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Monetary Policy after Financial Liberalisation: A Central Bank Reaction Function for Botswana

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Centre for Research in Economic Development and International Trade, University of Nottingham

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Acknowledgements
The authors wish to thank Keith Jefferis of the Bank of Botswana, participants in an IMF African Department seminar, and various members of the IMF Monetary and Exchange Affairs Department for helpful comments on previous versions. Any errors that remain are of course the authors' responsibility.

October 2001

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Abstract
A reaction function is estimated for interest rates set by the Bank of Botswana since financial liberalisation. Interest rate changes tend to be larger and somewhat less frequent than in developed countries. Interest rates are nevertheless smoothed in the sense that successive changes tend to be in the same direction. Interest rates react significantly to private sector credit growth and to recent inflation, but not to the real exchange rate or to South African interest rates. The estimated long-run inflation coefficient is low, and much lower than in developed countries.

Outline

1. Introduction
2. History of Monetary Policy in Botswana
3. The Central Bank's Reaction Function: Specification and Estimation
4. Empirical Results
5. Is Monetary Policy Effective?
6. Conclusions

I. INTRODUCTION

In recent years there has been a great deal of interest in inflation targeting, monetary policy rules and the empirical analysis of interest rate setting by central banks (Bernanke *et al*., 1999; Clarida *et al*., 1998; Leiderman and Svensson, 1995; Taylor, 1999). Explicit inflation targeting has been adopted by a number of larger, higher-income developing countries,[1] but many low- and middle-income countries are reluctant to adopt a fully independent monetary policy, which requires "an institutional commitment to price stability, absence of fiscal dominance, policy instrument independence, and policy transparency and accountability" (Mishkin and Schmidt-Hebbel, 2001, p. 3). Although many such countries have an announced inflation target (or at least a more vaguely defined objective), the weight of the inflation policy objective relative to others is often far from clear.

Developing countries have historically been weak on policy transparency and on monetary policy independence, and have tended to be characterised by "financial repression", with interest rates substantially negative in real terms and of negligible importance to the regulation of aggregate demand (Agénor and Montiel, 1996). Median inflation rates have been significantly higher than those of developed countries over a long period of time, which suggests only a limited commitment to price stability. Nevertheless there have been significant improvements in this respect in the later 1990s, and the fact that these improvements have coincided with greater flexibility of exchange rates indicates a strengthening of domestic institutional arrangements for monetary policy.

How far has financial liberalisation shifted monetary policy in the direction of genuine independence and providing an effective nominal anchor? There are various possible approaches to this question, but the one which we favour is to characterise monetary policy in particular countries econometrically. For this exercise we require countries with a stable monetary regime that is not driven by fiscal or speculative pressures, without a firm external nominal anchor, and which satisfy the data requirements. In

1 Mishkin and Schmidt-Hebbel (2001) list Chile, Colombia, Czech Republic, Israel, Korea, Mexico, Peru, Poland, South Africa and Thailand as inflation targeters. Schaechter *et al*. (2000, p. 3) note that the inflation-targeting developing economies are "large, relatively well developed, and have more developed financial systems compared to their counterparts".

practice these criteria rule out a large number of developing countries, and the single country which we select for study here is Botswana. Botswana is typical of many developing countries in its relatively small size (population 1.5 million) and limited financial system. It is, however, atypical of Africa in that it has transformed itself from a low- to a middle-income country in a matter of decades. As one of the world's major diamond producers, it also has a very strong external and fiscal position.[2] We estimate an interest rate reaction function for the Bank of Botswana for the period since financial liberalisation in 1989, and compare the estimated coefficients with those for developed countries and committed inflation targeters like Chile. In many respects the results are surprisingly similar, the main (but critical) difference being the weak response of interest rates to inflation shocks in Botswana.

The paper is structured as follows. After a brief history of monetary policy in Botswana in Section Two, we develop our econometric model in Section Three. Results are presented in Section Four, and Section Five concludes.

II. HISTORY OF MONETARY POLICY IN BOTSWANA

Botswana attained monetary independence in 1976, establishing its own currency (the pula) and a central bank, and withdrawing from the Rand Monetary Area (RMA) – a monetary union that used the South African rand as the union currency. Initially, exchange rate policy was actively used to influence the inflation rate (since imports represent about 50% of GDP), and interest rates were regarded more as a component of development strategy than as a tool of demand management. The prevailing policy then was to maintain low interest rates[3] to aid investment and economic growth and to mop up excess liquidity in commercial banks caused by excess diamond proceeds that filtered into the mainstream economy through the government.[4] However, inflation problems

2 Botswana's 1995 PPP gross national income per capita was above that of any other African country except South Africa and Mauritius (source: World Development Indicators database), and it has never borrowed from the IMF. Foreign exchange reserves represented 29 months of imports at the end of 1999, and the government budget has been in surplus in recent years.

