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Asymmetries in the Effects of Monetary Policy: The Case of South Africa

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Abstract

PPP is unlikely to hold instantaneously for all commodities across the different regions of a monetary area. It is therefore possible that monetary expansions or contractions will have different effects in different regions, if there are regional asymmetries in the monetary transmission mechanism. We estimate the size of such asymmetries across the nine provinces of South Africa over the period 1997-2005. There are large and statistically significant differences in the response of prices to monetary expansions and contractions.

Keywords: Inflation, monetary union, South Africa, transmission mechanism

JEL classification: E31, E50, O11

1. Introduction

Renewed interest in the economics of monetary union, following the formation of the European Monetary Union, has generated a number of papers examining the potential costs of a single monetary area when different parts of the area are subject to asymmetric shocks, or when there is heterogeneity in the monetary transmission mechanism. For example, recent papers on transmission mechanism heterogeneity in the Euro Zone include Fountas and Papagapitos (2001) and Mihov (2001). A similarly motivated paper by Haug *et al*. (2003) examines differences in the response of output and inflation to interest rate changes in Australia and New Zealand with a view to assessing the costs and benefits of a hypothetical Australasian monetary union.

The concerns about transmission mechanism heterogeneity are not limited to international monetary unions. They are equally applicable to individual countries in which there are regional differences in the response of macroeconomic variables to changes in monetary policy. The theory of optimal monetary policy is founded on the idea of maximising the welfare of a representative agent, as in the type of model exemplified by Khan *et al*. (2002). Real-world monetary policy targets make reference to the rate of inflation of a national consumer price index, that is, the rate of growth of the cost of living for a "typical" consumer. But if consumers in different regions face different prices then concerns about the distribution of inflation rates resulting from a given monetary policy become relevant.

Transmission mechanism asymmetries in prices are likely to be larger in economies where markets are less developed, with less arbitrage across regions. So this problem is likely to be at least as relevant to development macroeconomics as it is to the macroeconomics of industrialized countries. In this paper we use data from the Republic of South Africa to measure the size of transmission mechanism asymmetries across regions. The asymmetries turn out to be large, which brings in to question the existing monetary policy based on an aggregate national inflation target.

2. Monetary Policy in South Africa

Since the democratic reforms of 1993, South Africa has been divided into nine provinces: Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, North West, Northern Cape and Western Cape. These regions are depicted in Figure 1. South Africa forms a contiguous geographical area, bounded to the south by coastline, to the north-west by Namibia and Botswana and to the north-east by Zimbabwe, Swaziland and Mozambique. The independent state of Lesotho lies entirely in the interior of South Africa, bounded by the Eastern Cape, the Free State and KwaZulu.

The nine provinces encompass a wide variety of demographic and socio-economic characteristics, as indicated by Tables 1-2. Provincial population densities vary from two people per square kilometre in the Northern Cape to over 450 in Gauteng, the province made up by the Johannesburg / Pretoria region. *Per capita* GDP levels also vary substantially, Gauteng's being by far the highest, as do life expectancy rates. The low correlation between income and life expectancy in different provinces reflects complexities in the epidemiology of HIV and malaria infections.

South Africa constitutes a single monetary area. The Rand circulates in all parts of the country (as it does in many of the countries bordering South Africa). Recognising that South Africa is a relatively small open economy, the Reserve Bank enacts policy ultimately designed to stabilize the exchange rate. Since 2000, this objective has been pursued through an explicit inflation target:

"The primary objective of monetary policy is to protect the value of the currency in order to obtain balanced and sustainable economic growth in the country… It requires the achievement of financial stability, i.e. price stability as well as stable conditions in the financial sector as a whole."[1]

Current Reserve Bank monetary policy is based on adjustment of the interest rate on its repurchase transactions, although in the recent past it has made reference to a wider range of policy instruments. Because the focus on the interest rate is a recent phenomenon, this paper will be concerned mainly with the inflationary effects of an intermediate monetary variable, that is, the stock of M1. Although the Reserve Bank does not control M1 directly, it can influence the money supply through a variety of conventional policy instruments.

There is a national money market in South Africa: there are no restrictions on the movement of capital between provinces. Indeed, much of the money stock consists of liabilities of banks that are not specifically located in any one province. No regional disaggregation of M1 is economically meaningful, and no direct or intermediate monetary policy instrument operates at a provincial level. Nevertheless, as we shall see, consumer price indices *do* vary from one region to another. This is due partly to regional variation in the weights on different commodities (because, for example, of regional differences in average income levels), but the variation in weights is typically quite small. The main reason for the variations in consumer prices indices is the absence of complete arbitrage for certain kinds of goods and services. South Africa is a large country: inter-provincial transport costs for low-value items (such as staple foods) can be substantial, as can regional variations in the value of real estate.

Given the absence of arbitrage and the economic heterogeneity of South Africa's provinces, there is an *a priori* case for considering the extent to which monetary expansions or contractions have a heterogeneous impact in different parts of the country. For example, regional variations in the degree of price inertia might lead to regional variations in the size of the initial response of

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[1] Appendix to the Statement of the Monetary Policy Committee (6th April 2000).

inflation to a change in monetary policy. It then remains to be seen for how long the variations persist. Large and persistent variations may mean that monetary policy needs to be based on a social welfare function that permits a richer characterisation of the economy than one based on fiction of the representative consumer.

3. The Empirical Model

In this section we present an empirical model of the factors driving provincial prices in South Africa. Our main interest is in the impact on prices of monetary expansions and contractions. Before we begin to describe the model, a point of clarification is in order. Our sample period spans a substantial change in the conduct of monetary policy in 2000: it is highly unlikely that there is a stable Reserve Bank policy reaction function over the whole of the period.[2] Our model is fitted to the data in a way that allows us to remain agnostic about the factors driving monetary policy changes. This model is then used as the basis for simulations, but these simulations are *not* conditioned on a certain monetary policy rule specifying feedback from income and price changes. Rather, we perform simulations based on a given hypothetical change in policy, without feedback. Our interest is in the way in which purely hypothetical changes in policy impact on prices, rather than in tracing the impact of policy "shocks".

