A Cross Country Study of Asymmetric Preference:

The case of Inflation and employment targeting

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1 Introduction

1.1 Context Of The Study

The advent adoption of inflation targeting in the early 1990's saw the emergence of a monetary policy regime that sought to control the growth prices, following from policies of nominal money growth. The construction of this policy comes from the use of Phillips curve and Social loss function of the central bank to derive a monetary rule that is used to mitigate or stimulate the growth of prices i.e. inflation. Business cycle theory has emphasized the value of inflation in promoting growth and advocates that using inflation targeting results in a trade-off between inflation and growth.

This trade-off of economic growth brings about realization that in the process of targeting the inflation rate by means of the nominal interest rate subsequently leads to volatility in real economic growth (Cecchetti & Ehrmann, 1999). Through Okun's Law this leads to volatility in the labour markets, as the volatility is captured in the creation and destruction of employment opportunities. In the presence of structural problems in the market, technical change coupled with insider-outsider problems may lead to unemployment hysteresis (Mankiw,2001).

Prevailing monetary policy does not seek to create employment, with Jayadev(2008) concluding how there exists a class dimension to the inflation targeting policy regime. The income distribution problems of the regime can be mitigated by monetary policy that seeks to bolster output, more specifically employment creation.Giving significance to an employment regime. Unemployment, in South Africa, has surged in recent times despite the presence of aggressive expansionary fiscal policy. In order for these fiscal expansions to be efficient policy, monetary policy needs to be complimentary.

1.2 Significance Of The Study

The focal point of the analysis will be to review the social loss function of the central bank and to evaluate the conditions by which this function can optimize the ability of the economy to create jobs. A growth-preferring central bank would be able to increase the growth of the economy, subsequently leading to reduced unemployment however this is heavily dependent on the responsiveness of labour market to real economic changes.

This points to the structure of the economy. The study aims to assess the loss function weights and to investigate the effect of a redistribution of preference towards unemployment as a posed to inflation. Existing research measures the asymmetric preference for a singular country and these are usually developed economies such as United States, United Kingdom etc... Whilst this paper seeks to measure the very same countries but also with the inclusion of developed economies such as South Africa and Brazil.

1.3 Problem Statement

This paper will evaluate and measure he central bank preferences under an inflation-targeting regime and how these can be adjusted to foster employment creation in emerging markets such as South Africa. These preferences are compared to economies that follow the same regime but different employment trajectories.

1.4 Economic Contribution

The contribution of this study would be in the analysis of the social loss functions; their weights on the ability of the economy to create employment such that growth is maintained at its appropriate levels. The analysis consists of the measurement of the asymmetric preferences of the monetary authorities for multiple countries.

This assessment will measure the developing economies of Brazil and South Africa, and see if the inflation targeting framework is significant in influencing the economies employment trajectories based on the preferences of the central bank.

1.5 Structure Of The Paper

Section 2 of this study will present a review of existing literature, whereby the existing body of knowledge and delivering arguments for the study. Section 3 reviews the methodology that will be used for the analysis . Section 4 looks at the work schedule of the assessment.

2 Literature Review

2.1 Background

"The purpose of any nation's economic policy is to advance its economic well-being, meaning the prosperity of its citizens and the vitality of the institutions through which they participate in economic activity, both in the present and for the future."- (Friedman 2008, Pg 155)

In the spirit of this, there have been debates around the construction and some elements of the social loss function. The social loss function is used in the welfare analysis of the community. The debates revolve around the trade-off between output growth and inflation. Looking at how excessively high prices can erode away the ability of the market to correct itself; hitting communities hard as they are unable to afford certain goods and services. Taking another look through the lens, do the consumers care about other variables such as real economic activity?

Low priced goods are lovely, but without a consistent income or wage intertemporal consumption of these good and services cannot be adequately smoothed. Subsequently the debate around social loss functions focusing on economic activity enters the frame, not only through real output but also through the ability of the economy to create employment.

This definition points to the direction of the paper; by evaluating the existing policy instruments in the arsenal of the monetary authority and how they can be used to optimize the welfare of the citizens that it presides over. This is important as the social loss function used by monetary officials should seek to optimize the social utility of the economic agents within the economy for which they preside.

It is for this reason that this paper seeks to review the various monetary policies available with the consideration of its effects on the economic agents in the economy, namely the workers that provide human capital.

The literature review will look at the role of the social loss function, its functional representation and role in monetary policy. It will further dive into the core issue of inflation targeting with reference, with particular attention given to the Phillips curve and its evolution.

The inflation-targeting literature also looks at the fiscal policy; its effect on employment and output then concludes with a discussion on its benefits. The final section of the literature looks at employment targeting as a comparative regime to inflation-targeting. This section expands how employment targeting offers an alternative to inflation-targeting by monetary policy authorities adjusting the functional weighting or preferences.

2.2 The Social Loss Function

The social loss function of the central monetary authority of an economy maps out the trade-off between to macroeconomic variables within an economic system in an attempt to understand their behaviour. The social loss function captures the utility of the monetary authority hence it has been used extensively in monetary policy analysis, with most famous being the quadratic loss function.

Further adding that the preferences of the monetary body in an economy can be changed subject to political pressure. Though the loss function is quadratic in output and inflation gaps, monetary authorities will experience an incentive to prioritise real economic contractions over economic expansions.

2.2.1 Social Loss Function Representation

The quadratic representation has risen to prominence as it portrays an equal evaluation of all deviations away from their natural, long run or target levels (Suricho, 2006). This implies that a recessionary gap is deemed to be equivalent, in the eyes of the central bank, to an expansionary gap. Similarly in the case of inflation where inflationary pressure is equivalent to deflationary pressure.

These valuations are done to reduce uncertainty about the macroeconomic variables at hand, allowing economic agents to make decisions without ambiguity. Clarida et al (1999) states that the use of such a representative agent loss function can be misleading in welfare analysis because it

may underestimate or overestimate the cyclical fluctuations effect of various groups of individuals more especially based on the employment structures of the economy.

The suffering of the individual can be reinforced by incomplete insurance and credit markets, which in themselves are affected by variations in the nominal interest rate.

2.2.2 Social Loss Function and Inflation

The most common loss function is that of the output and inflation gap system. The loss function is a linear combination of the two gaps. The gaps are weighted by their relative preferences or risk aversions (Chadha & Schellekens, 1999). An inflation-averse monetary authority will place more weight on the inflation gap as oppose to the output gap.

In doing this the monetary authority will communicate its preferences for little variation in inflation to large variations in growth. For a social loss function that is quadratic in output and inflation gaps; monetary authorities can experience an incentive to prioritise real economic contractions over economic expansion, as expansions can bring with them inflation. It is for this reason that the weights and preferences of the monetary body are asymmetric in nature.

The preferences of the monetary body are said to be symmetric if it is indifferent between deviations in inflation and growth, subsequently asymmetric preferences is when they prefer one over the other. Clarida et al (1999) discusses how there exists an IS trade–off between the inflation volatility and the output growth when cost push inflation is present. This volatility is emphasised by the presence of preferences but a great deal of emphasis for the trade-off comes from the presence of cost push inflation. Without cost-push inflation there is no trade-off between the two. Suricho (2006) finds that under a discretionary decision-making process, asymmetries in the preferences of the central bank can lead to an inflation bias, stemming from the policy preferences for the output gap.

Barro & Gordon (1983) reviewing the loss function under nominal money regime realise that, under a discretionary policy, the monetary authority would experience an inflationary bias if the growth rate was above its

potential level only. The defect of discretion has resulted in the consideration of policy rules, with respect to the intended use of the social loss function.

2.3 Inflation Targeting

2.3.1 Phillips Curve

Phillips (1958) computed a linear relation between unemployment and inflation from United Kingdom Data from 1861-1957, concluding that the stable parameters and goodness of fit pointed to the atheoretical negative relationship between the two variables. This relation was later termed the Phillips Curve.