3 Commercial bank and other lending rates were kept low by holding down the central bank call rate, as well as by direct regulation of commercial bank interest rates. An overnight call account facility had been introduced in 1976 to enable commercial banks to earn some interest on the excess liquidity in the system. The interest rate for call deposits at the Bank was set at 6.0% in 1976, was reduced to 4.5% in 1977 and to 3.5% in 1978, and remained at that level for the next ten years. The real interest rate was negative for most of the period, thus stimulating the demand for credit and unproductive investments.

4 The government had a 25-year long-term loan facility for state owned enterprises. The rate was set at a level which was normally significantly less than the commercial banks' prime lending rate. Through this facility

arose from excess liquidity, as cheap credit extended to households and firms was invested in unproductive ventures at a rapidly expanding and ultimately unsustainable rate. Moreover, exchange rate policy failed to address this type of domestically generated inflation, and in 1989 the central bank abandoned its policy of direct intervention and low interest rates and allowed market forces to play a greater role in determining the level of interest rates.

To introduce market principles, interest rate ceilings and floors were abandoned, and commercial banks were allowed to set their own interest rates and bank charges and commissions in 1988. Bank of Botswana Certificates were introduced and open market operations commenced in 1991, and since then adjustment of the Bank Rate has been the principal instrument of monetary policy. In 1991 the Bank of Botswana acquired full operational control over the Bank Rate (previously interest rate adjustments had had to be agreed by the Government), and its autonomy was further strengthened by the 1996 Bank of Botswana Act. A succession of interest rate increases after 1988 resulted in positive real lending rates, but most deposit rates remained below the rate of inflation.

The Bank of Botswana does not have formal inflation targets, but the 1996 Bank of Botswana Act requires it to maintain "monetary stability", and only to promote economic development in so far as it is not inconsistent with this goal. Exactly what inflation rate the Bank interprets as a threat to "monetary stability" is unclear. Over the period 1990-2000 consumer price inflation has varied between 6% and 16% p.a., and in its 2001 Monetary Policy Statement the Bank of Botswana expressed the wish that inflation should fall initially to the average level for developing countries and ultimately to the level prevailing in developed countries, but did not set a timeframe for these objectives.

A relevant point is that Botswana's exchange rate regime is a peg to a basket of currencies. The exact composition of the basket is a closely guarded secret, but it broadly reflects Botswana's trade patterns, and the South African rand is known to have the greatest weight (South Africa supplies 80% of Botswana's imports).[5] Studies have

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the government became the dominant player in extending credit to the economy, and at negative real interest rates.

5 Officially the basket comprises the SDR and the currencies of Botswana's regional trading partners in unspecified proportions.

consistently shown that developing countries which peg their exchange rates tend to have lower inflation rates, especially if the peg is a "hard" peg, such as a currency board or a collective commitment such as the CFA (Bleaney and Fielding, 2002; Edwards, 1993; Ghosh *et al*., 1995). Bleaney and Fielding explain this in terms of a model in which developing countries, being poorer than developed countries, care relatively more about output and less about price stability, so that unless they import price stability through an exchange rate peg they tend to have higher inflation rates. Calvo and Reinhart's (2001) finding that currency crashes are much more inflationary in developing countries is consistent with this argument. In the case of Botswana, the capacity to import low inflation from developed countries has been limited by the weight of the (floating) South African rand in the currency basket, and also by the fact that the peg has been subject to devaluations in the past.[6] Moreover recent Monetary Policy Statements make it clear that the Bank of Botswana would be prepared to devalue if this were necessary to prevent real exchange rate appreciation.[7] Although there are relatively few restrictions on capital movements, interest rate policy does not appear to be significantly constrained by the exchange rate peg, because of a combination of thin bond markets, prudential restrictions on the exchange rate exposure of banks and pension funds, and exchange controls in South Africa.[8]