Our empirical model of provincial prices is constrained by the availability of relevant data published by the Reserve Bank of South Africa and Statistics SA. Monthly and quarterly provincial price data are available only from 1997, Aggregate price, money supply and real income data are available for a longer period, but income is measured only at the quarterly frequency. In order to build a long-run money demand function into our empirical model in a coherent way we make use of both the quarterly data, to estimate the long-run elasticity of money demand, and the monthly data, to estimate the short-run price dynamics, subject to the long-run constraints implicit in the money demand equation. We first clarify the nature of the data available and then outline the structure of the model.

The following monthly time-series data are available for South Africa. The first of these, p_t^i, is reported for the period 1997m1-2005m2. The others are reported for a longer period.

1. The urban consumer price index (p_t^i, $I = 1,\ldots,9$) for all nine provinces. p_t^i is constructed as a weighted average of the prices of consumer goods sold in urban areas in each province. (Note however that the consumers need not be resident in urban areas; many will commute to town to make purchases.) The weights on individual commodities change periodically.

[2] Aron and Muellbauer (2005) discuss the complexities of South African monetary policy.

2. The national urban consumer price index (p_t^{AG}). This is a weighted average of the p_t^i; again the weights change periodically.
3. The volume of M1 at the *end* of the last working day in month t (m_t). This timing will be important in the identification of our model.
4. An index of national industrial production (q_t).

Quarterly averages of p_t^{AG}, q_t and m_t, denoted P_t^{AG}, Q_t and M_t, are reported for a much longer period (1982q1-2004q4). So also is real gross domestic expenditure (Y_t).

Using standard stationarity tests, the null that $\ln(Y_t)$ is I(1) cannot be rejected; but neither can the null that it is I(0). The same is true of $\ln(M_t) - \ln(P_t^{AG})$. So we estimate the long-run money demand equation on quarterly data using an ARDL specification of the form

$$\Delta[\ln(M_t) - \ln(P_t^{AG})] = \kappa.\Delta\ln(Y_t) - \eta.[\ln(M_{t-1}) - \ln(P_{t-1}^{AG}) - \mu_M] - \theta.(Y_{t-1} - \mu_Y) + u_t \qquad (1)$$

where μ_M and μ_Y are the mean values of $\ln(M) - \ln(P^{AG})$ and $\ln(Y)$ respectively, and u_t is a regression residual.[3] This regression is reported in Table 3, along with diagnostic test statistics indicating that u_t is well behaved. Pesaran *et al*. (2001) provide a range of critical values for an F-test of the joint null that $\eta = \theta = 0$, i.e., there is no long-run relationship between the variables. The lower bound of the range of critical values corresponds to the assumption that all variables are I(0); the upper bound corresponds to the assumption that they are all I(1). Our F-statistic (4.28) exceeds the upper bound of the relevant 5% critical value, so there is evidence for some long-run relationship. The implicit long-run elasticity income of money demand is 2.61.

Our short-run price dynamics are estimated by fitting a model to monthly data, the unrestricted version of which is a conditional VAR in provincial price inflation rates:

$$\boldsymbol{B}(L)\,\Delta\ln(\boldsymbol{p}_t) = s_t + \beta_1(L)\,\Delta\ln(m_{t-1}) + \beta_2(L)\,\Delta\ln(y_{t-1}) + \boldsymbol{\alpha}\,ECM_{t-1} + \boldsymbol{v}_t \qquad (2)$$

where s_t is a seasonally varying intercept and $\boldsymbol{v}_t$ is a vector of regression residuals. $\boldsymbol{P} = [p^1,\ldots, p^9]'$ is a vector of the nine monthly provincial price series. y is a monthly interpolation of the quarterly real income series using the monthly variation in the industrial production series: $y_t = 0.25\cdot[q_t / Q_t]\cdot Y_t$. $\boldsymbol{B}(L)$ is a 9 × 9 matrix of lag polynomials; $\beta_1(L)$ and $\beta_2(L)$ are 1 × 9 vectors of lag polynomials; $\boldsymbol{\alpha}$ is a 1 × 9 vector of constants. Standard ADF tests indicate that $\ln(m)$, $\ln(y)$ and all elements of $\boldsymbol{p}$ are at least difference-stationary. *ECM* is the equilibrium correction term $[\ln(m) - \ln(p^{AG})^* - 2.61\cdot\ln(y)]$, where $\ln(p^{AG})^*$ is an approximation to $\ln(p^{AG})$ with time-invariant weights on the logs of the different provincial price indices, so that we have a model that is linear in lags of the provincial

[3] Lags of $\Delta\ln(y)$ and $\Delta[\ln(m) - \ln(p)]$ are statistically insignificant.

price levels. The weights are indicated in Table 4; the correlation coefficient for $\Delta\ln(p^{AG})^*$ and $\Delta\ln(p^{AG})$ is over 96%.

We should not expect large values for the α coefficients. Figure 2 depicts the three series $\Delta\ln(p_t^{AG})$, $\Delta\ln(m_t)$ and $\Delta\ln(y_t)$. It can be seen from the figure that the variation in aggregate inflation is much smaller than the variation in either money growth or output growth. (On the other hand, Table 5 shows that the variation in inflation rates does not differ greatly from one province to another.) This suggests that any response of prices to changes in the money supply will be marked by a considerable degree of inertia. It remains to be seen precisely how large this inertia is, and how much asymmetry is exhibits across provinces.

Equation (2) implies that provincial prices will adjust in response to disequilibrium in the money market, captured by *ECM*, but it does not imply that all prices will necessarily respond at the same rate. Nor does it embody any long-run PPP condition across the different elements of $\boldsymbol{p}$. When standard ADF tests are applied to the 36 bilateral provincial real exchange rate series $\ln(p^i / p^j)$ across the nine provinces, there is just one, probably spurious case (Eastern Cape – Mpumalanga) in which the ADF statistic exceeds the 5% critical value. Figure 3 illustrates eight of these bilateral real exchange rates, in each case depicting prices relative to those in the Free State. In each case the relative price series appears to be drifting upwards with no apparent mean reversion, at least within our sample period. We do not impose the restriction that changes in m have a uniform long-run effect on all of the provincial price series. A 1% increase in m will lead eventually to a 1% increase in p^{AG}, but some of the provincial elements of p^{AG} may rise more than others.

