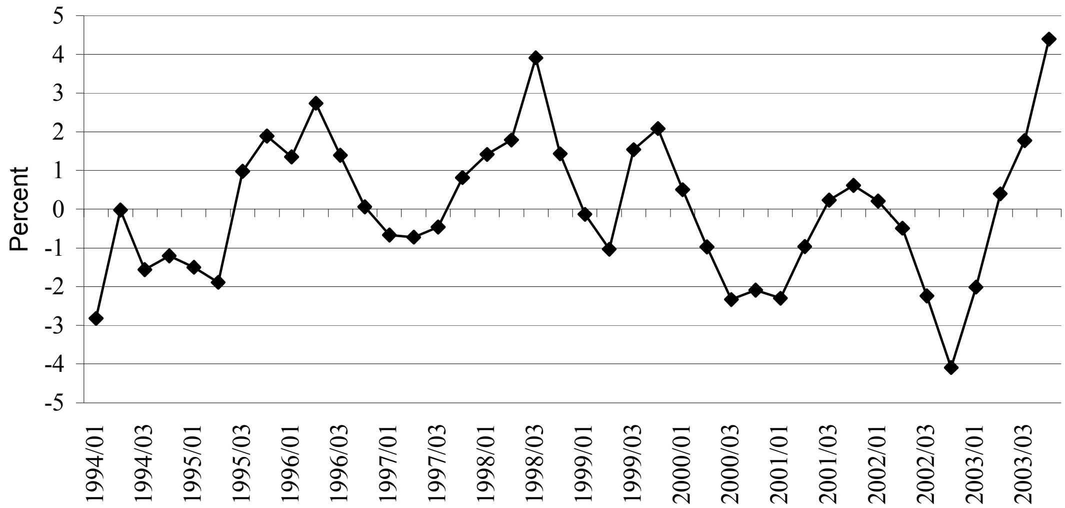

Figure III: Percent point deviation of real interest rates from base interest rate, Source own calculations on basis of SARB online statistics.

The time series "Real effective exchange rate" (see figure IV) was derived from the quarterly SARB index of the real effective exchange rate. Again Hodric-Presscot-filters were used to derive base values of the real effective exchange rate. The differences between logged real effective exchange rate and logged base values of the exchange rate were used to calculate the percent point change of the exchange rate. The time series is stationary.[12]

The necessary data to estimate the weights of the MCI is provided with the time series "output gap", "real interest rate" and "real exchange rate". Now the model can be specified and the weights of the MCI can be estimated.

[11] The Dickey-Fuller test with intercept and a maximum lag length of nine shows that the null hypothesis, that the time series would show a unit root, can be rejected accepting a probability error of one per cent.

[12] The Dickey-Fuller test with intercept and a maximum lag length of nine shows that the null hypothesis, that the time series would show a unit root, can be rejected accepting a probability error of one per cent.