Figure 1 plots rates of inflation and the Bank Rate for the period 1976-2000. In the late 1980s real interest rates were negative, and nominal interest rates were tending to fall even though inflation was, if anything, increasing. After the change of policy in the late 1980s the adjustment of the Bank Rate to achieve positive real interest rates was quite dramatic. In order to curb inflationary pressures caused by a devaluation of the pula and a large fiscal expansion, the Bank Rate was raised steadily from 6.5% in 1989 to a peak of 14.25% in 1992. Since then the Bank Rate has fluctuated between 12.5% and 14.25%, whilst the inflation rate has declined steadily from its peak of 16% in 1992 to

6 The pula was revalued by 5% in June 1989, and devalued by 5% in August 1990 and again in August 1991. There was also a "technical adjustment" (effectively a devaluation) of 2.5% in June 1994. Between the end of 1996 and the end of 2000 the pula fell in value by 33.3% and the rand by 46.5% relative to the SDR, suggesting that the basket can be approximated as 70% rand and 30% SDR. Before 1997, however, the rand appears to have had virtually a 100% weight: between the end of 1994 and the end of 1996 the pula fell by 32.1% and the rand by 30.1% relative to the SDR.

7 The Monetary Policy Statements for the years 1999-2001 are available on the website: http://www.bankofbotswana.bw.

8 We report on formal tests of the role of South African interest rates (which have generally been higher than rates in Botswana) below. Portfolio investors in Botswana, such as pension funds, have invested in South Africa,

just over 6% in 1998, accelerating slightly in 1999 and 2000. Thus real interest rates have risen strongly since 1989.

Does the Bank of Botswana behave differently from central banks in developed countries? Before examining this question econometrically, we look at some basic statistics on interest rate adjustments. Table 1 shows the date and size of every Bank Rate adjustment from 1991 to 2000. Over this ten-year period there were nineteen interest rate changes, in five "runs" of the same sign: four increases, then two decreases, followed by three increases, five decreases and five increases. We may compare this with similar statistics for other countries. Over the period January 1996 to May 2001, the U.S. Federal Reserve made twelve changes, in three "runs", and the Bank of England 23 changes in five "runs". Thus the pattern of interest rate smoothing looks similar in Botswana to the U.S. and the U.K., with successive interest rate changes tending to be in the same direction (i.e. the number of "runs" is lower than would be expected if signs were random), but with some suggestion that adjustments occur less frequently.

There are greater differences in the typical size of interest rate adjustments. As Table 1 shows, the Bank of Botswana's median interest rate change was 0.5%, and adjustments of 0.25% occurred only five times out of nineteen. By contrast, the Federal Reserve and the Bank of England normally make adjustments of 0.25%, and appear to resort to larger adjustments only if a rate of 0.25% per month is deemed too slow. Of the Bank of England's 23 adjustments, 20 were of 0.25% and three of 0.5%, all of which occurred in the period October 1998 to February 1999 when interest rates were reduced in each month and by a total of 2% in five months. The Federal Reserve made seven 0.25% adjustments between January 1996 and March 2000, then raised rates by 0.5% in May 2000, reducing them by 1% in January 2001, and by 0.5% in March, April and May 2001. In summary, there is a tendency for the Bank of Botswana to make larger, somewhat less frequent Bank Rate adjustments, but otherwise to smooth interest rates in much the same way as in developed countries.[9]

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but exchange controls in South Africa limit the opportunities for South African borrowers to take advantage of the lower interest rates in Botswana.

9 One might also compare Botswana with Chile, a committed inflation targeter. Chile made 24 interest rate adjustments between January 1996 and July 2001, in six "runs", and eleven of these changes were of 0.25%, so Chile resembles the U.S. and the U.K. fairly closely.

III. THE CENTRAL BANK'S REACTION FUNCTION: SPECIFICATION AND ESTIMATION

This section specifies and describes a monetary policy reaction function for the Bank of Botswana. It is based on the assumption that the central bank has some autonomy over its monetary policy, which has been the case in Botswana since the late 1980s, and particularly since 1991 when the Bank acquired operational control of monetary policy.

Taylor's rule (1993) defines interest rate policy as a linear combination of lagged inflation and the output gap, although later work has shown that it is preferable to replace lagged inflation with an inflation forecast (Isard *et al*., 1999; Svensson, 1999). Subsequent research also suggests that the central bank may wish to place some weight on output deviations and (in a small open economy) on the exchange rate (Ball, 1999; Svensson, 2000). In practice, as mentioned in the previous section, central banks tend to prefer a series of smaller changes in interest rates to less frequent, larger changes, and this suggests a type of partial adjustment model in which interest rates only gradually move towards their new level. "Interest rate smoothing" of this kind is a prominent feature of the central bank reaction functions estimated by Clarida *et al*. (1998) for developed countries.