Despite the absence of PPP, there is a high correlation of inflation rates across the nine provinces (Table 6). Prices in each region appear to be driven largely by common shocks, despite the fact that they do not converge in the long run.

Equation (2) is to be interpreted as part of a reduced-form VAR in y and the elements of $\boldsymbol{p}$; corresponding this reduced-form representation is an unidentifiable structural model embodying instantaneous interactions between y_t and the different p_t^i. However, it is reasonable to suppose that m_t has no impact on $\boldsymbol{p}_t$ or y_t: remember that $\boldsymbol{p}_t$ and y_t measure prices and income *during* month t, whereas m_t is a stock variable measuring the money supply at the *end* of the last working day of month t. Moreover, m_{t-1} is weakly exogenous to all period t variables, so the impact of changes in m on the system will be identified, and the fitted coefficients can be used to trace out the effect on prices of a hypothetical exogenous change in m. (If we fitted an additional equation for $\Delta\ln(m_{t-1})$ then we could trace out the effect of structural shocks to m in the system. However, our policy analysis will not be concerned with the effects of monetary *shocks*, allowing for feedback from $\boldsymbol{p}$ to m; rather, it will be concerned with the effects of a hypothetical *change* in policy that is designed to cause a permanent rise or fall in m by a certain value.)

Estimates of the parameters in the unrestricted system in equation (2) are not reported here. There are many nuisance parameters in the unrestricted model, so instead we report in Table 7 the result of fitting a parsimonious version of equation (2) that minimizes the Schwartz-Bayesian Information Criterion.[4] The diagnostic statistics included in the table indicate that $\boldsymbol{v}_t$ is well behaved. There is a marked symmetry in this version of the model. Shocks to the nine equations are highly correlated (Table 8): conditioning on money and lagged prices picks up only a small fraction of the unconditional correlation between inflation rates noted above. No lag of income growth is significant in any equation. The only lag of money growth that is significant in any of the price equations is $\Delta\ln(m_{t-2})$, and this term is significant in all nine equations. The only lagged price that is significant in any of the equations is $\Delta\ln(p_{t-1}^{\text{KwaZulu}})$, and again this term is significant in all nine equations. ECM_{t-1} is significant only in the equation for inflation in KwaZulu, where it is has a predictably small coefficient (0.0034): prices take a long time to adjust in response to a change in m. Since the interactions of the different prices are captured only in reduced form, one should be cautious in placing any economic interpretation on this structure. Nevertheless, the results are consistent with the interpretation that KwaZulu is in some sense the "lead" region, in that the effects of global price shocks are typically felt there before they have an impact in other parts of South Africa.

It can be seen from Table 7 that there are marked differences in the size of the coefficients on $\Delta\ln(m_{t-2})$ in different provinces. These differences imply provincial asymmetries in the immediate effect of changes in the money supply on inflation and (in the absence of inter-provincial PPP) on prices in the long run. Such asymmetries are best illustrated graphically, so Figures 4-7 illustrate the impact on provincial inflation and prices of a permanent, exogenous unit increase in $\ln(m)$.

Figure 4 illustrates the effects on inflation in the two regions that are most and least affected by the monetary expansion, that is, Mpumalanga and the Free State respectively. The figure shows how inflation can be expected to evolve over the 12 months following the monetary expansion (months t+2 to t+13), with two-standard-error bars around the point estimates. It can be seen that there is a significant difference in the inflation responses in the two regions in the first couple of months, although beyond this point the typical "butterflying" of the error bars renders the differences insignificant. Table 9 shows the effect of the monetary expansion in month t+2 in all nine provinces. It can be seen that there is a group of "high inflation" provinces (Gauteng, Eastern Cape, Mpumalanga) whose responses are all significantly higher than another group of "low inflation" provinces (Free State, Northern Cape). The relative magnitudes of all the inflation

[4] The nine equations in the model are estimated simultaneously by Maximum Likelihood. These estimates differ slightly from OLS estimates, because the *ECM* term appears in only one equation.

responses are shown in Figures 5-6, which depict the inflation in each province *in excess* of that in the Free State over the first 12 months following the monetary expansion.

The differences in inflation correspond to long-run differences in price levels: the monetary expansion changes all of the provincial real exchange rates. Figure 7 shows the magnitude of the changes in the real exchange rates. In the provinces where there is most inflation (Mpumalanga, Eastern Cape and, in the long run, KwaZulu), the real exchange rate relative to the Free State can be expected to rise by over 10%.

These differences should be of serious concern to monetary policy-makers. There are sharp asymmetries in the consequences of a change in monetary policy in different parts of South Africa. If some exogenous shock raises all provincial prices by 10%, a "stabilizing" monetary contraction designed to bring national prices back to their initial level will result in a fall in some provincial prices below their initial level, while prices in other provinces will remain high. A first-best solution to this problem would involve the manipulation of province-specific monetary (or, more likely, fiscal) instruments. A second-best solution would at least be based on an objective function that eschewed the fiction of the representative agent in favour of a target that explicitly recognised the regional distributional consequences of monetary policy interventions.

The causes of provincial asymmetries remain to be investigated. However, we can already point to a number of salient facts. First, there is some spatial correlation in the of inflation responses. In Figure 1, those four provinces with the largest inflation responses are marked in dark grey and those four with the smallest in light grey. (The median province, Western Cape, is excluded from both groups.) Low-inflation provinces all lie in the interior of the country, and along its northern border. Secondly, while this spatial correlation may have a number of explanations, it is noteworthy that there is a significantly positive relationship between the size of the immediate inflation response in a province (Table 9) and its population density (Table 1). The Spearman rank-order correlation coefficient for these two variables is 0.67. One potential line of research is to investigate whether a monetary expansion is felt with more force in regions where markets are larger or where the average consumer has less distance to travel to the nearest market.

