Implementation of Taylor Type Rules in Nascent Money and Capital Markets Under Managed Exchange Rates

A thesis submitted for the degree of Doctor of Philosophy

by

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Abstract

We investigate the practical use of Taylor-type rules in Trinidad and Tobago, which is in the process of implementing market based monetary policy and seeks to implement flexible inflation targeting in the presence of a managed exchange rate. This is motivated by the idea that normative Taylor rules can be shaped by the practical experience of developing countries. We find that the inflation – exchange rate nexus is strong, hence the country may be unwilling to allow the exchange rate to float freely. We contend that despite weak market development the Taylor rule can still be applied as the central bank is able to use moral suasion to achieve full pass through of the policy rate to the market rate.

Our evidence rejects Galí and Monacelli's (2005) argument that the optimal monetary policy rule for the open economy is isomorphic for a closed economy. Rather, our evidence suggests that the rule for the open economy allows for lower variability when the rule is augmented by the real exchange rate as in Taylor (2001). We also reject Galí and Monacelli's (2005) hypothesis that domestic inflation is optimal for inclusion in the Taylor-type rule. Instead we find that core CPI inflation leads to lower variability. Additionally, our evidence suggests that the monetary rule, when applied to Trinidad and Tobago, is accommodating to the US Federal Reserve rate.

Further, we expand the work of Martin and Milas (2010) which considered the pass through of the policy rate to the interbank rate in the presence of risk and liquidity. By extending the transmission to the market lending rate, we are able to go beyond those disruptive factors by considering excess liquidity and spillovers of international economic disturbances. We found that these shocks are significant for Trinidad and Tobago, but it is not significant enough to disrupt the pass through. As a result, full pass through was robust to the presence of these disruptive factors.

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Chapter 1

Implementation of Taylor type rules in nascent money and capital markets under managed exchange rates

1.0 Introduction

The literature on the Taylor rules has been largely developed through normative theoretical studies with regard to guiding interest rate decisions of the central bank. Taylor (2010) observed that rules at the start of the century were motivated by the need to avoid monetary excesses in order to avoid hyperinflation. This was followed in the middle of the century by Friedman proposed constant growth rate with the same idea of avoiding hyperinflation. Taylor (2010) then pointed out that in contemporary times the rules are developed to avoid instability in price and output. According to him rules have been developed to avoid monetary excesses in a bid to avoid triggering economic recessions. In this context he remarked that the absence of rules would lead to 'chaotic monetary policy'.

New tools have been ushered in by the development of dynamic stochastic general equilibrium models (DSGE) in the presence of rational expectations and sticky prices. The downside of the literature on the implementation of monetary rules in DSGE models is that these studies have been developed through restrictive assumptions of perfect markets so that a change in assumptions can lead to different conclusions. In this respect the practical usefulness of the Taylor rule depends on how well it can be adopted in the real world, where perfect conditions often do not exist.

Accordingly, we contend that the theoretical building of monetary rules is incomplete without empirical validation to discover its practical application. We note that the real world is replete with subtle variations in exchange rates and market structures stemming from the historical evolution of the financial markets. Consequently mere simulations of theoretically derived models are incomplete, since findings are based on assumptions made in setting up the model.

We therefore investigate to see whether the monetary rules are empirically validated in a small open developing country with limited markets. In reality, countries are at different stages of transition to market based monetary policy, so the question arises as to the universality of Taylor type rules across countries with unique circumstances. The unique circumstances include the type of managed float, smallness of and dependency of the economy, trading pattern of the country, stage at which it is at exercising market based monetary policy.

The thesis use a case study to examine how Taylor type rules perform in shallow internationally integrated financial markets under managed exchange rates. This exercise is executed with the idea that it can provide guidance in the formulation of simple policy rules for those economies wishing to implement flexible inflation targeting while developing money and capital markets. By flexible inflation rate it is meant that the policy maker objective is to put a positive weight on real output in forecasting inflation and adjust the conditional inflation towards the inflation target.[1]

In essence the study provides a test case concerning the universal implementation of Taylor rules for market based monetary policy. It raises the question as to whether empirics can be used to provide guidance on the normative design of Taylor-type rules. The case study used is with respect to Trinidad and Tobago, a small open energy based economy with a managed float that is making a transition to market based monetary

[1] See Svensson (1999) for an elaboration on this.

policy. The economy is resource intensive, been an oil producer in which the government is the major recipient of foreign exchange. The exchange rate is a managed one in which the central bank is able to judiciously supply foreign currency to the foreign exchange market as opposed to using demand instruments to subdue demand.

The study is largely an empirical one in which we compare our findings with the analytical models in the literature. In particular we benchmark the empirical model with the DSGE as developed by Galí and Monacelli (2005). Their model allows us to formally derive the new Phillips curve given market imperfections through price stickiness and monopolistic competition. In addition the demand side is developed through the IS equation. An important feature of their model is that it is isomorphic in the sense that the same monetary rule that maximises welfare in the closed economy form also maximises welfare in the open economy. Thus we would like to see if their conclusion is validated empirically against the alternative that the rule must be augmented when applied to the open economy.