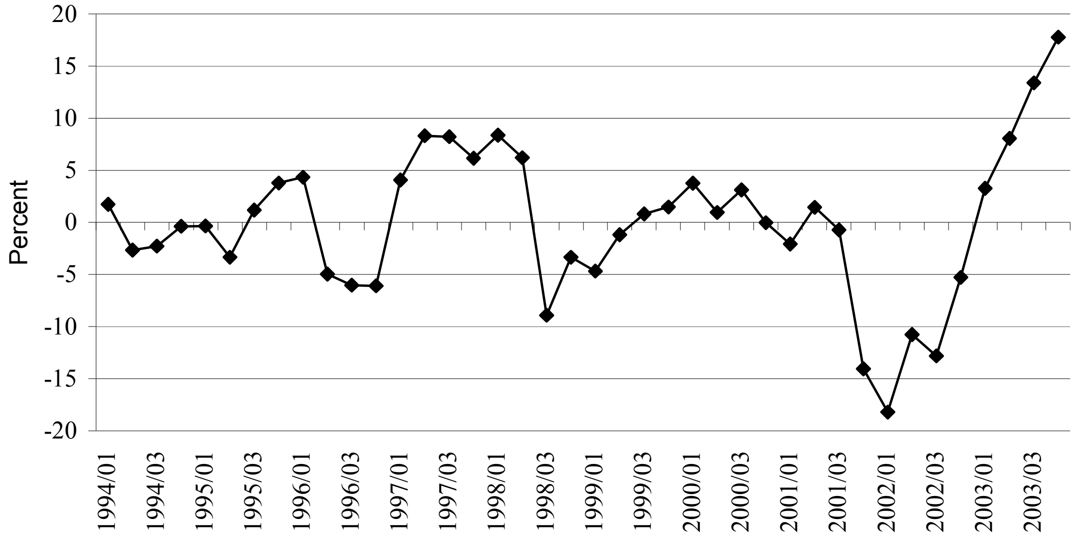

Figure IV: Percent point deviations of the real effective exchange rate in South Africa from its base values, source: own calculations on basis of SARB online statistics.

The estimation equation used to estimate the weights of real interest rates and real exchange rates in the MCI can be specified as:

2) $y_{gt} = \beta_0 + \beta_1 y_{gt-1} + \sum_{i=s}^{k} \beta_{2i} \Delta r_{t-i} + \sum_{i=s}^{k} \beta_{3i} \Delta e_{t-i} + u_t$.

The structure of the model follows economic and econometric considerations. Initially, a constant term (β_0) is introduced to cover possible level effects. Secondly, the lagged dependent variable (y_{gt-1}) is introduced to reflect longer lasting shocks to the economy. Thirdly, it has to be considered that the empirical research uncovers differently lag lengths in the effect of changes in interest rates and exchange rates on real measures to capture the appropriate lag length of the independent variables.[13] To identify the appropriate lag length of the independent variables a broad estimation was done including eight lags for the interest rate and the exchange rate measure. Analysing the estimation results leads to the conclusion that changes in real interest rates influence the output gap strongest after zero, one and four periods, while changes in real effective exchange rates influence strongest after four, five and six periods.[14]

[13] The lag structure of monetary policy is discussed in the context of controllability of economic aggregates by monetary authorities. Cf. e.g. Bofinger et al. (1996: 129-30). Other authors, e.g. de Wet (2002) estimate the MCI on basis of current figures only.

[14] The results of the correlation analysis suggest that changes in interest rates are influence real measures much faster than changes in exchange rates. Changes in interest rates are already of importance after half a year, while changes in exchange rates affect the real economy after up to two and half years.

Therefore, the interest rate measure lagged by zero, one and four periods was included in the final estimation equation and the exchange rate measure lagged by four to six periods were also included in the model.

The estimation of equation (2) provides the picture as provided in table II. Thereby, the constant term is not significant at a ten percent significance level. However, the parameter of the lagged output gap has a value of 0.827 and is significant on a ten per cent level. The estimated coefficients of exchange rates lagged by five and six periods are not different from zero if a probability error of 10 percent is taken into account. However, the estimated coefficients for the interest rate measure lagged by zero, one and four periods and for the exchange rate measure lagged by four periods are significant on a 10 percent level.

Variable	Coefficient	Standard deviation	t-value	Probability
C	-0.042241	0.104210	-0.405348	0.6885
Output gap (-1)	**0.827160**	**0.103868**	**7.963554**	**0.0000**
Interest rate	**0.230752**	**0.082577**	**2.794397**	**0.0096**
Interest rate (-1)	**-0.277802**	**0.090991**	**-3.053078**	**0.0052**
Interest rate (-4)	**0.148137**	**0.078368**	**1.890272**	**0.0699**
Exchange rate (-4)	**0.052258**	**0.024281**	**2.152222**	**0.0408**
Exchange rate (-5)	-0.044516	0.028579	-1.557638	0.1314
Exchange rate (-6)	0.024207	0.024328	0.995014	0.3289

R^2	0.774843	Durbin-Watson stat	2.254035
Adjusted R^2	0.714224	Mean dependent var	-0.065639
S.E. of regression	0.582756	S.D. dependent var	1.090120
Sum Squared resid	8.829721	Akaike info criterion	1.960228
Log likelihood	-25.32388	Schwarz criterion	2.319372

Table II: Estimation output of the estimation of weights for the MCI of South Africa (EViews output), source: own calculations.

The quality of the estimation is evaluated by using different tests. The calculated F-statistic shows that the null-hypothesis, that the coefficients cannot be used in order to explain the dependent variable, can be rejected at a probability error of one per cent. It is therefore safe to assume that the model was specified in a way that the independent variables explain the dependent variable.