4. Conclusion

We have seen that while inflation rates across South African provinces are highly correlated, because the different provinces face common shocks, there is no discernable long-run convergence of price levels; that is, there is no inter-provincial PPP. Moreover, there is marked heterogeneity in the immediate response of provincial prices to monetary expansions and contractions. This means that changes in monetary policy lead to substantial and persistent changes in relative prices. It is important that these effects do not lie outside the objective function of the monetary policy-maker.

Monetary policy based solely on targets for on national macroeconomic aggregates is unlikely to be optimal.

The underlying causes of the heterogeneity are a pressing topic for future research. It is possible that prices are more flexible and responsive to monetary expansions and contractions in more densely populated areas, where markets are closer together and transport costs are perhaps lower. It also remains to be seen whether the magnitude of the heterogeneity that appears in South Africa is replicated elsewhere. If it does, then we should begin to view nation states as monetary unions, rather than as homogeneous macroeconomic entities.

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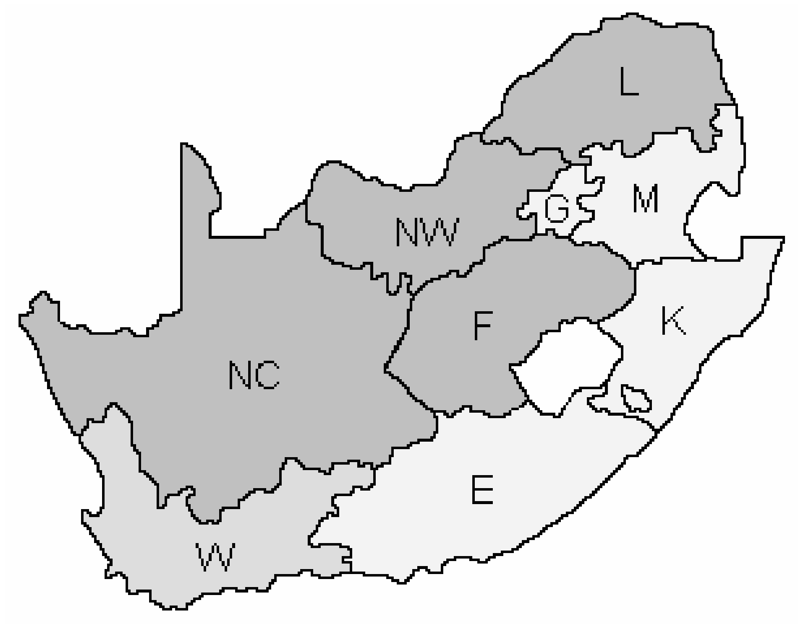
Figure 1: South African Provinces



E: Eastern Cape
F: Free State
G: Gauteng
K: KwaZulu-Natal
L: Limpopo
M: Mpumalanga
NC: Northern Cape
NW: North West
W: Western Cape

Figure 2: Monthly Growth Rates of Aggregate Price, Money and Real Income

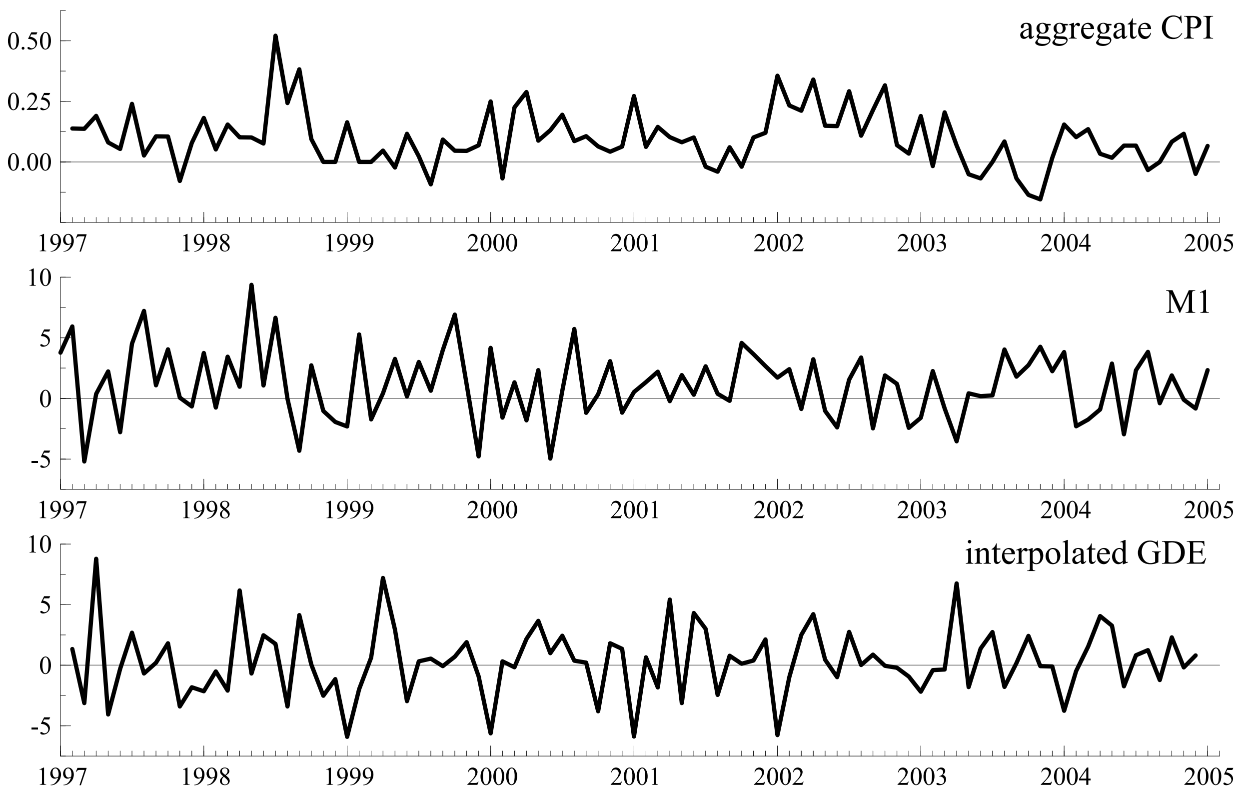


Figure 3: Monthly Provincial Consumer Price Indices Relative to the Free State, 1997-2005