The Phillips curve captures the linear relation between inflation and the unemployment rate in an economy. This negative relation postulates that an increase in inflation will result in a fall in the unemployment rate; this relationship hinges on the ability of firms to supply more goods and services into the market when prices rise.

This finding became central to macroeconomic modelling because it enabled policy makers to review the dynamics of a wage-price spiral, which is at the center of inflation dynamics (Goodfriend & King, 1997).

2.3.2 Evolution of the Phillips's Curve

The Phillips relation has over the years evolved from the linear relation to a more nonlinear design, which has illustrated great policy benefits by adequately capturing inflation relationships that were overlooked. The Phillips curve was initially based on the idea that economic agents create expectations of current and future inflation given the historical information that was at their disposable. Lucas (1976) critically analysed the use of adaptive expectation in the formulation of the Phillips curve, citing that if expectations are adaptive the relationship will collapse.

The recent application of the curve has also seen it struggle to capture and forecast the behaviour of the two economic variables. With a nonlinear curve looking more feasible, this is because policy was able to find that the reduction of inflation did not result in unemployment that decreased

linearly. The specification of the Phillips curve encapsulates the inflation persistence of an economy, affecting the level of the sacrifice ratio (Furher & Moore, 1995).

The sacrifice ratio is the percentage of unemployment that the central bank is willing to create in order to stabilise the price level through disinflationary monetary tools. A disinflationary process leads to unemployment because of price-wage setting frictions that exist when firms and workers negotiate factor prices (Ball, 1994). These frictions have led to discussions for more gradualist monetary policy that will realise lower inflation over a large time horizon such as to reduce the employment causalities of disinflation.

The evolution continued with the prominent rise of the New Keynesian Phillips curve which uses the dynamic sequential general equilibrium (DSGE) modelling to adjust the behaviour to unemployment. The DSGE model omits the effects of inflation inertia (Ball,1994) subsequently resulting in a model that is misspecified and can suffer from endogeneity problems. By making this omission the model does not capture the effect of monetary interventions on the prevailing inflation levels (Mankiw, 2001).

2.3.3 Phillips' representation of Unemployment-Inflation trade-off

The relation struggles to win a consensus with the atheoretical nature of the relation coming to question. Gordon (1989) argues that the relationship observed by Phillips and many others was actually a result of the prolonged unemployment i.e. unemployment hysteresis. Since the deviations from the Non-Accelerating Inflation Rate of Unemployment (NAIRU) result in changes in the growth rate of prices, what was observed in Europe and the Americas was actually high inflation driven by a high level of unemployment. This was a result of structural impediments resulting in high wages Gordon (1989).

2.3.4 Regime Construction - The Role of Phillips

Through the use of the Phillips curve relation and the social loss function of the central bank, monetary policy has been able to evolve to meet the needs of a growing economy. A growing economy brings with it challenges

of inflation, and inflation targeting policy seeks to offer stability to the growth of prices. This form of economic modelling seeks to forecast future levels of inflation. A policy rule will be used to control inflation such as to meet a point or boundary requirement.

The modern monetary policy rule follows that of Taylor (1993) where economic modelling that is incorporative of the rational expectations of the consumers, producers and other economic agents. The role of monetary policy authorities is exposed to the challenges which are that there exists a trade-off between inflation and unemployment, highlighted by the Phillips curve (Mankiw, 2001). The Taylor (1993) rule uses the interest rate which is adjusted in an instance whereby inflation, or at times growth, deviates away from its potential levels. For an inflation-averse monetary Authority, it is the variations in inflation that are at the centre of policy.

Inflation-targeting policy rules emphasise the trade-off between output growth and inflation. In the short-run, an inflationary shock can result in the monetary authority adjusting interest rates to keep inflation expectations within the band or target. In a multi-country analysis Cecchetti & Ehrmann (1999) find that the migration of countries to an inflation-targeting regime has consequently lead to increased volatility in the output growth of those countries.

Epstein & Yeldan (2006) point that inflation targeting regimes have lost the consideration for growth hence output stability is no longer part of their mandate. Mishkin (1999) raises the concern that inflation-targeting can result in below optimum growth levels and that during disinflationary phases of the policy there is low output growth and employment.

2.3.5 Inflation-targeting and Fiscal Policy

In Mishkin (2000) there is an acknowledgement that inflation-targeting cannot stop or impede on Fiscal dominance which can lead to the collapse of the regime as a whole. When excessive fiscal expansions are financed by debt this may create incentives for seigniorage subsequently leading to the insurgence of inflation.

This aspect of inflation-targeting becomes problematic during periods of recession and stagflation whereby the economic system is struggling to grow, and any additional stimulus offered by the government –through

increased expenditures- will be greatly countered by the monetary policy framework that prevails.

The inflation targeting mechanism of increasing interest rates to reduce inflation subsequently leads to a positive and high real interest rate. High real rates can improve the domestic currency, making dollarized debt relatively cheaper and lead to lower inflation, henceforth inflation targeting has benefits for the fiscus.

Blanchard (2004) points out that the inflation targeting regime can have the pervasive effect of destabilising the fiscus and inflating the debt levels of the economy. An increase in real interest rates can affect the ability of the economy to repay its debt and this can translate into currency depreciations; increasing inflation and deterring the government's ability to raise new debt (Blanchard, 2004).

2.3.6 Inflation-targeting and Employment

Stockhammer & Sturn (2012) investigate the relationship between interest rates and the NAIRU, concluding that an inflation-targeting regime through expansionary monetary policy during recessions can actually increase the structural employment level of an economy and deepen existing employment hysteresis. Mankiw (2001) adds to the conversations by stating the monetary shocks are persistent in an economy and one of the results of this persistence is employment hysteresis.

Mankiw (2001) further adds that the persistence of the monetary shocks puts into question the natural rate hypothesis. Epstein & Yeldan (2006) emphasises that growing global financialisation continues to create larger income differentials across countries and this reinforces the financial and employment instability within countries.

2.3.7 Benefits of Inflation Targeting

Inflation-targeting has immense benefit in that assures households of price stability. By offering stability and transparency to the economic agents, inflation targeting reduces the odds of falling into a time-inconsistency trap (Mishkin, 1999). Announcement of inflation-targets provide clarity on the stance of the monetary officials and assist economic agents to create inflation expectations in accordance to the prevailing policy frameworks.

This continual credible policy stance will result in the sacrifice ratio falling such that the severity of disinflation diminishes over time. Chortareas et al (2002) find that transparency of the monetary policy Authority is negatively related to inflation. Goncalvez & Salles (2008) find that the credibility component is vital in being able to offer economic stability.

Goncalvez & Salles (2008) Adds that the monetary policy authorities in advanced economies have enough credibility to stabilize the economy without the use of a nominal anchor in contrast emerging market economies-whom do not possess this credibility- need to conform to an inflation targeting regime.

As a result of the credibility component, the inflation targeting regime has benefits in that it stabilises the growth and inflation trajectory of the adopting economy. This achieved by anchoring the inflation expectations of the economy (Ball, 2011).

One ramification of this credibility differential is that the advanced economies experience little benefits from a regime that targets inflation whilst their emerging market counterparts experience large benefits from inflation targeting (Ball, 2011). Using a difference-in-difference method, Goncalvez & Salles (2008) find that the implementation of inflation targeting in developing economies has the benefits consistent with that of Ball (2011).

The result being that the countries that were in the control group (non-targeting) experienced larger variations in inflation and output. In sharp contrast, the treatment group (targeting) experienced lower volatility in output and inflation; further adding that the remarks that inflation targeting impedes output growth are refuted by the data.

Thornton (2016) critiques this assessment on the basis of poor controls as the choice of countries was poorly controlled with certain OECD countries included in the emerging market sample of inflation-targeting economies. This casts doubt about the validity of the results. Another critique is that the control group economies had varying monetary regimes whilst the assessment assumed uniformity in monetary policy across the control group.