The quality of the estimation can be scrutinized by using the R^2 statistic. The calculated value of the R^2 statistic of 0.77 indicates that the estimation equation is better than a pure random walk. If one takes the number of explanatory variables into account and looks at the adjusted

R^2 statistics, a value of 0.71 is shown, which can also be regarded as satisfactory. The Durban-Watson statistic shows a value of 2.25 and can be deemed as an indicator for the absence of autocorrelation. However, the estimation includes a lagged depended variable, which distorts the Durban-Watson statistic. One may use Durban's-h-statistic, which was developed for this case of distortion, in order to solve the problem.[15] The null-hypothesis, that there is no autocorrelation present in residuals, could not be rejected taking a probability error of ten per cent into account. The residuals are stationary.[16] Thus, it can be assumed that the residuals are independent, which is a major condition for the efficiency of the ordinary least square method.

Therefore, the quality of the estimation allows an interpretation of the estimation results. We expected positive algebraic signs for both the interest rate measure as well as the exchange rate measure as estimation results, because a positive effect on the output gap was expected if an appreciation as well as an increase in interest rates occurred.[17] To calculate the overall influence of exchange rates and interest rates on the output gap all significant estimation results are summed up. The signs of the coefficients of the significant variables match the expectations. The value of the sum of coefficients (0.101087 for the interest rate measure and 0.052258 for the exchange rate measure) allow the calculation of the relative influence of changes in interest rates and changes in exchange rates on the output gap. The ratio is 1.9:1. This important estimation result is also in line with the set expectations, since one would have expected the ratio to be much smaller in South Africa than in the relatively large OECD countries and, on the other hand, higher than in very small and open economies. As stated before, another result of the analysis is that changes in interest rates are faster in their influence on the output gap than changes in the exchange rate are. The transmission of interest rate effects starts already in the current period, while the transmission of exchange rate effects takes one year to have a significant influence on the output gap.

The estimation of the coefficients of the MCI now enables us to derive the MCI over the sample period. The MCI can be derived in different ways. The MCI is defined as a linear combi-

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[15] Cf. e.g. Studenmund (2001: 616) for more details on Durban's-h-statistic.

[16] The Null hypothesis of the Augmented Dickey-Fuller test, that the residuals have a unit root could be rejected on a 1% error level.

[17] A positive output gap means that the current output is below its potential level. The more restrictive monetary conditions are (be it by increased interest rates or by an appreciating currency) the larger is the output gap. Here an exchange rate index is used that increases with the appreciation of the currency. That is why we expect a positive sign of the exchange rate parameter and not a negative one as was stated in section 2 (equation 1).

nation of deviation of interest rates and exchange rates from a defined base period. In the simplest case one could take the antecedent period as the base period to calculate deviations. Doing this allows to calculate the MCI. It does, however, not allow concluding form the derived figures whether the monetary conditions have been to loose or to tight, since the previous period may have not been an equilibrium period. It is, therefore, impossible to derive policy rules from an MCI that is based on deviations from the antecedent period. Ideally, one would calculate deviations from a base period, which was an equilibrium period. This would provide the possibility to compare any situation with the equilibrium and to conclude whether or not the monetary conditions in the period have been too tight or too loose compared with the equilibrium period.

The approach chosen in this paper was to calculate deviations from a base period. The deviations are now weighted with the estimated weights to show the monetary conditions in South Africa.