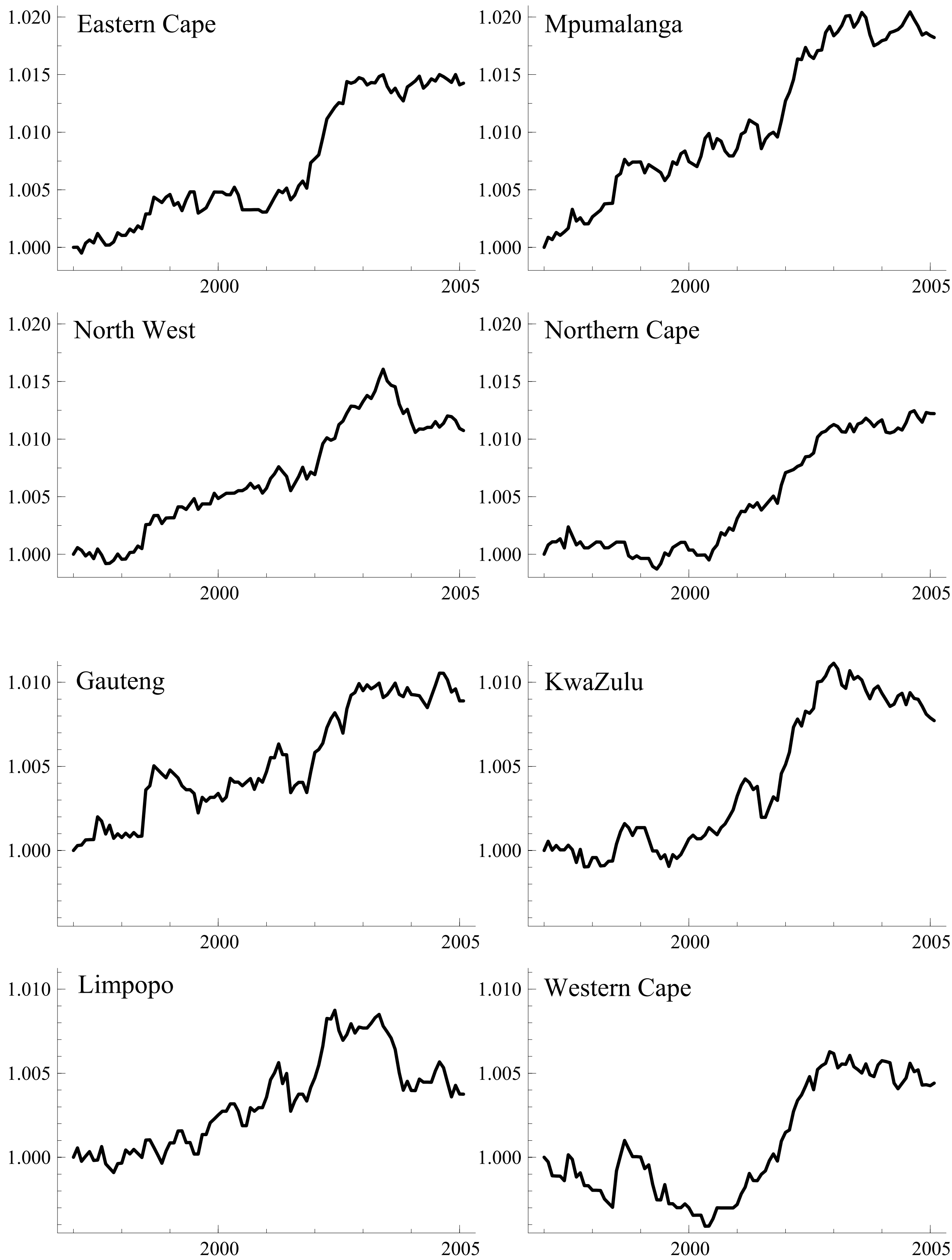


Figure 4: 12-Month Inflation Response to a Unit Increase in M1 in Mpumalanga and the Free State (in Percent with Two-Standard-Error Bars)