My major contribution In Chapter 2 is to show how the theoretical results posited by GM can be crudely laid out in a graphical linear two dimensional form. This simplifies the analysis of GM conclusions by superimposing openness on the closed economy model. An advantage of doing so is that it shows graphically how the IS and Phillips Curves become flatter as the economy becomes more open. Further it provides a visual picture of how the natural rate of output expands with openness of the economy. Using this we are able to graphically illustrate that the open economy is isomorphic to the closed economy in that the IS and Phillips curve become flatter as openness increases. In so doing, we are able to show that the natural rate of output expands with openness.

We then use the rest of the thesis to empirically discover how the findings deduced by GM compare to the empirical results obtained when the study is applied to a small open economy with a managed float where the exchange rate is not determined in a competitive market and 2), the small open economy is subject to spillovers from larger economies. This is in contrast to GM where they formulated their theoretical model under the assumptions where the economies are assumed to be atomistic to the rest of the world and the exchange rate is determined under competitive market conditions. We therefore argue that theoretical model by GM is incomplete without examining how the results can apply to the real world where these assumptions are violated.

In order to apply the Taylor rule to Trinidad and Tobago, we consider the practical experience of that country as it seeks to make a transition from the use of direct controls to market based monetary policy upon which we can apply Taylor-type rules. We then compare the transmission for the Trinidad and Tobago market with the advanced industrialised countries, which we use as the first best given their greater market sophistication and longer experience with market based monetary policy. Here we examine whether disrupting factors to the transmission mechanism for the Trinidad and Tobago market, offset the effectiveness of Taylor-type rules. These frictions are excess liquidity and spillovers of international disturbances. This allows us to investigate the extent to which the transmission mechanism from the policy rate to the market lending rate is effective as portrayed in theoretical models.

We contribute to the literature in three major ways. First we consider how a country with an underdeveloped capital market can still achieve pass through from the central bank policy rate to the private sector market lending rate. This is an important area of research for those countries seeking to make a transition from the use of direct monetary policy to market based monetary policy given their limited state of money and interbank markets.

We further contribute to the debate with respect to whether the policy reaction function for an open economy should be isomorphic or augmented compared to the closed economy, by exploring the empirical evidence emanating with respect to Trinidad and Tobago. In addition we also use GMM estimation to see how the variables used in the theoretical studies compare as candidates for the reaction function. Coming out of our empirical research we arrive at suggestions for the monetary rules.

We also contribute to the literature by investigating whether the effectiveness of the Taylor-type rule may be thwarted by spillovers of international spillovers. To our knowledge, these issues have not been resolved in the literature. Yet, we consider this to be a useful area of research as the transmission may be fraught with frictions that open economies such as Trinidad and Tobago must grapple with.

The GM model applied to a small open natural resource economy is appropriate, in that it is readily lends itself to analyse the applicability of the Taylor rule for an open economy. This therefore guided the derivation of the hypotheses to be tested. However, the model is limited as it assumes that the exchange rate is determined in a competitive environment in an autonomous economy. In essence, we suggest that though the GM model is useful for a nascent market, it may benefit from customising the monetary policy in terms of augmenting the real exchange rate.

2.0 Rational for Study

The study is developed by first critically analysing the workhorse DSGE model by Galí and Monacelli (2005). This is undertaken in Chapter 2 where the Taylor rules are located within the theoretical construct of the general economy. In this model all market imperfections are removed, leaving price rigidity through Calvo (1983) pricing as the only remaining market imperfection. They used an IS and New Phillips open

economy equations in a DSGE framework, in which they fit the monetary rule to achieve stabilisation as the only intervention by the central bank. They simulated the model under flexible exchange rates.

Our contribution to the theoretical literature developed by Galí and Monacelli (2005) is to develop a graphical analysis to examine how the closed economy model can be extended to the open economy. By doing so we are able to show that open economy IS and Phillips curves are flatter than the closed economy version. We argue that the simple representation of the canonical form of the Galí and Monacelli (2005) model is useful for putting together the relation between interest, inflation and the output gap. Through this we are able to show the effect of openness on the natural rate of output. We also show how the open economy Phillips curve collapses to the closed economy version when the price elasticity of substitution between imports and domestic goods and between variety of goods in country i disappear. This therefore is illustrated following Galí and Monacelli (2005) conclusion that the open economy is isomorphic to the closed economy.

The successive chapters arise principally from the limitations of Gali and Monacelli (2005) model. We note three limitations of the Galí and Monacelli (2005) model. First it is predicated on a simulation where there are perfect conditions. We therefore investigate how our case study in chapter 3 departs from the theoretical model constructed by Galí and Monacelli (2005). Secondly, in chapter 4 we test the hypothesis that the Taylor rule is isomorphic. Thirdly, we test the implications of excess liquidity and spillovers to the pass through from the policy repo rate to the market lending rate confronted by the central bank of Trinidad and Tobago (CBTT), given that the exchange rate is not determined by perfect capital market but instead is influenced by speculation in the market.