Thornton (2016) goes further to state that the reduction of inflation from inflation targeting was not statistically different from countries that have a currency peg. Stating that once the incorrect economies are removed and controls are in place for mean reversion; the inflation targeting regime did not reduce output volatility.

2.4 Employment Targeting

Though not a prominent regime of monetary policy, employment targeting has benefits for economies that are suffering from unemployment challenges and unemployment hysteresis. The targeting of employment seeks to create employment opportunities within the economy through policy that seeks to stimulate real economic activity and to increase the labour intensity of the growth (Pollins et al, 2006).

Public expenditure has been seen as a key driver of employment creation however the consistent fiscal commitment is constrained by a growing budget deficit and can be impeded by monetary policy.

In a case study of South Africa, Epstein (2008) finds that under an employment targeting framework a 4 percentage point fall in lending rates, for 5 years, can help realise growth which is 0.6 percent above average with inflation notching only 1 percentage points. This comes with the benefit of lower growth volatility.

Employment targeting enables the fiscus to optimise their fiscal expenditures and get more "value for their rand". Inflation targeting regimes can be unaccommodating of aggressive public expenditures that are focused on creating employment (Epstein & Yeldan, 2006). An employment targeting regime seeks to reinforce this effect hence making growth less volatile.

2.4.1 Benefits of Employment Targeting

Epstein(2008) discusses the structural frameworks required in order to achieve a regime that can continually permit job creation; pointing to the requirement for strong capital management techniques that will avail room for monetary policy to dampen exchange rate volatility. On the international stage, a monetary regime should strive to make domestic industries relatively competitive.

Frenkel & Taylor (2006) discuss how monetary policy can improve the Real Exchange Rate (RER), such as to empower domestic industries to increase labour intensity. Frenkel(2006) reiterates the importance of the preservation of the RER and its effect in stimulating the process of job creation. Inflation control become important in the framework as the output and employment optimisation process has to be within the space of available resources (Frenkel, 2006).

Epstein (2007) suggests that the transformation of the credit markets will further enhance the regime by availing cheap liquidity to development financial banks; this can be in the form of sovereign credit guarantees and concessionary loans. Ruge-Murcia(2004) illustrates that the asymmetric preferences that are placed on natural rate of unemployment can result in (as with inflation-targeting) a inflation bias problem.

3 Methodology

The Methodology section will look at the various models and estimation techniques that the literature offers as instruments of analysis for approaching this problem.

This section will proceed with the mathematical formulation of the theoretical model. Looking at what the theory proposes the Taylor rule should look like and how its derivation can assist in the estimation of the central bank preferences, looking at the real variables of inflation and in this study the unemployment rate as a form of real economic activity.

3.1 Theoretical Model

The seminal paper of Ruge-Murcia(2001) has been at the forefront of asymmetric preference estimations, with various authors adopting the Central Banker - Public model as a foundation for their analysis. In this paper, the social loss function is comprised of inflation deviations and deviations in unemployment from the target and natural levels respectively.

In modeling unemployment as an autoregressive moving average(ARMA) process , the author attains an estimate to natural level of unemployment.

This procedure allows for the estimation of the central bankers asymmetric preferences in a 3 country case. The author finds that the preferences are substantially different across countries. The Ruge-Murcia(2001) model will form the foundation of the analysis in addition to that is the inclusion of an interest rate term that will form a part of the policy rule predominantly used by inflation-targeting central banks.

The inclusion of interest rates generalises the analysis and puts an emphasise on the central banks preference for interest rate smoothing in its ventures to control inflation-output deviations. This is done for currency stabilisation and also to avoid the adverse effects of large changes in interest rates.

The theoretical model adopted for this investigation will follow that of the Surico(2006), whereby the monetary policy is authority is faced by an economy with the following dynamics:

$$\pi_t = \theta E_t \pi_{t+1} + k y_t + \epsilon_t^s \tag{1}$$

$$y_t = E_t y_{t+1} - \omega(i_t - E_t \pi_{t+1}) + \epsilon_t^d \tag{2}$$

Such that y_t and π_t represent the output gap and inflation rate respectively with ϵ_t^s denoting the supply side shocks as well as ϵ_t^d which encompasses the demand side shocks of the economy. Given that the economy is currently in an inflation-targeting regime, if a new policy was to change the preferences of the monetary officials to that of an employment averse one.

These dynamics look at the effect of rational inflation expectations on the wage setting relationship. Employment contracts have incorporated expectations hence a forward looking Phillips curve is utilised for the analysis.

For the purpose of this analysis it is vital to include the unemployment variable into the analysis. Ruge-Murcia(2001) states that no additions or transformations are needed as unemployment deviations are also measures of real economic activity. Hence : For which u_t is the unemployment gap and is described as u_t - u_t^n, for u_t^n being the natural rate of unemployment

By adopting the Linear Exponential (Linex) functional form proposed by Nobay and Peel (2003), Surico(2006) With the Ruge-Murcia(2001) adjustment comes to the following loss function:

$$L_t = \frac{e^{\alpha(\pi_t - \pi^*)} - \alpha(\pi_t - \pi^*) - 1}{\alpha^2} + \lambda \frac{e^{\gamma u_t} - \gamma u_t - 1}{\gamma^2} + \mu \frac{(i_t - i^*)^2}{2} \tag{3}$$

for which α and γ are the weight values of the central banks objective function.γ denotes the parameter of the monetary authorities preference for growth. Whilst λ and μ represent the central banks preference for losses related to deviations in output and interest rates. These are normalised in the loss function such that if $\lambda > 1$ then this would imply that the monetary authority is growth averse. This systematical illustrates the monetary authority's preference for job creating and an aversion for inflation.

The above give a general overview on the instruments required for the construction of a monetary policy rule. A policy rule requires a nominal anchor (Mishkin, 2000) and in this analysis this, would be the nominal interest rate. The nominal interest rate would be used by the central bank in order to attain the optimal employment path that minimises the loss of the society. The above model would have the following optimization problem:

$$\min_{i_t} E_{t-1} \sum_{\tau=0}^{\infty} \delta^{\tau} L_{t+\tau}$$

for

$$L_t = \frac{e^{\alpha(\pi_t - \pi^*)} - \alpha(\pi_t - \pi^*) - 1}{\alpha^2} + \lambda \frac{e^{\gamma u_t} - \gamma u_t - 1}{\gamma^2} + \mu \frac{(i_t - i^*)^2}{2}$$

This function contains very interesting analytical properties, in a situation whereby the economy contracts, the degree of severity is higher on the Loss Function whereas if there is an expansionary output gap. When computing the optimization problem, after substituting (1) and (2) furthermore applying the first order conditions, we arrive at the following:

$$E_{t-1} L_t = E_{t-1} \left(\frac{e^{\alpha(\pi_t - \pi^*)} - \alpha(\pi_t - \pi^*) - 1}{\alpha^2} + \lambda \frac{e^{\gamma u_t} - \gamma u_t - 1}{\gamma^2} + \mu \frac{(i_t - i^*)^2}{2} \right) \tag{4}$$

for $\pi_t = k u_t + f_t$ and $y_t = -\psi + g_t$
for $f_t = \theta E_t \pi_{t+1}$ and $g_t = E_t u_{t+1} + \psi E_t \pi_{t+1} + \epsilon_t$

Such that inflation is a linear function of unemployment gap and inflation expectations encapsulated by f_t. The output gap y_t has a constant variation and can be induced by g_t which is simply based on the expectation about unemployment and inflation in the next period.

$$E_{t-1}\left(\frac{e^{\alpha(\pi_t-\pi^*)}-\alpha(\pi_t-\pi^*)-1}{\alpha^2}\right)+\lambda E_{t-1}\left(\frac{e^{\gamma u_t}-\gamma u_t-1}{\gamma^2}\right)+\mu\frac{(i_t-i^*)^2}{2}=0$$

$$-E_{t-1}\left(\frac{e^{\alpha(\pi_t-\pi^*)}-1}{\alpha}\right)k\psi-E_{t-1}\left(\frac{\gamma u_t-1}{\gamma}\right)\lambda\psi-\mu(i_t-i^*)=0$$

This shows the central banks response to developments in the economy.

$$-k\psi E_{t-1}(\pi_t-\pi^*)-\psi\lambda E_{t-1}u_t+\mu(i_t-i^*)=0$$

$$i_t=i^*-\omega E_{t-1}(\pi_t-\pi^*)-\delta E_{t-1}u_t \tag{5}$$

for $\psi=k\frac{\psi}{\mu}$ and $\delta=\lambda\frac{\psi}{\mu}$

The above gives a monetary policy rule that can evaluated to the effect of variation of interest rates on the unemployment gap. The following rule insists that the monetary authority should reduce interest rates in an instance where by unemployment lies above its targeted level.