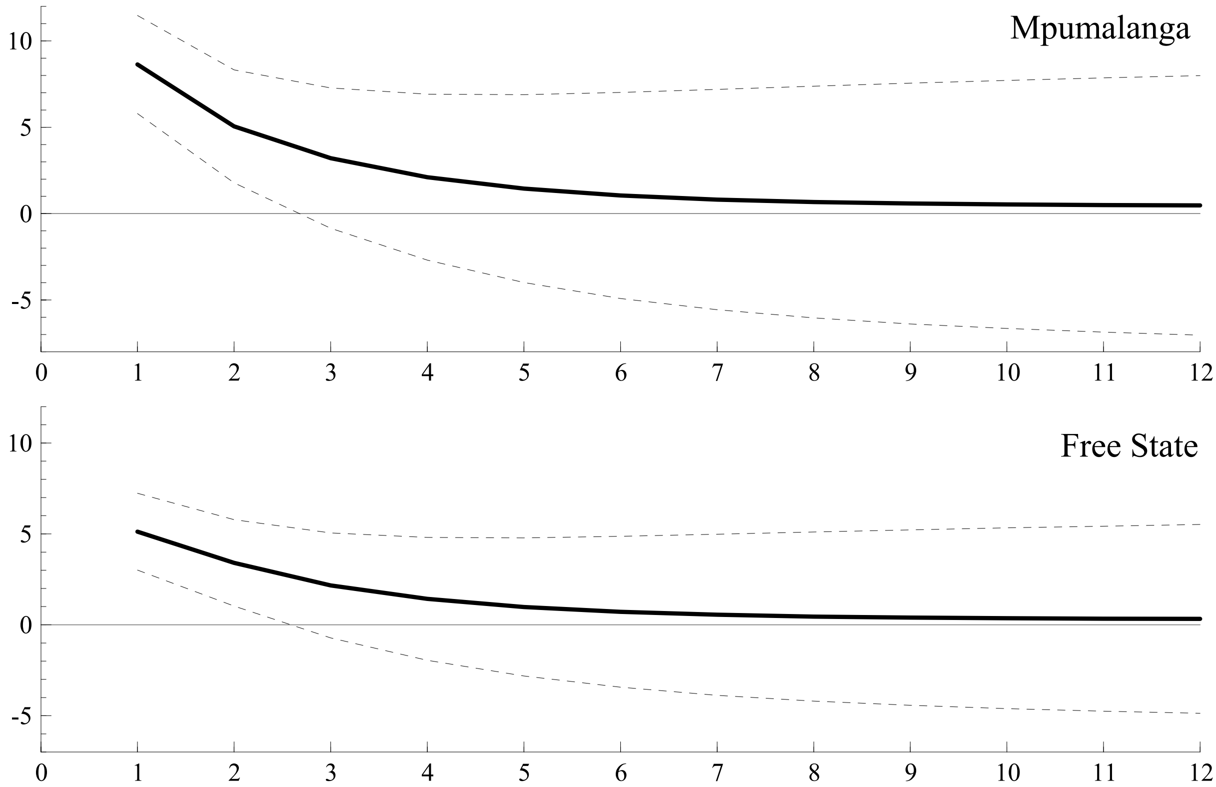


Figure 5: 12-Month Inflation Response (Relative to the Free State) with a Unit Increase in M1

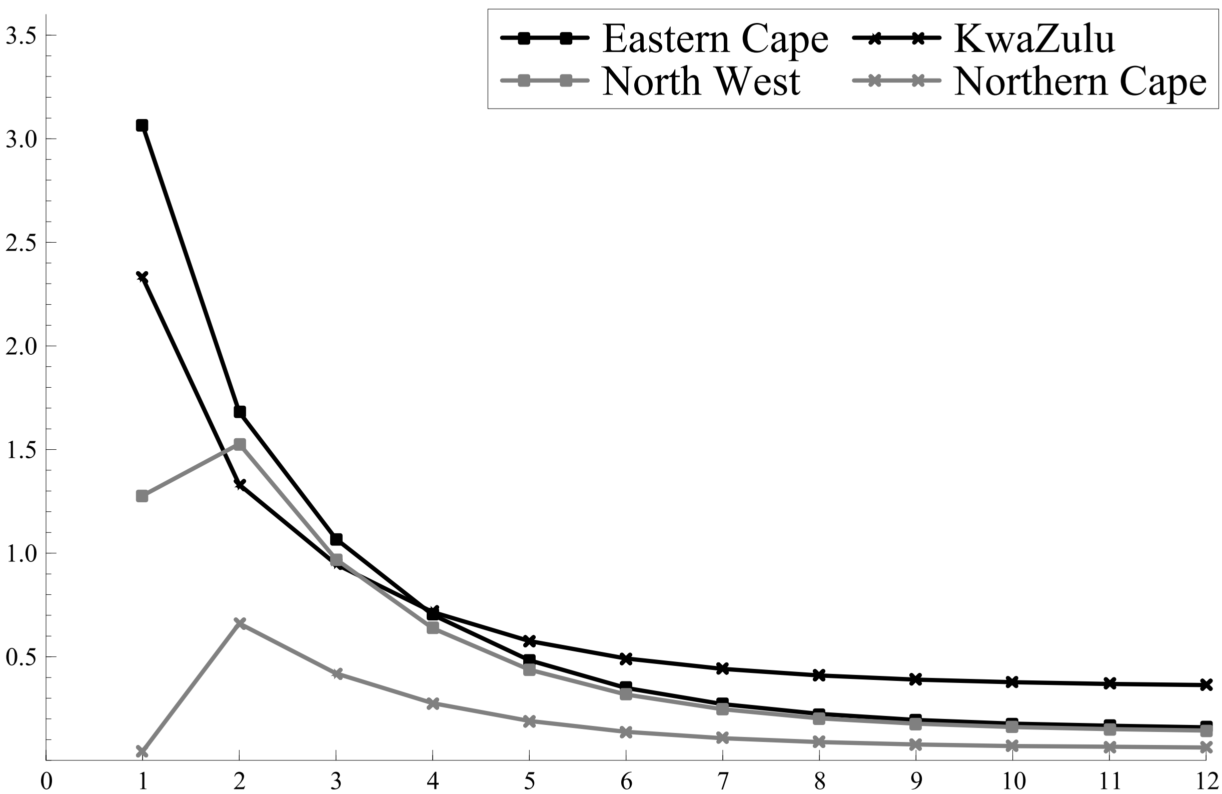


Figure 6: 12-Month Inflation Response (Relative to the Free State) with a Unit Increase in M1