Since output data are only available annually for Botswana, we replace the output variable with the deviation of log real private sector credit from trend, since credit growth is described in the 2001 Monetary Policy Statement as "the Bank's key intermediate target variable" and the data are available monthly. Finally, in the case of Botswana, it may be appropriate to introduce a time trend into the reaction function, to allow for the fact that the target real interest rate has increased over time as the Bank sought to eliminate the legacy of financial repression. Thus the reaction function which we estimate can be expressed as:

$$R_t = \alpha + \beta R_{t-1} + \gamma \pi_{t,t-j} + \delta C_t + \eta S_t + \lambda RSA_t + \phi T + \varepsilon_t \qquad (1)$$

where R_t is the Bank Rate in month t; $\pi_{t,t-j}$ (+) is the annualised rate of consumer price inflation between periods t-j and t; C_t (+) is the deviation from trend of the log of credit to the private sector, deflated by the consumer price index; S_t (+) is the deviation of the log of the real rand-pula exchange rate from trend (an increase representing an

appreciation); *RSA* (+) is the South African discount rate; *T* (+) is time measured in months; and ε_t is a random error.[10] The signs in parentheses indicate the expected signs of the coefficients according to theory. Note the expected sign of the real exchange rate. In a country which floats its exchange rate, one would expect an appreciated exchange rate to be met by interest rate reductions (i.e. the coefficient is negative), reflecting the desire to avoid too much misalignment, and to influence capital flows to that end (as found by Parrado, 2001, for Chile). With a currency peg and limited capital flows, this channel does not operate; instead, since the nominal exchange rate is pegged, the real exchange rate variable effectively captures inflation differentials. If the monetary authorities care about international competitiveness, they will react more strongly to inflation shocks that are not matched by similar inflation shocks in the country's trading partners, and this difference in response should emerge as a *positive* real exchange rate coefficient.[11] Equation (1) assumes that the Bank reacts to inflation over the last *j* months, and theory does not tell us exactly what value *j* should take. We report results for three alternative values of *j*: 3, 6 and 12.

The partial adjustment coefficient (β) is expected to have a coefficient between zero and one. The long-run response of interest rates to any of the explanatory variables will be $1/(1-\beta)$ times the short-run response. Of particular interest is the long-run response of interest rates to inflation. For effective inflation targeting real interest rates must be positively correlated with inflation (Taylor, 1999). This requires that the long-run inflation coefficient in an interest rate reaction function exceed unity. Using data from 1979 to 1994, Clarida *et al*. (1998) estimate values of approximately 1.3 for Germany, 2.0 for Japan and 1.8 for the United States, but their graphical evidence suggests much lower coefficients for an earlier period. Parrado (2001) estimates a value of 3.0 for Chile under inflation targeting.

10 The real rand-pula exchange rate was calculated using the nominal rate and consumer price indices for the two countries. The trends in real private sector credit and the real exchange rate were estimated as the fitted values of a regression in logs on a constant and a time-trend.

11 That the Bank has some concern with competitiveness is indicated by the following sentences from the 2000 Monetary Policy Statement: "A reduction in inflation will help to support economic diversification by bringing greater stability to the macroeconomic environment within which investment decisions are made. An important aspect of the diversification effort is the need for Botswana to maintain competitiveness against its trading partners without having to resort to exchange rate devaluations."

IV. EMPIRICAL RESULTS

Table 2 presents estimates of equation (1) using six-month inflation rates from mid-1989 to the end of 1999. In regression (1), South African interest rates and the real exchange rate are omitted because they are statistically insignificant. The time trend implies an increase in interest rates of slightly over 0.5% p.a. for given values of the other regressors.[12] This reflects the Bank's commitment to raising real interest rates. The inflation and credit coefficients are positive and statistically significant, but not very high, implying long-run responses of about 0.5 percentage points to either a 1% inflation shock or a 10% credit shock. Although the equation is structurally stable, it exhibits poor diagnostics in terms of functional form and heteroscedasticity.