Before the estimation of the modified Taylor rule, the unemployment process needs to be modeled using the ARMA process suggested by Ruge-Murcia(2001). This will require that the natural unemployment rate at time t be described by the following relation:

$$\triangle u_t^n=\psi-(1-\delta)u_{t-1}^n+\sum_{i=1}^{q-1}\theta_i\triangle u_{t-i}^n+\nu_t \tag{6}$$

Ruge-Murcia(2001) argues that this modelling of the natural rate of unemployment is needed because of the dynamic nature of the labour market and the rapid innovations in technology. Furthermore, Ruge-Murcia(2001) argues that assumptions that u_t^n is constant lead to u_t^n being white noise. The above model (using a constant natural rate of unemployment) could experiences problems of autocorrelation.

3.1.1 Natural Rate of Unemployment

The natural rate of unemployment is not directly observable compared to interest rates, actual unemployment as well as inflation. Subsequently a model based on observable variables is constructed in Ruge-Murcia(2001). In order to get to equation (6) above, we need to derive the equation using the evolution model of the natural rate of unemployment described as follows:

$$u_t^n = \psi - (1-\delta)u_{t-1}^n + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i}^n - \lambda\epsilon_t + \sigma \tag{7}$$

$$u_t = E_{t-1}u_t^n + \sigma - \lambda\epsilon_t + \nu_t \tag{8}$$

Taking conditional expectations of equation (9) we get:

$$E_{t-1}u_t^n = E_{t-1}(\psi - (1-\delta)u_{t-1}^n + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i}^n - \lambda\epsilon_t + \sigma)$$

then substituting the above relation into equation (10) yield:

$$u_t = E_{t-1}(\psi - (1-\delta)u_{t-1}^n + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i}^n - \lambda\epsilon_t + \sigma) - \lambda\epsilon_t + \nu_t$$

$$u_t = \psi + \delta)u_{t-1}^n + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i}^n + \sigma - \lambda\epsilon_t + \nu_t$$

adding and subtracting $\psi+\delta u_{t-1}+\sum_{i=1}^{q-1}\theta_i \triangle u_{t-i}$ give us the following result:

$$u_t = \psi + \delta u_{t-1}^n + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i}^n + \sigma_t - \lambda\epsilon_t + \nu_t + \psi + \delta$$

$$u_{t-1} + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i} - (\psi + \delta u_{t-1} + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i})$$

$$u_t = \psi + \delta(u_{t-1}^n - u_{t-1}) + \sum_{i=1}^{q-1} \theta_i \triangle (u_{t-i}^n - u_{t-1}) + \sigma_t - \lambda\epsilon_t +$$

$$\nu_t + \psi + \delta u_{t-1} + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i}$$

letting $u_{t-1}^n - u_{t-1} = \sigma_t - \lambda\epsilon_t$ we attain:

$$u_t = \psi + \delta u_{t-1} + \delta(\sigma_t - \lambda\epsilon_t) + \sum_{i=1}^{q-1} \theta_i(\triangle\sigma_{t-i} - \triangle\lambda\epsilon_{t-i})$$

$$- \lambda\epsilon_t + \nu_t$$

subtracting u_t from both side will help us arrive at:

$$\triangle u_t = \psi - (1-\delta)u_{t-1} + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i}^n + \delta(\sigma_t - \lambda\epsilon_t) + \sum_{i=1}^{q-1} \theta_i \triangle (\sigma_{t-i} - \lambda\epsilon_{t-i})$$

$$-\lambda\epsilon_t + \nu_t$$

Since $E_{t-1}u_t^n = u_{t-1}$ we are able to make the transformation such that the above equation becomes:

$$u_t^n = \psi + \delta u_{t-1}^n + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i}^n - \lambda\epsilon_t + \nu_t + \mu_t \tag{9}$$

If the above error terms namely $\lambda\epsilon_t, \nu_t, \mu_t$ are assumed to be serially uncorrelated, for all lags. Then we can say that the model can be seen to be an ARMA data generating process. Ruge-Murcia(2001) aggregates the errors

in such a fashion that the white noise errors, namely $\delta(\sigma_t - \lambda\epsilon_t) + \sum_{i=1}^{q-1} \theta_i \triangle (\sigma_{t-i} - \lambda\epsilon_{t-i}) - \lambda\epsilon_t + \nu_t$ is equivalent to an Moving average process of order q i.e. $MA(q)$ such that equation becomes:

$$u_t^n = \psi + \delta u_{t-1} + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i}^n - w_t + \sum_{i=1}^{q} \tau w_t \tag{10}$$

Subsequently the natural rate of unemployment can be modelled as an ARMA(q-1, q) model whereby the prevaling level of natural rate is based on the lagged values of unemployment. Thus the unobservable natural rate can be modelled using the observable unemployment data. This model will be used to compute the unemployment gap required in the estimation of equation (5).

3.2 Estimation Technique

The literature offer guidance on the various approaches for the estimation of (5). The difference will lie in the fact that the derived monetary rule varies with that in the literature, however it is policy rule nonetheless.

In order to assess the monetary rule, Rotemberg & Woodford (1994) use a Vector Auto Regressive (VAR) to estimate the values of the structural parameters of the Taylor Rule. This is used to evaluate the effects of exogenous changes in interest rates on the economy.

Looking at the current regime, the structural VAR was investigated to understand the role of the structural dynamics on the effectiveness of that economy to manage output and inflation movements.

In their assessment they assume that the United States Federal reserve (The Fed) will have a feedback rule of the form:

$$r_t = r^* + \sum_{k=1}^{n_r} \mu_k (r_{t-k} - r^*) + \phi_k \sum_{k=0}^{n_\pi} (\pi_{t-k} - \pi^*) + \theta_k \sum_{k=1}^{n_y} y_{t-k} + \epsilon_t \tag{11}$$

for r_t being the federal reserve rate.

The error term in the analysis is assumed to have minimal effect on output and inflation within the same period that the shock occurs.

Epstein(2008) approached the analysis of a policy rule through the use of a structural VAR model. Estimating the structural parameters of a monetary rule similar to Taylor(1993) under a the frameworks of a monetary policy that will be employment targeting. The modification allowed the assessment to simulate the growth prospects of South Africa under the employment targeting regime.

Ruge-Murcia(2001) estimated the preferences of the central bank using the method of Full Information Maximum Likelihood. This method was effective to attain the parameter estimates. This was done because of occurrence of serial correlation and heteroscedasticity in the unemployment variable that affected the ability of the model to estimate the natural level.