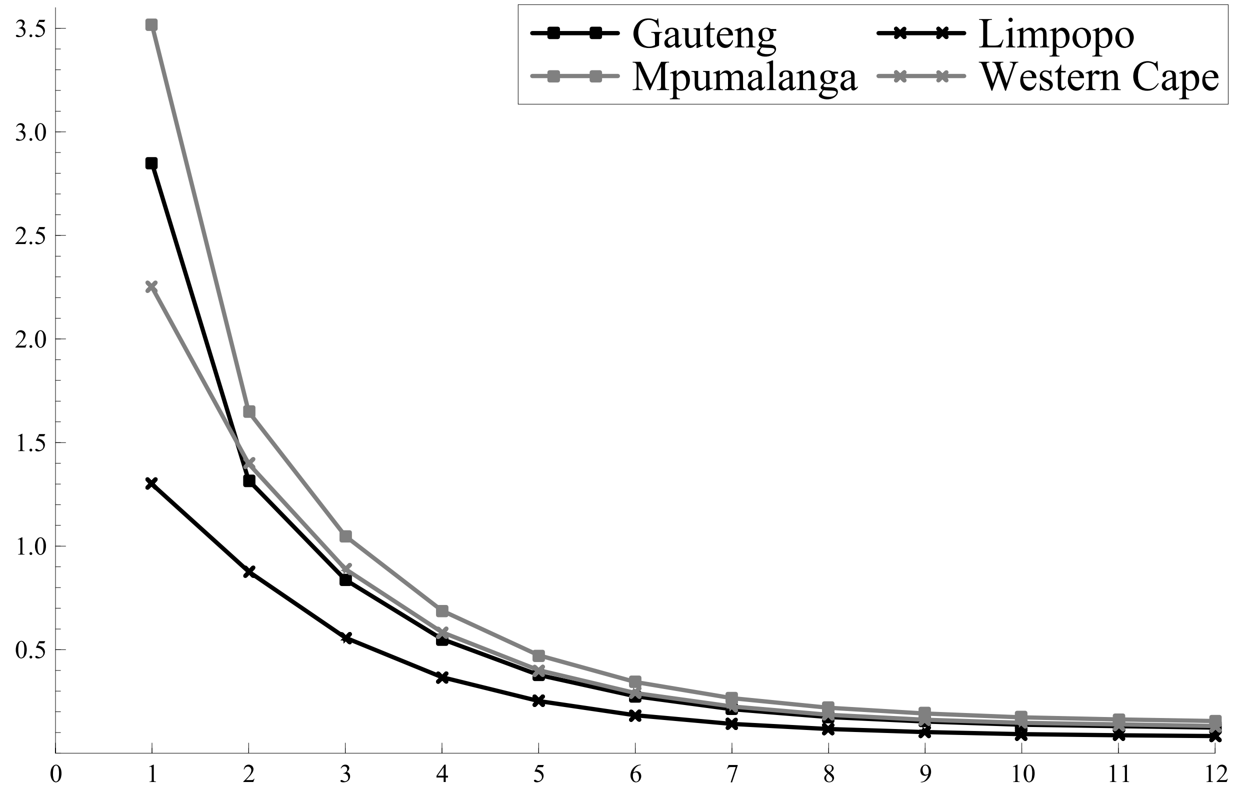


Figure 7: Real Exchange Rates with the Free State over 20 Months Following a Unit Increase in M1

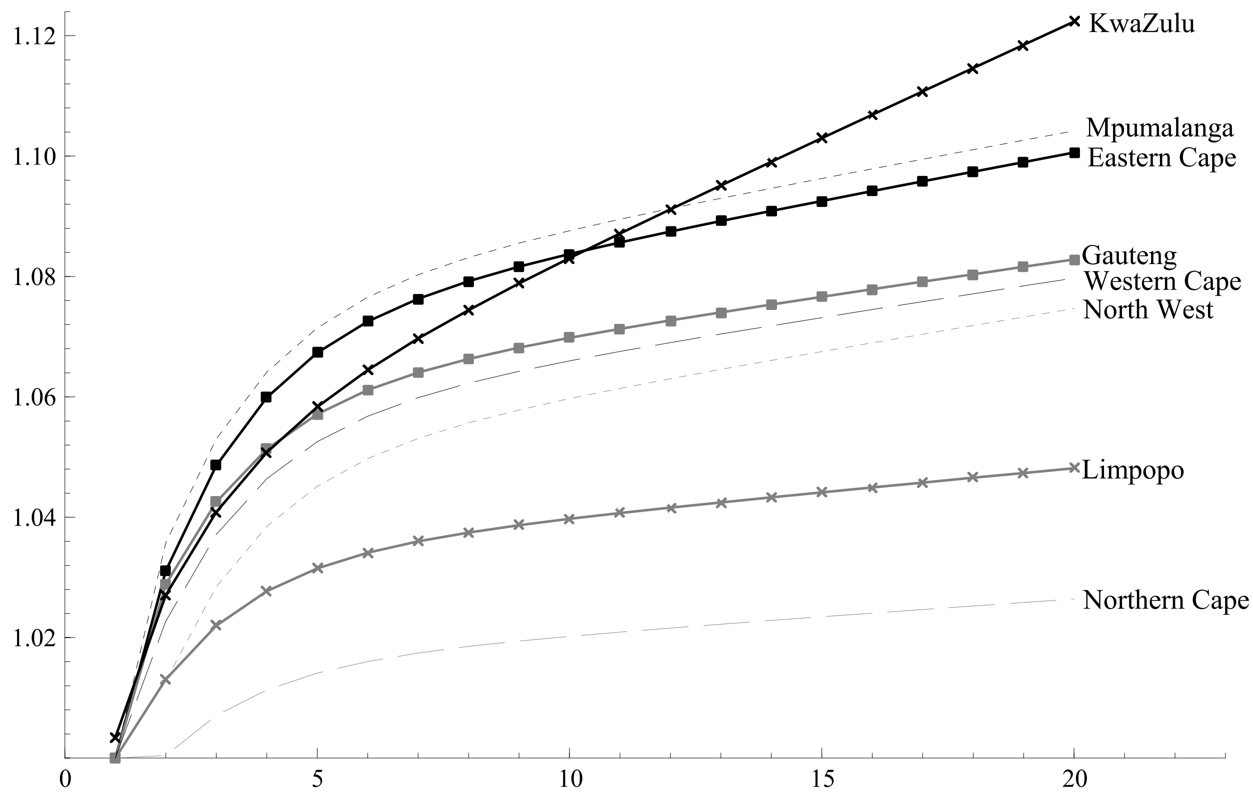


Table 1: Provincial Demographic Statistics for 1999 (Source: Statistics SA)

	Area (km^2)	Population (thousands)	Density (persons per km^2)	Percent urban
Eastern Cape	169,580	6,769	40	36.6
Free State	129,480	2,813	22	68.6
Gauteng	17,010	7,778	457	97.0
KwaZulu	92,100	9,003	98	43.1
Limpopo	123,910	5,310	43	11.0
Mpumalanga	79,490	3,000	38	39.1
Northern Cape	361,830	2,890	2	70.1
North West	116,320	3,592	31	34.9
Western Cape	129,370	4,171	32	88.9