It is not plausible that the Bank would wish to push real interest rates above their 2000 levels as a long-term objective, but a linear time-trend implies this, so in regression (2) a quadratic term in time is included to capture the idea that the real interest rate adjustment was intended to be faster initially. The significant negative coefficient of time squared is consistent with this hypothesis, although the Chow statistic now indicates considerable structural instability (significant at the 0.1% level). To avoid the implication that the target real interest rate must eventually start falling again, a third specification is investigated in regression (3), in which there is a linear time trend up to the end of 1994 only, and then no trend. This fits the data slightly better than a continuous trend, but with structural instability (the Chow statistic is significant at the 5% level). In both regressions (2) and (3) the estimated long-run inflation coefficient is lower than in regression (1), at about 0.3 instead of 0.5. Finally, in regression (4) the real exchange rate and South African interest rates are included. These variables are not statistically significant, and their inclusion weakens the power of the Chow test, but the other diagnostics are still poor.

Given the poor diagnostics and the evidence of structural instability if data back to 1989 are used, we now investigate a shorter data period over which the real interest rate readjustment could be assumed to be complete. Accordingly, in Table 3, similar regressions are reported for the period January 1992 to December 1999, but with the time trend omitted. Table 3 reports results for different inflation measures. Note that the standard error of the regressions is much lower than in Table 2, indicating a much better

fit, and that the diagnostics are much improved. In regression (5), inflation over the past three months only is used. The inflation coefficient is significant at the 1% level, but the estimated long-run response is low, at only 0.12. The credit coefficient is also significant at the 1% level, but also implies a lower long-run response than in Table 2, with a 10% shock only moving interest rates by 0.27 percentage points. Adding inflation over the previous three months as an additional regressor (regression (6)) raises the estimated long-run response slightly to 0.14, and produces much the same results as if we use inflation over the previous six months as one variable (regression (7)). With twelve-month inflation (regression (8)), the results are also similar. Since regression (7) produces marginally the best fit, we focus on regressions using the six-month inflation measure.

Even taking into account private sector credit as a potential indicator of future inflationary pressures, the results in Table 3 indicate a very weak response of interest rates to any conceivable combination of inflation and credit shocks. For example, with real credit 20% above its historical trend together with an inflation shock of 3%, regression (7) implies an interest rate increase of only 0.9 percentage points. Such low coefficients are not consistent with stabilising inflationary expectations at low levels. These low estimated coefficients are nevertheless in accordance with recent experience: interest rates were only increased by 1.5% between March 1998 and March 1999, when private sector credit was growing at over 40% p.a. and inflation was beginning to increase also.

Finally Table 4 presents some further regressions for 1992-99 based on six-month inflation. In regression (9) a time trend is included to confirm that it is indeed statistically insignificant.[13] Regressions (10) and (11) include respectively the real exchange rate and the South African discount rate, but neither improves the fit, and only the real exchange rate has the predicted sign. Finally regression (12) tests for the possibility that the inflation response of interest rates is stronger when inflation is higher. If a central bank has an ill-defined inflation target, it may react more strongly when the inflation rate reaches uncomfortably high levels than to movements within the acceptable range. If this is the pattern, then the inflation rate will stay in the acceptable

12 Calculated as 0.00497 x 12 / (1-0.894).
13 The estimated time-trend is less than +0.1% p.a.

range most of the time and a linear response specification may produce a low coefficient, as in Tables 2 and 3.[14] Accordingly regression (11) includes the square of the inflation rate as a regressor, to test whether the inflation coefficient increases significantly at higher inflation rates. The coefficient is not statistically significant and in fact negative, contrary to the hypothesis.

V. IS MONETARY POLICY EFFECTIVE?

Do the channels of monetary policy work, in the sense that the policy instruments affect the intermediate target variables? The evidence suggests that they do. The correlation between the Bank Rate and commercial bank lending rates over the period January 1989 and December 1999 is 0.958, and we cannot reject the hypothesis that lending rates move one for one with the Bank Rate (t=1.60). Growth of bank credit is significantly negatively correlated with commercial bank lending rates (t= -2.78).

VI. CONCLUSIONS

Few developing countries satisfy the criteria necessary for estimating a central bank reaction function in the way that has been done for industrial countries, because of a combination of lack of monetary independence, instability of the policy regime, speculative exchange rate pressures, and paucity of data. Botswana has had a stable policy regime during the 1990s and a strong fiscal and external position, and raised real interest rates fairly rapidly to positive levels.