Surico(2006) uses Generalised Method of Moments (GMM) to estimate the following monetary structural equation on the US economy to evaluate a symmetric preferences hypothesis for the economies. This is attained from reparameterising the equation below which is similar to equation (6) except for the unemployment gap is replaced with an output gap:

$$-E_{t-1}(\frac{e^{\alpha(\pi_t-\pi^*)}-1}{\alpha})k\psi - E_{t-1}(\frac{\gamma y_t - 1}{\gamma})\lambda\psi - \mu(i_t - i^*) = 0$$

The Taylor series expansion of the above equation is taken and the result is the following equation when i_t is made subject of the formula.

$$i_t = c_0 + c_1\pi_t + c_2 y_t + c_3\pi^2 + c_4 y_t^2 + \rho i_{t-1} + v_t \tag{12}$$

The assessment allowed the author to discern that the parameter in various regimes was able to change given the preferences of the Fed over time. Pointing that at times the preferences as discussed in most literature can be politically induced. The analysis was instruments in uncovering the effects of the preferences on the structural equation as well as to map the behavior of the fed in terms of how they would go about changing the federal borrowing rate.

This method is ideal for the analysis that is to be conducted as it encapsulates the idea of preferences within the assessment without the inclusion of technical models such as Markov regime switching models such as that used in Assenmacher-Wesche(2005).

In this analysis the structural parameters of preferences are said to be time variant and this parameters followed a Markov process. Assenmacher-Wesche (2005) finds that the preferences of the monetary authority is based on the state by which the economy is experiencing.

Markov-switching models are good because they are good with dealing structural breaks and unlike the analysis conducted by Surico(2006), and other authors that segment the period of analysis such as to avoid structural breaks. The state variables used in these models are able to model the parameters even in the event of a policy regime change.

The literature points to the use of a maximum likelihood estimation procedure in order to firstly assess the effect of the unemployment gap on the interest rate rule chosen by the monetary authority.

The technique enables for the analysis of the structural parameters, in order to discern the effects of the asymmetric preferences of the monetary authority. This is component is vital to the analysis as to quantitatively assess the effect of the weights placed on the social loss function of the monetary officials.

An alternative to the methods of moments estimation used by Surico(2006) would be the use of Nonlinear Least Squares (NLS) estimation. An advantage of the least squares estimation is that it has small sample properties that ensures that if the assumptions are satisfied, the estimates will have the desired linearity and efficiency properties.

The methodology is able to pick up nonlinearity in the estimation parameters which is central to measuring asymmetric preferences of monetary policy, such a study includes on by Martin & Milas(2004). Studies that measure the nonlinear monetary properties have preferred to use G-MM estimation such as Surico(2007).

The sample size properties of Nonlinear Least Squares make it a more attractive estimation technique to mitigate against issues of estimation bias.

3.3 Econometric Analysis

The analysis will comprise of emerging market economies, namely South Africa, Brazil as well as the developed economies United States, United Kingdom and Australia. These countries have employed inflation-target monetary frameworks, and have experienced varying growth and inflation dynamics. The inclusion of the last three countries is to offer a comparison of the weights to their developed counterparts.

The analysis will proceed with the evaluation of each countries social loss function as a function of employment and inflation.This study will require econometric data of the following variables: Real Output growth, price inflation, unemployment and nominal interest rates. The data will be quarterly, for a period of 2002Q1 - 2017Q1. The data used in the analysis is available from the Global Financial Data (GFD) database.

The first thing we have to do to enable the estimation the Taylor rule above is to compute the inflation gap and unemployment gap. This requires the modelling of the unemployment in order to track the dynamics of the natural rate of unemployment u_n as well as transforming the consumer price data in order to include the inflation target of each state.

3.3.1 Inflation Gap

We begin the computation of the inflation gap by differencing the Consumer Price Indices so as to compute the consumer price inflation. This done as follows:

$$\pi(t) = log(CPI_t) - log(CPI_{t-4}) \tag{13}$$

The inflation is tracked quarter-on-quarter, this is because annualised inflation targets will be checked on the inflation performance based on the same quarter's performance the year earlier. The respective central banks will evaluate the inflation with respect to its targets prior to making decisions about future inflation and how to maintain or mitigate the trend.The inflation gap is denote as below:

$$\pi_t = \pi(t) - \pi^T \tag{14}$$

Table 1 below will illustrate the inflation targets prevailing within each country and the value that is used as the π^T for the analysis.

Table 1: Table of Inflation Targets for Each Country

Countries	**Estimated Targets**	**Target Used**
Australia	2-3%	2.5%
Brazil	3.5 - 4.5%	4.0%
South Africa	3 -6%	4.5%
United Kingdom	2%	2%
United States	2%	2%

Using the values in the last column, we are able to complete the inflation gap of the data.

3.3.2 Unemployment Gap

As stipulated in the methodology, the unemployment is modelled for each country as an autoregressive process of the past observable values of unemployment. This method smooths the trajectory of the natural level of unemployment, allowing us to see how unemployment behaves around the natural level. The unemployment gap, denoted:

$$u_t = u_t - u_t^n \tag{15}$$

The various models of each country can be illustrated as below, with AR processes being mapped by the following lag lengths. In order to ensure that the models are as parsimonious as possible; the model estimation that exhibits the lowest Akaike Information Criterion(AIC) value given the lowest amount of explanatory lags will be chosen. The models are drafted from:

$$u_t^n = \psi + \delta u_{t-1}^n + \sum_{i=1}^{q-1} \theta_i \triangle u_{t-i}^n - \lambda \epsilon_t + \nu_t + \mu_t$$

such that

$$E_{t-1} u_t^n = u_{t-1} \tag{16}$$

Table 2 illustrates the models selected using AIC:

Table 2: Table of Natural Unemployment Models

Countries	**AR(p)**	**AIC**
Australia	2	-0.1784
Brazil	6	-2.9313
South Africa	2	2.786
United Kingdom	2	-0.1166
United States	3	0.1988

As with Ruge-Murcia(2001), the given AR processes for the natural unemployment rates are modelled in such a manner that it insures that the resulting series is stationary. The mapped natural rate of unemployment can be illustrated as below by Figures 1-5:

Figure 1: Unemployment of Australia

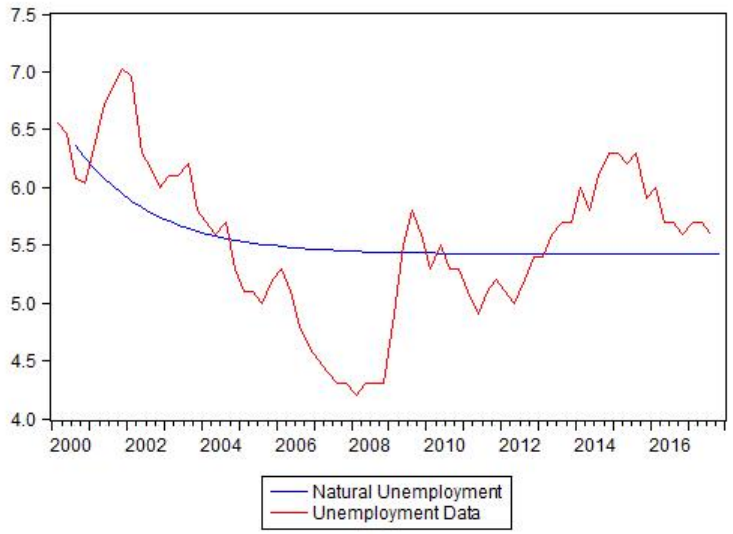


Figure 2: Unemployment of Brazil

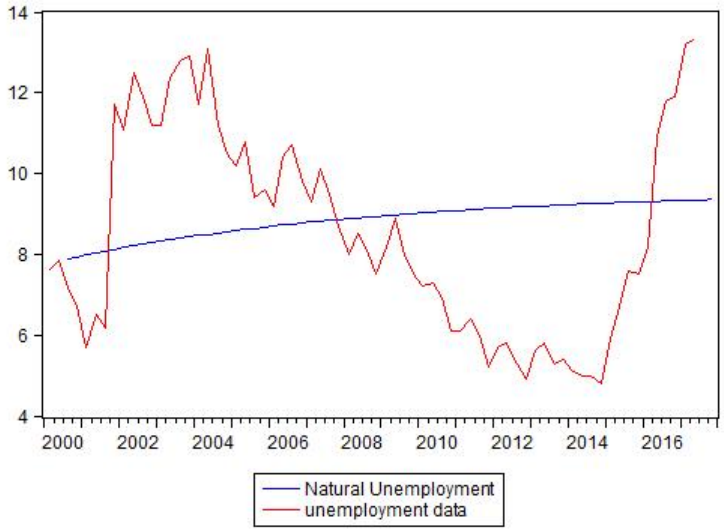


Figure 3: Unemployment of South Africa

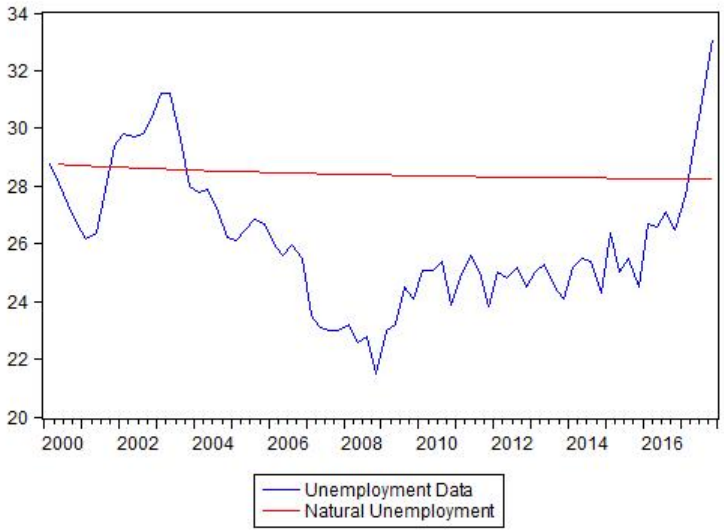


Figure 4: Unemployment of the United Kingdom

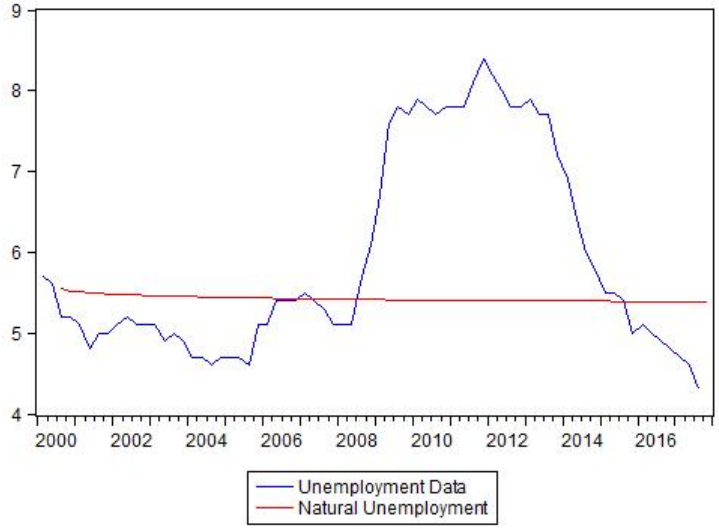
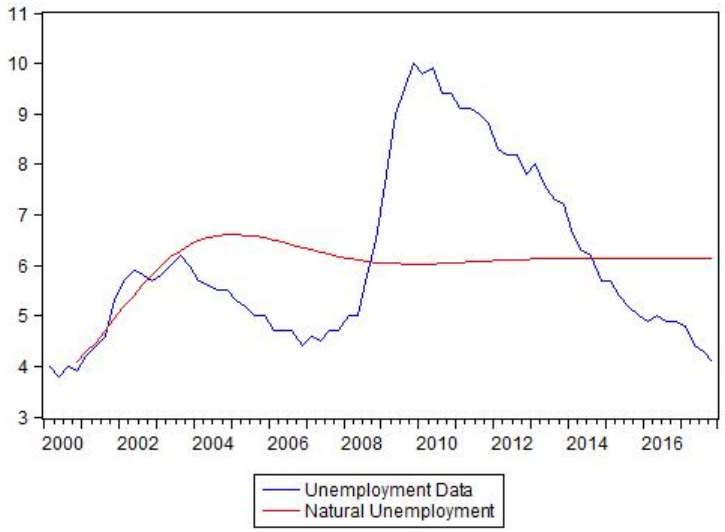


Figure 5: Unemployment of the United States



The above figures illustrate a smoothed natural rate of unemployment that is able to differentiate itself from the periodic changes in the unemployment rate however still being able to follow the trend of unemployment, illustrating the dynamics of the labour market which changes with structural shocks such as technology and skills improvements etc.

4 Results

The following section will look at the results attained from the analysis of the Taylor rule in order to attain the social loss function preferences of the countries within this study. In the analysis, White's covariance matrix is used to correct for any existing heteroscedasticity that maybe present in the various time series. Prior to estimation the time series are checked for the existence of a unit root.

Unit Root testing is performed using the method proposed by Philip & Perron(1982) as it possess good sample power properties that are lacking in using the Dickey-Fuller tests. The methodology finds that-uniformly across the countries-the central bank interest rate as well as the unemployment gaps all experience a unit root at levels. Continued testing reveals that the series are difference stationary, formerly integrated of order 1.

The study will first try estimate the parameterised social loss function of equation (12). To avoid the issue of stationarity the equation is modified to the following:

$$\triangle i_t = c_0 + c_1\pi_t + c_2 \triangle u_t + c_3\pi^2 + c_4 \triangle u_t^2 + \rho \triangle i_{t-1} + v_t \tag{17}$$

This is to firstly test, if the quadratic specification of the central bank loss function holds. This is done before checking the non-linear linex specification illustrated as :

$$\triangle i_t = d_0 + d_1\frac{e^{\alpha\pi_t}}{\alpha} + d_2\frac{e^{\gamma\triangle u_t}}{\gamma} + \rho \triangle i_{t-1} + v_t \tag{18}$$

The equation above will enable us to evaluate the exact nature of the modelling of preferences in the countries of interest and to see exactly if their preferences are skewed and by what measure. The equations will be estimated using the least squares methodologies.

We begin by using Ordinary Least Squares for the linear parameterised equation, to assess whether the monetary authority exhibits symmetric preferences. Non-linear least squares estimation is used for the linear exponential model specification used by Surico(2006).

In the tables below, table 3 represents the results from the symmetric estimation equation (17) and table 4 produces the results from equation (18).

4.1 Australia

In order to estimate the preference parameters of the central bank, we imply ordinary least squares to the above equations and use the data from 2002Q1 till 2017Q1. It is at this time that all the countries within the study have all adopted inflation-targeting as their respective monetary regime. We begin the analysis with Australia.

The models illustrate some interesting results. Firstly the first column of table 3 shows that the differences in the central bank interest rates are positively influenced by the inflation gap, subsequently a 1% change above the inflation target will realise a 0.01% change in the Australian interest rate.

The changes in the unemployment gap will also see a change in the central interest rate, so a 1% positive increase in the unemployment gaps will realise negative change in the central interest rate by 0.60%, similarly the same occurs when the square of the differences in the unemployment, which will realise a 0.66% increase in the change in the central interest rate.

The interesting result of this column is the hypothesis that the central bank has or exhibits symmetric preferences between changes in inflation and unemployment. This hypothesis holds if c_3 and c_4 are not statistically significant from zero, however c_4 is statistically significant from zero, illustrating a symmetry for economic activity. Inflation and the unemployment gap are statistically significant in determining interest rate, with a 1% rise in inflation and unemployment gap resulting in 0.01% rise and 0.61% fall in interest rates respectively. The results in table 3 illustrate

that the central bank illustrates having nonlinear or asymmetric preferences for inflation and somewhat symmetric preferences for the unemployment gap. This is consistent with the theoretical expectations for an inflation-targeting monetary authority.