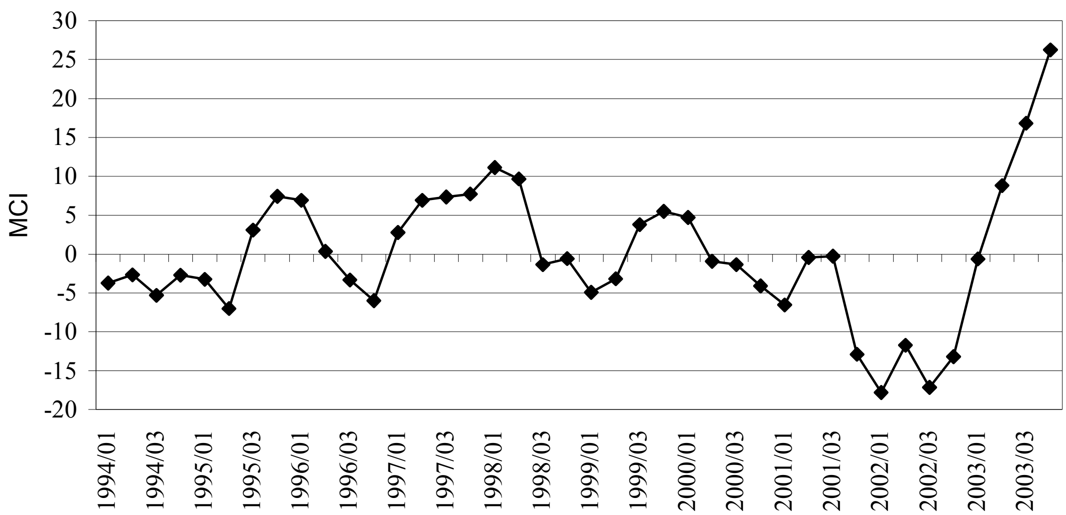

Figure V: Monetary Conditions Index for South Africa, source: own calculations.

The developing of the MCI shows the different phases of the development of monetary conditions in South Africa. The phase until 1998 was characterised by relatively high real interest rates and – except for the devaluation episode in 1996 – real exchange rates, which were stable on a high level. The strong nominal devaluation of the Rand in the aftermath of the Asian crisis in 1998 in combination with declining real interest rates resulted in a phase of relaxed monetary conditions. Low real interest rates as well as a second devaluation round of the

Rand (with a peak in 2001) are responsible for the further shrinking of the MCI after 1998. After 2001 the MCI rose enormously due to increasing real interest rates as well as the strong appreciation of the Rand. What is also obvious from figure V is that monetary conditions became increasingly volatile after the abolishment of exchange rate smoothing in 2000.

The calculation of the MCI and the estimation of the weights of the MCI in the preceding section are therefore regarded as economically meaningful. Some conclusions can be drawn form the analysis so far: The first conclusion, which can be drawn from the developing of the MCI for South Africa is that monetary conditions were subject to change during the period of observation. While the MCI concept considers values of the MCI as optimal, which are closed to zero, the situation in South Africa shows monetary conditions that have been quite closed to the optimum in some periods, but became less optimal in the last periods of observation.

The second conclusion is that the parameters as well as the MCI outcome meet the expectations. The estimation can therefore be regarded as economically meaningful. Thus, the concept could and should be part of the analysing tools of the monetary authorities as well as of public observers.

One could further ask what implications the MCI concept has on monetary policy. One answer could be that the MCI should be used to derive the optimal use of interest rate policy and exchange rate policy to target the inflation rate as done in the following sections. What is a clear outcome of the model is that neglecting exchange rate developments in the conduct of monetary policy leads to volatile monetary conditions. This may be the major conclusion of the above exercise.

4. Optimal Monetary Policy

Burger & Knedlik (2004) developed a model of optimal monetary policy for open emerging market economies based on the concept of the MCI, from which rules for central bank operating targets are derived. This model is briefly summarised below to be than specified by using the above estimations.

Starting point of derivation is the formulation of monetary policy targets. There are two targets formulated for open emerging market economies: First, monetary policy should aim to provide optimal monetary conditions. Secondly, monetary policy should manage to avoid volatility of capital flows by targeting interest rate parity. The two targets can be called internal and external stability. The model also allows the central bank not to react on shocks.

The first target strongly relates to the concept of the MCI, which is integrated into a standard macroeconomic model consisting of an IS curve relation for the demand side and a Phillips curve relation for the supply side of the economy. The external stability target is formalised by using interest rate parity theory.

The derived rules for operating targets of the central bank take the form of:[18]

3) $\Delta r_{t+1}^{target} = \dfrac{-MCI_t - u_t - b_3 y_{gt-1} + b_2(r_t - r_{t+1}^f)}{b_1 - b_2}$

and

4) $\Delta e_{t+1}^{target} = \dfrac{MCI_t + u_t + b_3 y_{gt-1} + b_1(r_{t+1}^f - r_t)}{b_2 - b_1}$.