Table 2: Provincial Socio-economic Statistics (Source: Statistics SA)

	Average age at death in 1999 (female)	Average age at death in 1999 (male)	*Per capita* GDP in 1996 (PPP $000)
Eastern Cape	56	50	2.86
Free State	50	46	5.19
Gauteng	53	46	11.86
KwaZulu	49	43	4.56
Limpopo	57	52	2.02
Mpumalanga	50	46	6.11
Northern Cape	53	48	6.51
North West	50	47	3.51
Western Cape	58	50	9.38

Table 3: Quarterly Model of $\Delta[m - p^{AG}]_t$ (1982q2-2004q4)

	coefficient	standard error
Δy_t	0.30418	0.1370
$[m - p^{AG}]_{t-1} - \mu_m$	-0.12552	0.0440
$y_{t-1} - \mu_y$	0.32784	0.1134

Test	distribution	value	p-value
Residual AR(1) test	F(1,87)	0.2262	0.6355
Residual ARCH(1) test	F(1,86)	0.3443	0.5589
Heteroskedasticity test	F(6,81)	0.8493	0.5359
Residual normality test	$\chi^2(2)$	0.6565	0.7202
Joint significance of levels	F(2,88)	4.2832	

Table 4: Weights in the constant-weight approximation to the CPI

Eastern Cape	0.360786
Free State	0.150295
Gauteng	0.153840
KwaZulu	0.124214
Limpopo	0.035943
Mpumalanga	0.075792
Northern Cape	0.033331
North West	0.023090
Western Cape	0.042708

Table 5: Sample Means and Standard Deviations for Monthly Inflation, 1997-2005

	East Cape	Free State	Gau-teng	Kwa Zulu	Lim-popo	Mpum-alanga	North West	North Cape	West Cape
mean	0.467	0.398	0.441	0.436	0.416	0.485	0.449	0.459	0.422
s.d.	0.523	0.431	0.531	0.495	0.507	0.575	0.540	0.467	0.538

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Table 6: Monthly Inflation Correlations, 1997-2005

	East Cape	Free State	Gau-teng	Kwa Zulu	Lim-popo	Mpum-alanga	North West	North Cape
Free State	0.813							
Gauteng	0.866	0.834						
KwaZulu	0.849	0.850	0.880					
Limpopo	0.829	0.811	0.881	0.837				
Mpumalanga	0.814	0.795	0.887	0.823	0.888			
North West	0.856	0.852	0.846	0.842	0.834	0.785		
North Cape	0.812	0.846	0.869	0.860	0.813	0.788	0.825	
West Cape	0.885	0.862	0.901	0.864	0.808	0.810	0.851	0.883

Table 7: Monthly Model of Δp_t^i (1997m4-2005m1)

The regressions include seasonal intercepts. Standard errors are in italics.

	$100 \cdot ECM_{t-1}$	$\Delta p_{t-1}^{KwaZulu}$	Δm_{t-2}	$100 \cdot \sigma$
Eastern Cape		**0.68293**	**0.07949**	0.34797
		0.08234	*0.01553*	
Free State		**0.45721**	**0.04961**	0.29596
		0.07003	*0.01321*	
Gauteng		**0.63409**	**0.07750**	0.35720
		0.08452	*0.01595*	
KwaZulu	**0.34448**	**0.59315**	**0.06900**	0.33416
	0.17680	*0.08056*	*0.01500*	
Limpopo		**0.57501**	**0.06220**	0.34747
		0.08222	*0.01551*	
Mpumalanga		**0.67865**	**0.08401**	0.39793
		0.09416	*0.01776*	
North West		**0.66228**	**0.06168**	0.37598
		0.08897	*0.01679*	
Northern Cape		**0.54600**	**0.04974**	0.29117
		0.06890	*0.01300*	
Western Cape		**0.64491**	**0.07147**	0.32854
		0.07774	*0.01467*	

Test	**distribution**	**value**	**p-value**
Vector residual AR(1) test	$F(81,416)$	0.7428	0.9487
Vector residual normality test	$\chi^2(18)$	24.112	0.1514
Vector heteroskedasticity test	$F(270,181)$	0.9551	0.6358

Univariate Residual ARCH(1) Tests ($F(1,78)$)

	value	**p-value**
Eastern Cape	0.3083	0.5803
Free State	0.2977	0.5869
Gauteng	0.2251	0.6365
KwaZulu	0.1074	0.7440
Limpopo	0.0091	0.9242
Mpumalanga	0.0449	0.8328
North West	0.1927	0.6619
Northern Cape	0.1923	0.6622
Western Cape	0.0062	0.9373

Table 8: Monthly Regression Residual Correlations

	East Cape	Free State	Gau-teng	Kwa Zulu	Lim-popo	Mpum-alanga	North West	North Cape
Free State	0.669							
Gauteng	0.732	0.626						
KwaZulu	0.686	0.686	0.736					
Limpopo	0.682	0.654	0.787	0.679				
Mpumalanga	0.655	0.597	0.791	0.649	0.766			
North West	0.710	0.700	0.658	0.682	0.692	0.576		
North Cape	0.656	0.656	0.699	0.710	0.704	0.608	0.629	
West Cape	0.827	0.712	0.799	0.744	0.676	0.673	0.671	0.706

Table 9: Initial Responses of Inflation to a Unit Increase in M1

	Free State	North Cape	North West	Lim-popo	West Cape	Kwa Zulu	Gau-teng	East Cape	Mpum-alanga
estimate	0.0512	0.0516	0.0640	0.0642	0.0737	0.0745	0.0797	0.0818	0.0864
+ 2 s.e.	0.0723	0.0724	0.0908	0.0890	0.0972	0.0994	0.1052	0.1067	0.1148
– 2 s.e.	0.0301	0.0308	0.0371	0.0394	0.0502	0.0496	0.0542	0.0570	0.0579