We have examined the behaviour of interest rates set by the Bank of Botswana since financial liberalisation in 1989. Interest rates are adjusted somewhat less frequently and by larger amounts than in developed countries (the median change is half of a percentage point rather than a quarter of a percentage point), but there is a similar pattern of interest rate smoothing, as evidenced by the tendency for successive interest rate adjustments to be of the same sign. Interest rates respond positively to deviations of real private sector credit from trend and to inflation. They do not respond significantly to variations in international competitiveness, nor to South African interest rates. There is little

14 There is an analogy here with models of non-linear mean-reversion in real exchange rates, in which there is near-random walk behaviour close to equilibrium but mean-reversion when misalignment is greater. In these models, the real exchange rate spends most of its time in the near-random walk region, only occasionally straying out of it before being pulled back, and this non-linearity emerges as random walk behaviour in linear tests (e.g. Bleaney and Mizen, 1996).

difference between the results for inflation rates over the previous three, six and twelve months.

Whatever the precise specification, however, the long-run response of interest rates to inflation is low (well below 0.5), which is much lower than in developed countries since 1979. The long-run response of interest rates to excess credit is also surprisingly low, given that this is described as "the Bank's key intermediate target variable". We have found no evidence that interest rates respond more rapidly or more strongly to inflation shocks when inflation is higher. We can discount the possibility that this is because monetary policy operates through channels other than interest rates, such as moral suasion, as observers agree that these are not significant.

The Bank's own Monetary Policy Statements suggest an inflation target somewhat below its current level, and our econometric results show that monetary policy responds to the inflation rate and to private sector credit growth. Why is the response so weak? We suggested earlier that poorer countries are more reluctant to sacrifice output for price stability. The Bank's explicit statement in 1999 that it was not raising interest rates further because of the impact on investment is consistent with this view. Although monetary stability is supposed to take priority over growth according to the 1996 Bank of Botswana Act, the low coefficients estimated here, and the reluctance of the Bank to pursue lower inflation more aggressively, suggest that the true priorities are more likely the reverse of this: that below a certain inflation level monetary stability is subordinate to growth. Various favourable influences have helped to hold inflationary expectations down and prevented this policy from collapsing: in particular the lack of a fiscal need for seigniorage revenue, the fact that there have been no high-inflation episodes in the past, and the short-run restraints on inflation from imports and the currency peg.

Given the low value of the estimated long-run coefficients, the Bank of Botswana cannot be characterised as engaging in an implicit form of inflation targeting. On the face of it there is a danger that inflation could accelerate and meet only an ineffective monetary response, although this danger is mitigated by the recent adoption of inflation targets of 3-6% p.a. by South Africa, since the rand has such a high weight in the currency basket to which the exchange rate is pegged. In future, therefore, Botswana has the opportunity effectively to import a low inflation target (conditional on no devaluation).

The econometric results presented above indicate that there are clear benefits for developing countries in a move to full-fledged inflation targeting. Even though monetary policy in Botswana fulfils the preconditions for effective inflation targeting in that it responds appropriately in direction to private sector credit and inflation shocks (and is not driven by fiscal deficits or external speculative pressures), the policy regime lacks transparency, and interest rate adjustments are inhibited by opposition from "the development lobby" which argues that they penalise investment. A more explicit inflation targeting regime would enhance the credibility of the central bank's stated inflation objectives and would ensure that price stability was the principal objective of monetary policy in deeds as well as in words.