The asymmetric estimates illustrated in column 1 of table 4 finds that the nonlinear specification does not illustrate that there is a statistically significant relationship between changes in interest rates and the inflation gap as well as the changes in the unemployment gap. The nonlinear specification does show that the coefficient (d_1) of the inflation function is statistically significant.

Subsequently implying that deviations in inflation are factored into the decision making process of changing interest rates. However the lagged differenced interest rates are not statistically significant in both regressions, which points to an interesting question of whether the monetary authority is considerate of interest smoothing.

From the results one can infer that 1% increases in inflation above its target, will decrease interest rates by 0.03%. This result is not consistent with expectations under an inflation targeting regime. Similarly a 1% rise in unemployment, according to the estimation results, bring about a 31.07% rise in rates. This result is biased and exceptionally large.

The Akaike Information criterion asserts that the nonlinear specification is the superior model of fit and it also has a Durbin-Watson statistic closest to 2. Showing the least amount of serial correlation or misspecification, however this will be confirmed in the coming sections. Although the linearised equation, postulates some asymmetric preferences in inflation, the nonlinear model does not show this.

4.2 Brazil

The symmetric estimation results for Brazil are illustrated below in column 2 of table 3. They illustrate that the changes in the differenced interest rate are determined by the lagged differences of interest rate. This implies that an increase in the differenced interest rate gap will be cause the difference in the next time interval to by 0.047% in the linear relation and by 0.400% in the nonlinear relation. This stresses the importance of interest smoothing for the central bank.

The statistical significance of the real variables i.e. differenced unemployment gap and the inflation gap is alarming. The theoretical expectation would be that the central bank would have non-symmetric preferences however the linear model states that there is a lack of significance; pointing to the monetary authority having symmetric preferences.

The coefficients of the quadratic terms are not statistically significant from zero, imposing that the central bank has symmetric preferences and not the hypothesised asymmetric representation. The results in table 3 illustrate how increases in the inflation and unemployment gap will realise increases in the central bank interest rate. A 1% change in either would bring about a 0.02% and 0.1% rise in interest rates.

The nonlinear representation in column 2 of table 4 also illustrates similar results for the values of the differenced unemployment gap and inflation gap are also not statistically significant. The prior expectations of signs are no met, such that a 1% rise in inflation decreases interest by 1.46% whilst a rise in unemployment above its natural level will see a fall in interest rates by 1.85% for every 1% rise.

This subsequently follows from the results in table 3 since the results of c_3 and c_4 are not significant i.e. exhibit symmetric preferences such that the model fails. This is further reinforced by the fact that the linear model has a lower Akaike Information value, illustrating the better model. The Durbin-Watson statistic is significantly different from 2 for both nonlinear and linear specifications. A Lagrange Multiplier test will be conducted later in order to check for possible autocorrelation. If the statistics illustrates that there is no autocorrelation, and the challenge might lie within the model specification.

4.3 South Africa

Now to look at the analysis of the South African economy, column 3 of table 3 illustrates the OLS estimates of the linear model which tests the hypothesis of symmetric preferences. The South African model illustrates that the linear relation, has the coefficients as having statistical significance. It follows from this result that the monetary authority has asymmetric preferences

This implies that the changes in the central bank rate is influenced by the variables and for our investigation the important result is the statistical significance of the quadratic terms c_3 and c_4 which show that they are statistically significant to zero, at the 10%. This leads to the inference that the South African Reserve bank can be said to have asymmetric preferences.

The linear model also postulates that there is a positive relationship between inflation and interest rates. This is such that a 1% rise in inflation will lead to a 0.24% rise in the rate. Past interest rates are also significant in determining the present rate, an increase in past rates would result in higher rates later on.This illustrates the consideration of interest rate smoothing, such as to prevent the adverse effects of aggressive rises in interest rates. The South African Reserve Bank has non-symmetric inflation preferences which is consistent with the theory of an inflation targeting regime.

The nonlinear model in column 3 of table 4, also illustrates that the inflation gap is a statistically significant determinant of the central bank rate. The results states that within the period, the inflation gap was given more emphasis than the changes in real economic activity illustrated by the differenced unemployment gap. The lagged difference term is also significant at the 1% level. The South African model is consistent with theoretical expectations of a inflation targeting monetary policy regime.

The nonlinear specification states that a 1% change in inflation gap will bring rise to a 1.18% rise in the central bank rate. The change in the unemployment gap, is found to not be statistically significant, however the sign of the coefficient is consistent with theoretical expectations. A rise in the unemployment gap, brings about a fall in rates of 0.69%.

This shows that accelerating unemployment would push the monetary authority to reduce rates and stimulate the economy. The normalisation if the inflation gap coefficient would show that inflation deviations are weighted more than real economic activity. This robustly illustrates the existence of the inflation targeting framework. The lagged interest rate differential is statistically significant and can arise in an 0.52% rise in current rates for a 1% rise. The AIC test shows that the linear specification is the better model specification for the data, and the linear specification also has less autocorrelation illustrates by its Durbin-Watson d statistic.

4.4 United Kingdom

The above equations when estimated using OLS reaps the results captured in column 4 of table 3 below. The results tell us that the linear model, that the differences in the central bank interest rate is statistically influenced by the inflation gap, as the inflation gap is solely statistically significant at the 1%.

This model also says that the coefficients of the quadratic inflation and differenced unemployment gaps are not statistically different from zero. This shows that the central bank has symmetric preferences. This reinforces the idea that the inflation targeting framework within this economy is not evident in the data. The lagged rates are found to not be statistically significant from zero and this can be an indicator of the interest rate preferences of the UK monetary authority. Though biased, we can infer that a 1% fall in the lagged interest rate differential will realise a 0.25% fall in central rate.

To reiniforce the idea of the symmetric preferences, column 4 of table 4 illustrates the results, with only the coefficient attached to the inflation gap being statistically significant. The result that α is not statistically different from zero illustrates the failure of the estimation to pick up the inflation targeting framework, however the coefficient of inflation is significant, illustrating that inflation is vital in informing the decisions of the UK monetary authority on their changes in the central interest rate.

The nonlinear specification postulates that the rise in rise in the inflation gap will realise a fall in interest rates by 0.0008% for each 1% increase. This is inconsistent with economic theory.

The estimation results of the model may be subject to some model misspecification or serial correlation as the Durbin-Watson test statistic is significantly different from 2; signalling the existence of the autocorrelation or misspecification problems. This be because the DW statistics are 2.54 and 2.43 for the linear and nonlinear specification respectively. There will also be checks for possible negative serial correlation. These will be reviewed again in the diagnostic tests section of the analysis. The Akaike Information Criterion informs us that the nonlinear specification is the better fit for the UK data.

4.5 United States

The final state in our analysis is the United States, the estimation of the Taylor rule has realised the following results tabulated in column 5 of table 3. The estimation procedure produces some interesting results. Similar to the analysis of Brazil the estimation reveals that the changes in the central bank rate is dependent on the differences in the lagged value of the interest rate. Such that a 1% fall in the lagged interest rate differentials leads to a 0.34% fall in the current rates.

The analysis disregards the effects of the inflation gap as well as the differenced inflation gap. With the coefficients c_3 and c_4 not being statistically significant, this illustrates that the FED exhibits symmetric preferences, and as in the data used in the Surico(2007) study, the estimation is unable to pick up the inflation targeting framework.

Table 3 illustrates that the central bank exhibits nonlinear preferences because the c_3 and c_4 are not statistically significant from zero. This implies that the US fed has symmetric preferences with regard to changes in inflation and the differenced output gap. The linear specification shows that the prior expectations about the sign of inflation gap is not met. The model states that rises in the inflation gap should arise in falls in interest rates.