Equation (3) states that the central bank should derive the target deviations of the real interest rate (Δr_{t+1}^{target}) and the real effective exchange rate (Δe_{t+1}^{target}) form their equilibrium levels for the period to come by taking into consideration the current developments in the MCI, current shocks to the economy (u_t), the output gap of the previews period (y_{gt-1}) and the inter-temporal interest rate differential $(r_t - r_{t+1}^f)$. The different measures to derive the optimal use of instruments are weighted with help of weights of interest rates (b_1) and exchange rates (b_2) in the MCI and a measure for the persistence of shocks (b_3).

The monetary policy concept in which the above rules would fit in is an inflation targeting approach with managed floating exchange rates. Thereby inflation rates play the role of the nominal anchor and interest rates as well as exchange rates are used as monetary policy oper-

[18] For the derivation of the operating target rules from the model see Burger & Knedlik (2004).

ating targets and are adjusted by refinancing operations on money markets and by open market operations on the foreign exchange markets.[19]

The aim of this paper is not to discuss the theoretical issues of modelling optimal monetary policy, but rather to specify the monetary policy rules of one model by using the estimates for the MCI for South Africa. This is done in the below section.

5. Optimum Monetary Policy in South Africa

The combination of empirical estimations of parameters with the theoretically derived monetary policy rules in Burger & Knedlik (2004) yields specific rules for the use of instrument targets in South Africa.

In section 3 the parameters (b_1) and (b_2) were estimated to be b_1= 0.101087 and b_2= 0.052258. The parameter (b_3) was not defined so far, though that it was also already estimated. b_3 is the persistence parameter of deviations of output from its long-term trend, or measures the influence of past output gaps on the current output gap. From table II one can see that the parameter (b_3) takes the value of 0.827160. This means that a certain output gap in one period is persisting into the next period with 82.3% of its value. Including the estimation results in equations (3) and (4) yields:

$$\text{(3a)}\quad \Delta r_{t+1}^{target} = \frac{-MCI_t - u_t - 0.827160\, y_{gt-1} + 0.052258(r_t - r_{t+1}^f)}{0.101087 - 0.052258} = \frac{-MCI_t - u_t - 0.827160\, y_{gt-1} + 0.052258(r_t - r_{t+1}^f)}{0.048829}$$

and

$$\text{(4a)}\quad \Delta e_{t+1}^{target} = \frac{MCI_t + u_t + 0.827160 y_{gt-1} + 0.101087\,(r_{t+1}^f - r_t)}{0.052258 - 0.101087} = \frac{MCI_t + u_t + 0.827160 y_{gt-1} + 0.101087\,(r_{t+1}^f - r_t)}{-0.048829}.$$

[19] Note that this framework is contrary to a system with exchange rates as intermediate target, where exchange rates are targeted by adjusting interest rates. Here interest rates and exchange rates are used as two autonomous operating targets.

With equation (3a) and (4a) specific rules for the use of monetary policy instruments are derived. To calculate the target changes for interest rates and exchange rates for a certain period one simple has to include the different measures into the equation. MCI, output gap, and domestic interest rates were already detected for the period of observation. However, foreign interest rates and the values of shocks are unknown so far. To simplify the analysis it is hereafter assumed that the foreign real interest rate might equal two percent.[20] The assumption makes the construction of a trade or capital transfer weighted index of foreign interest rates dispensable, which would be helpful to have for using the policy rules in praxis. A second assumption is introduced with regard to the shock measurement. In praxis it is very difficult to identify demand and supply shocks on the economy. It is therefore assumed that the shocks that are included in the target rule equations might equal the output gap. Before calculating the target values of the instruments a redefinition of the MCI is needed. Until now the MCI was calculated with help of the standardised weights of 1.9 : 1. That was helpful to compare the relative weight of the MCI in South Africa with other countries. Here, however, we need to go back to the estimated weights of 0.101087 : 0.052258 to calculate the MCI. The picture of that newly calculated MCI (see figure VI) equals the picture MCI shown in figure V, except for the values.