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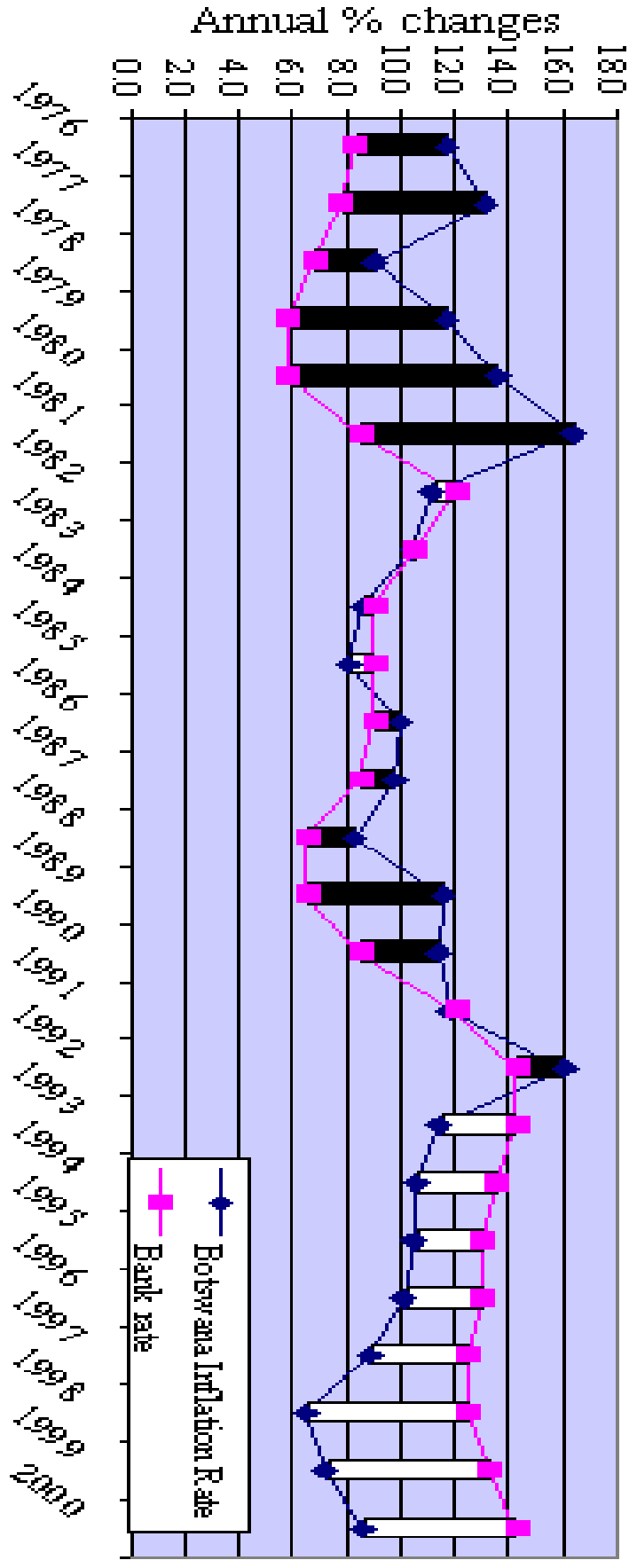

Figure 1 Interest Rate Policy

Table 1. Bank Rate Changes 1991-2000

Years	Number of changes	Max.	Min.	Dates of Changes New interest rate (%)			
1991	1	+2.00		Mar 12			
1992	3	+1.50	+0.25	Mar 13.5	May 14	Aug 14.25	
1993	0						
1994	4	+0.25	-0.75	Jan 13.5	Feb 13	Jul 13.25	Aug 13.5
1995	3	+0.50	-0.50	Feb 14	Sept 13.5	Dec 13	
1996	0						
1997	1		-0.50	Feb 12.5			
1998	3	+0.75	-0.25	Jan 12	Mar 11.75	Sept 12.5	
1999	2	+0.50	+0.25	Jan 12.75	Mar 13.25		
2000	2	+0.50	+0.50	Feb 13.75	Oct 14.25		

Table 2. An Interest Rate Reaction Function with Time Trends, 1989-99

Dependent variable: Bank Rate

Regression:	(1)	(2)	(3)	(4)
Constant	0.478 (1.67)	0.813∗ (2.53)	0.728∗ (2.45)	0.400 (0.61)
Lagged Bank Rate	0.894∗ (29.8)	0.800∗ (15.3)	0.846∗ (19.2)	0.832∗ (16.8)
Inflation *t-6* to *t*	0.0511∗ (2.55)	0.0573∗ (2.88)	0.0515∗ (2.69)	0.0517∗ (2.71)
Real private sector credit	0.590 (1.89)	1.04∗ (2.81)	0.745∗ (2.23)	1.026∗ (2.71)
Real exchange rate				−1.533 (–0.93)
South African discount rate				0.0255 (1.06)
Time trend	0.00497∗ (2.30)	0.0276∗ (2.60)		
Time trend squared x 10^{-3}		–0.135∗ (–2.18)		
Time trend up to end-1994			0.0122∗ (2.53)	0.0139∗ (2.83)
Implied long-run response to 1% inflation shock	*0.48*	*0.29*	*0.34*	*0.31*
Implied long-run response to 10% credit shock	*0.56*	*0.52*	*0.49*	*0.61*
No. of observations	126	126	126	126
R-squared	0.967	0.969	0.968	0.969
Standard error	0.422	0.415	0.420	0.417
Chow statistic	1.83	6.70∗	2.51∗	1.93
Serial correlation	14.79	13.03	12.91	17.37
Functional form	6.40∗	7.44∗	9.33∗	6.83∗
Heteroscedasticity	5.20∗	4.86∗	5.02∗	4.74∗