The nonlinear specification results presented in table column 5 of 4 illustrate that none of the coefficients are statistically significant at even the 10% level of significance. The nonlinear model fails to depict the skewed preferences that theory postulates an inflation targeting central bank should have.

The standard errors of the estimates are considerably large and the coefficients too. The model infers that positive deviations in CPI inflation and unemployment will raise rates, which is consistent with theory. The nonlinear specification has a Durbin-Watson test that is lower than 2 and this could be a sign of possible model specification error. The nonlinear functional form is, by the Akaike Information criterion, a better fit of the data than the linear specification.

Table 3: Taylor Estimation of Symmetric Model

Country List					
Coefficients	**Australia**	**Brazil**	**South Africa**	**UK**	**USA**
C_0	-0.0021	-0.690032	0.36374	0.052527	-0.009989
	(0.0534)	(0.943386)	(0.150481)***	(0.062969)	(0.184147)
C_1	0.0183	0.0231239	0.239530	0.076345	-0.176067
	(0.0054)***	(0.219294)	(0.081090)***	(0.026478)***	(0.212128)
C_2	-0.6084	0.101915	0.315807	-0.925170	-0.088943
	(0.2781)***	(0.182723)	(0.159879)*	(0.654869)	(0.206087)
C_3	-0.000362	0.122434	0.026605	3.15E-05	-0.091084
	(0.0002)	(0.151601)	(0.014583)*	(0.002028)	(0.059729)
C_4	0.662667	-0.039885	0.048166	0.140761	0.034380
	(0.2719)***	(0.047190)	(0.024122)*	(0.102562)	(0.044734)
ρ	-0.0247	0.467538	0.396599	0.416337	0.344478
	(0.1288)	(0.183615)***	(0.125909)***	(0.091647)	(0.172908)*
R-squared	0.575090	0.222307	0.484825	0.480589	0.315133
Adjusted R-squared	0.536462	0.152870	0.437991	0.433370	0.252872
Akaike info criterion	0.744187	3.630998	1.699211	2.169697	1.034106
Schwarz criterion	0.951814	3.836850	1.906838	2.377324	1.241733
Durbin-Watson stat	2.147093	1.546840	2.086562	2.535404	2.043500
$***, p < 1\%$ $**, p < 5\%$	$*, p < 10\%$				

Table 4: Taylor Estimation of Asymmetric Model

Country List					
Coefficients	**Australia**	**Brazil**	**South Africa**	**UK**	**USA**
d_1	0.0192	0.076941	0.133987	0.066910	0.067215
	(0.065693)**	(0.022348)***	(0.414744)		
α	-0.0282	-1.45544	1.185157	-0.000762	12.73737
	(0.0203)	(3.8883053)	(0.431789)***	(0.057816)	(19.08077)
d_2	-3.07E-07	0.022955	0.059294	-0.814260	-1.93E-08
	(0.000541)	(0.134575)	(0.075777)	(0.577666)	(9.17E-07)
γ	31.07445	-1.854875	-0.688974	1.608032	16.00901
	(3096.150)	(3.921850)	(2.782117)	(1.232331)	(37.91680)
ρ	-0.162388	0.400588	0.527764	0.250635	0.399094
	(0.156727)	(0.122620)***	(0.125048)***	(0.172539)	(0.280480)
R-squared	0.576345	0.181064	0.376844	0.576345	0.392394
Adjusted R-squared	0.546084	0.122569	0.332333	0.485505	0.348994
Akaike info criterion	0.708443	3.655679	1.856715	2.127401	0.881620
Schwarz criterion	0.881466	3.828702	2.029737	2.300423	1.054643
Durbin-Watson stat	1.974599	1.791139	1.778377	2.433070	1.736514
$***, p < 1\%$ $**, p < 5\%$	$*, p < 10\%$				

There are significant differences in the results for the countries, this speaks to more the characteristic of each economy however since all the economies within the period of interest have adopted inflation targeting as their monetary system; it creates a theoretical expectation. The expectation is the linearised model should show that asymmetric preferences hold namely that the c_3 and c_4 coefficients should be statistically significant from zero.

The results in tables 3 and 4 highlight the fact that over a period of 15 years the observed economies has been unable to exhibit their asymmetric preferences in the data. Alternatively, the data can not recognise the Inflation Targeting framework. The more these preferences become apparent, the more it will affect the behaviour of firms and consumers; as well as trade unions. The symmetry in preference could point to the existence of a dual mandated monetary authority. As data becomes available, it would be ideal to test the preferences over a significantly larger period. This would be done for robustness because the witnessed phenomena could be because of short term dynamics more especially with the differencing procedures conducted in the study. These can remove the information content of long term trends.

4.6 Specification Tests

4.6.1 Bresch-Pagan LM Test

The F-stat has been stated to have 52 df. With the null hypothesis being that there exists serial correlation, the following results give clarity to the models. The results above show that the linearised model, illustrates no

Table 5: Table of LM test values

Countries	**F stat**	**Prob**
Australia	0.864345	0.4272
Brazil	13.58331	0.0000
South Africa	0.509034	0.6040
United Kingdom	10.32343	0.0002
United States	0.731548	0.4860

serial correlation for Australia, South Africa and the United States as the Lagrangian Multiplier test statistic rejects the null hypothesis. Whilst the test finds serial correlation in the Brazil and United Kingdom models. This

will strongly affect the interpretations of these models and their statistical inferences. This is because the serial correlation in the model will make the coefficient standard errors larger, undermining the efficiency properties of the least square estimate.

A similar test can be conducted on the nonlinear model of asymmetric preferences amongst the countries, and the results are as follows:

Table 6: Table of LM test values

Countries	**F stat**	**Prob**
Australia	7.784342	0.0011
Brazil	7.178665	0.0017
South Africa	2.819056	0.0685
United Kingdom	6.192236	0.0038
United States	11.43198	0.0001

The above table illustrates that at the 10% level of significance, all the values are statistically significant and that the model possess no serial correlation, as the null hypothesis is rejected.

4.6.2 Ramsey RESET Test

This section will review the models and check for their statistical robustness but reviewing their stability properties and checking for correlation problems that could exist. The analysis will start with a Ramsey Reset test for the linear specification, the table below will include the test statistic and their chi-square values. The null hypothesis of the test is that there exists no model misspecification or omitted variable at all. The table below has the results:

Table 7: Table of RESET test values

Countries	**t-stat**	**Prob**
Australia	3.399930	0.0013
Brazil	0.228257	0.8203
South Africa	3.038675	0.0037
United Kingdom	1.271164	0.2091
United States	0.693962	0.4907

The above results illustrate that the models above vary in their model specifications. Although all following the linear functional form the RESET test finds that the model is correctly specified for Brazil, United Kingdom and the United States. The two former countries should be analysed again as there contain serial correlation which could affect the power properties of the RESET test. South Africa and Australia are both found to have been misspecified. The following tests above have shed light on the robustness of the linear model that houses symmetric preferences.

5 Conclusion

The above analysis of the preferences show that although some economies have adopted the inflation-targeting regime, it is empirically difficult to show these preferences for small deviation in inflation. A majority of the countries in this study are found to having symmetric preferences which is inconsistent with the theoretical framework for inflation-targeting monetary authority.

The study has revealed that preference vary exceptionally across countries but also that the model specification of the analysis has been put into question because it was rejected by the data. So there is space for econometric research into the correct specification of the linear exponential functional form model for estimating a Taylor rule in order to uncover asymmetric preferences.The study could also be expanded to measure the preferences of a dual mandated central monetary authority, as these preferences could be concealed under the framework of inflation-targeting. Such a phenomena could affect the model specification that is currently used in the body of literature.

6 Caveat

The nonlinear least square estimation technique has the limitation in that although the variables are stationary and the data series might exhibit serial correlation. A limitation to note about the approach is the fulfillment of the normality assumption, pertaining to the variables and residual error terms.

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