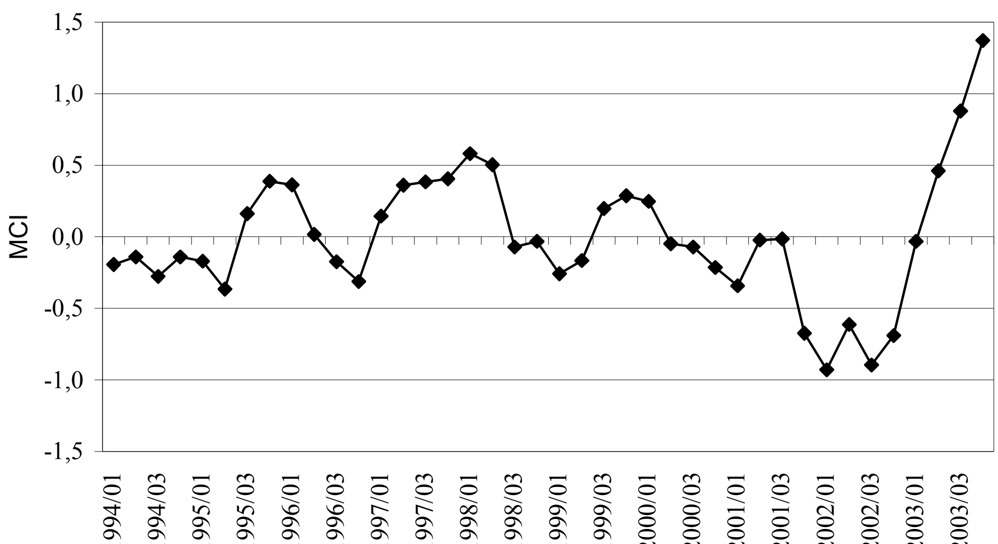

Figure VI: The MCI for South Africa on basis of non-standardised weights, source: own calculations.

[20] The assumption is based on the long-term interest rate estimated by Taylor (1993) for the USA.

With that it is now possible to calculate the ex-post target changes of interest rates and exchange rates for any date during the period of observation. As one example let's consider the target values for the fourth quarter of 1998. To calculate the targets the following information is needed:

- MCI of the third quarter of 1998 = -0.071272
- Output gap of the third quarter of 1998 = 0.637302
- Output gap of the second quarter 1998 = -0.002905
- Real interest rates in the third quarter 1998 = 10.69667%
- Foreign real interest rates = 2%.

Inserting the example into equations (3) and (4) yields:

(3b)

$$\Delta r_{1998:4}^{target} = \frac{-(-0.071272) - 0.637302 - 0.827160 \cdot (-0.002905) + 0.052258 \cdot (10.69667 - 2)}{0.048829},$$

$$= -2.235483$$

(4b)

$$\Delta e_{1998:4}^{target} = \frac{-0.071272 + 0.637302 + 0.827160 \cdot (-0.002905) + 0.101087\,(2 - 10.69667)}{-0.048829}.$$

$$= 6.461183$$

For interpretation of the results one should have a look at the assumptions again. It was assumed that the central bank does not react on shocks. In the example period the MCI corrected by shocks and persistent shocks indicates that monetary conditions have been too tight:

$$MCI_{1998:3} + u_{1998:3} + b_3 \cdot y_{g\,1998:2} = -0.071272 + 0.637302 + 0.827160 \cdot (-0.002905) = 0.563627.$$

To counteract the positive MCI measure the central bank should loosen its monetary instruments in order to reach a balanced MCI the target MCI for the following period must be previous MCI multiplied by minus one. This target MCI is reach by the above calculated target changes in interest rates (decrease interest rates by 2.2 per cent) and target exchange rates (devaluate the real exchange rate by 6.5 per cent):

$$\begin{aligned} MCI^{target}_{1998:4} &= b_1 \cdot \Delta r_{1998:4} - b_2 \cdot \Delta e_{1998:4} \\ &= 0.101087 \cdot (-2.235483) - 0.052258 \cdot 6.461183 . \\ &= -0.563627 \end{aligned}$$

The combination of interest rates and exchange rates is chosen in order to fulfil interest rate parity at the same time, e.g. the real target devaluation equals the difference between real domestic and real foreign interest rates:

$$\Delta e^{target}_{1998:4} = r^{target}_{1998:4} - r^{f}_{1998:4} = 6.461183 = (-2.235483 + 10.69667\,) - 2\,.$$

However the presentation of one enlightening example is not sufficient to judge the usefulness of the model and the estimation. Model suggested changes in operating targets (presented in appendix I) show results that deviate enormously from expectations. Quarterly changes of real interest rates and real exchange rates of above 50 per cent cannot seriously be recommended.