Notes: Figures in parentheses are *t*-statistics. ∗ denotes statistically significant at the 0.05 level. For precise definition of variables see text. Diagnostic tests are chi-square statistics. Serial correlation is an LM test with 12 degrees of freedom. Functional form is a RESET test based on the squares of the fitted values (1 d.f.). Heteroscedasticity is based on the correlation between the squared residuals and squared fitted values (1 d.f.). The Chow statistics refer to a break at the end of 1993, and the 5% critical values for the first three columns are respectively 2.29, 2.96, 2.29 and 2.10.

Table 3. An Interest Rate Reaction Function without Time Trends, 1992-99

Dependent variable: Bank Rate

Regression:	(5)	(6)	(7)	(8)
Constant	2.52∗ (4.30)	2.69∗ (4.44)	2.76∗ (4.63)	2.97∗ (4.74)
Lagged Bank Rate	0.791∗ (17.4)	0.774∗ (16.1)	0.768∗ (16.2)	0.749∗ (14.6)
Real private sector credit	0.568∗ (2.76)	0.559∗ (2.71)	0.567∗ (2.76)	0.573∗ (2.76)
Inflation *t-3* to *t*	0.0250∗ (3.17)	0.0211∗ (2.44)		
Inflation *t-6* to *t-3*		0.0103 (1.10)		
Inflation *t-6* to t			0.0320∗ (3.29)	
Inflation *t-12* to *t*				0.0337∗ (2.91)
Implied long-run response to 1% inflation shock	*0.12*	*0.14*	*0.14*	*0.13*
Implied long-run response to 10% credit shock	*0.27*	*0.25*	*0.24*	*0.23*
No. of observations	96	96	96	96
R-squared	0.890	0.892	0.891	0.889
Standard error	0.267	0.267	0.266	0.269
Serial correlation	14.14	14.15	13.21	9.42
Functional form	0.00	0.05	0.09	0.42
Heteroscedasticity	0.68	0.75	0.74	0.41

Notes: Figures in parentheses are *t*-statistics. ∗ denotes statistically significant at the 0.05 level. For precise definition of variables see text. Diagnostic tests are chi-square statistics. Serial correlation is an LM test with 12 degrees of freedom. Functional form is a RESET test based on the squares of the fitted values (1 d.f.). Heteroscedasticity is based on the correlation between the squared residuals and squared fitted values (1 d.f.).

Table 4. Further tests on the estimated equation 1992-1999

Dependent variable: Bank Rate

Regression:	(9)	(10)	(11)	(12)
Constant	2.52∗ (3.53)	2.83∗ (4.63)	2.83∗ (3.22)	2.74∗ (4.58)
Lagged Bank Rate	0.774∗ (16.0)	0.760∗ (15.4)	0.765∗ (13.6)	0.759∗ (15.3)
Inflation *t-6* to *t*	0.0385∗ (2.64)	0.0352∗ (3.14)	0.0323∗ (3.20)	0.0600 (1.37)
Real private sector credit	0.590∗ (2.82)	0.539∗ (2.55)	0.558∗ (2.55)	0.586∗ (2.82)
Time trend	0.00112 (0.59)			
Real exchange rate		0.757 (0.57)		
South African discount rate			–0.0019 (–0.11)	
Inflation t-6 to t squared				–0.00125 (–0.65)
Implied long-run response to 1% inflation shock	*0.17*	*0.14*	*0.14*	*n.a.*
Implied long-run response to 10% credit shock	*0.26*	*0.22*	*0.24*	*0.24*
No. of observations	96	96	96	96
R-squared	0.892	0.892	0.891	0.892
Standard error	0.267	0.267	0.267	0.267
Serial correlation	15.19	12.55	13.01	12.98
Functional form	0.04	0.13	0.08	0.03
Heteroscedasticity	0.93	0.92	0.72	0.78

Notes: Figures in parentheses are *t*-statistics. ∗ denotes statistically significant at the 0.05 level. For precise definition of variables see text. Diagnostic tests are chi-square statistics. Serial correlation is an LM test with 12 d.f.s. Functional form is a RESET test based on the squares of the fitted values (1 d.f.). Heteroscedasticity is based on the correlation between the squared residuals and squared fitted values (1 d.f.).

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