The deviations of the results from expectations can be explained by different reasons. A first reason may be shortcomings in the theory used. That counts in particular for the simplifying modelling of the transmission process, which assumes only interest rates, exchange rates and lagged values to influence the output gap. That may be just to simplistic. Other important measures such as changes in technology, fiscal policy, changes in regulation, and factor prices are exogenous to the model. The empirical estimation of output elasticises of interest rates and exchange rates has shown, that their influence is relatively low compared to the lagged values, which may bear some of the external effects. It also shows which small influence interest rates and exchange rates have to actually target the output gap. These facts must result in a model outcome that recommends enormous efforts of the central bank to close the output gap under ceteris paribus conditions within one period.

That means for interpretation of the instrument rule outcome that the derived results are optimal within the model. For the use as practical guide for monetary policy the results may indicated the direction of action needed. The model could therefore be extended by tolerating deviations from the monetary policy targets or by formulating a medium term target path. From the results of the model it seems to be impossible to close output gaps within one period.

However, another important reason for the deviations of model outcomes from expectations may lay in the fact that the South African Reserve Bank has not followed a monetary policy approach that would be optimal within the model. If the Reserve Bank would have followed a policy closed to the optimal policy in periods with relatively low output gaps, it could have created confidence in further efficient instrument adoption and would have created much lower output gaps. That could have led to easing requirements in the use of instruments in other periods. In other words: From looking ex-post on developments of target values for certain periods it cannot be concluded that one cannot expect model outcomes, which are much closer to expectation once the central bank would follow the described policy approach. On contrary in the frame of the model the results of the instrument rules have to be considered as optimal in general.

With the combination of empirical estimations of the MCI in section 3 with the theoretical model by Burger & Knedlik (2004), described in section 4, this section has now shown which particular targets should have been targeted during the period of observation. Completely unmentioned remains the problem of how these instrument targets could be reached. An answer to this question should be the task of further research.

6. Conclusions

Summarising it can be stated that the derivation of monetary policy rules for the use of instruments under consideration of internal and external stability led to an monetary policy framework that can be assigned into an inflation targeting approach, whereby exchange rates are employed as instruments in an exchange rate regime of managed floating exchange rates.

The parameters necessary to specify the model can be calculated by estimating the Monetary Conditions Index. The results of the estimation are according to expectations and are economic meaningful. The combination of the theoretical model with the empirical estimations leads to specific monetary policy rules. The ex-post analysis of monetary policy targets leads to the conclusion that the results of the model cannot be boundless recommended for practical application. They are, however, a guide for the alignment of monetary policy.

Further research is needed to incorporate further influencing variables into the model. It has further to be questioned weather or not central banks can follow the recommended policy of closing output gaps by their own or weather central banks should consider other targets or time pattern of targets.

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Appendix 1

	Target changes of real exchange rates	Target changes of real interest rates
1994:1	NA	NA
1994:2	NA	NA
1994:3	-24.86051	-26.42385
1994:4	-18.94864	-19.32198
1995:1	2.420225	1.336892
1995:2	13.35921	12.23255
1995:3	-3.667696	-4.744363
1995:4	-15.23314	-19.49647
1996:1	-23.38869	-28.85869
1996:2	-5.957091	-11.16376
1996:3	50.00728	43.17061
1996:4	77.20805	71.50138
1997:1	80.83744	76.28077
1997:2	70.79610	66.81943
1997:3	75.06874	71.03541
1997:4	60.65173	56.26839
1998:1	31.95897	26.26230
1998:2	14.67105	8.364386
1998:3	8.387615	1.744282
1998:4	6.461183	-2.235483
1999:1	-10.59875	-16.70541
1999:2	-19.27810	-23.67810
1999:3	-16.48345	-19.81345
1999:4	-34.03818	-39.73818
2000:1	-55.57592	-61.60259
2000:2	-38.83496	-43.04496
2000:3	-15.64640	-18.13307
2000:4	-21.67770	-22.54770
2001:1	-14.05936	-14.91269
2001:2	-12.57099	-12.96766
2001:3	-33.42300	-34.90967
2001:4	-51.89088	-54.34088
2002:1	-27.95715	-30.56382
2002:2	22.14464	20.15464
2002:3	23.28397	22.20064
2002:4	32.77959	33.63959
2003:1	54.03420	56.92420
2003:2	40.04557	41.01890
2003:3	13.09592	11.81259
2003:4	11.24012	8.726787