2.1 Development of Hypotheses

For chapter 3 we examine the case study with respect to Trinidad and Tobago, noting the departure of the real world from the perfect conditions simulated in Galí and Monacelli (2005) model. Moreover in view of the fact that the Taylor rule applies to market based monetary policy, to apply the rule, it is useful to study the degree of market development in order to study the existence of market based monetary policy in the market to which the study is applied. The chapter therefore picks up the discussion with respect to the development of the market in preparation for market based monetary policy. Accordingly, Trinidad and Tobago is used as a case study of a country seeking to make the transition to the use of market based monetary policy. That country embarked on a new style of monetary policy from in 1993, when it begun taking steps to move to a market based one. Hence it departed from a fixed exchange rate peg and started trading securities across the market to kick start the development of a money market. The 91 day Treasury bill rate is the most frequently traded security in the money market. The Repo policy rate was introduced in May 2002 as the policy rate of the central bank. Thus the market based monetary policy begun to take root.

To execute the study, the Trinidad and Tobago market is benchmarked against the UK and US markets the last two been developed markets. Three key findings emerge from this chapter. Firstly, it shows the sensitivity of inflation and exchange rates to changes in each other in the short run. Accordingly, changes in the exchange rate act almost immediately on the inflation rate. Our results therefore suggest that for Trinidad and Tobago changes in the exchange rate impacts immediately on import prices and given that imports form a high percentage of consumption, then it would be reflected strongly in domestic prices. This is in contrast to the UK and US where changes in the exchange rate take a longer time to act on the inflation rate. This is particularly due to the fact that the inflation rate in these countries act through the marginal cost of firms.

As such, we point out that changes in the exchange rate takes a longer time to be manifested in changes in inflation rate in these countries.

The evidence obtained show there is a nexus between inflation and the exchange rate. As a result we pay attention to the determination and measurement of both variables. The open economy allows for a richer set of measurement and determination of inflation. We therefore elaborate on the measures of inflation used by the central bank. Domestic inflation proxy is the producer price index, and CPI inflation measured in terms of headline and core inflation.

The exchange rate is primarily managed through sales of foreign currency as the central bank is the major receiver of foreign exchange in the economy, with the bulk of foreign currency accruing through energy exports. This allows the central bank of Trinidad and Tobago (CBTT) to judiciously supply foreign currency to the market and therefore act as a monopsonist supplier of foreign exchange. As a result, the central bank is able to manage the exchange rate with the goal of reducing its volatility.

Secondly, we investigate the autonomy of the private sector in Trinidad and Tobago with respect to the determination of market interest rates. An important finding emerging from the chapter is that market determined interest rates in Trinidad and Tobago are closely tied with the US and UK economic cycles. However, we find some deviation in the short run of the Treasury bill rate in Trinidad and Tobago from the short run rates in the UK and US markets. As a result the evidence suggests that if there is to be any autonomy it may exist only in the short run with respect to the determination of interest rates.

The central bank is at the stage of undertaking development of money and interbank markets to facilitate the pass through of the short-term policy rate through the term structure of interest rates. In developing these markets the central bank has had to

take strong liquidity absorption measures to increase the likelihood of a predictable relationship between the short term interest rate and the policy rate. As a result the central bank engages in measures to forecast liquidity to decide on the timing of intervention and intervention measures.

The third important point that emerges from the chapter is that whereas the advanced industrialised countries are able to rely on the transmission of the policy rate through the market system, a small market like Trinidad and Tobago is able to use moral suasion to do so. The shallowness of the markets has allowed the CBTT to use moral suasion. Its ability to use moral suasion stems from (1) the smallness of the market, (2) its ability to tie this with coercive powers given its monopoly as a regulator and (3) its ability to use information sharing as an inducement for financial institutions to cooperate. Thus, developed countries rely on the market mechanism while Trinidad and Tobago rely on moral suasion to conduct market based monetary policy in view of its under developed money and capital markets. Moreover, the country is able to take advantage of the smallness of the market in terms of the small number of financial institutions in the market.

In chapter 4 we conduct an empirical investigation to investigate whether augmenting the Taylor rule would yield superior stabilising results with respect to lower variability of inflation and output gap, when compared to the traditional Taylor (1993) rule. Thus the major hypothesis investigate the question raised by Galí and Monacelli (2005) and Clarida (2000) that the optimal monetary reaction function developed for the closed economy is isomorphic to the open economy. The assumption that the rule is isomorphic suggests the parameters developed for the closed economy are welfare maximising for the open economy. This arises in their model because of the assumption that constant elasticity of substitution and perfect capital mobility giving rise to the law of one price at all times.

The alternative hypothesis is that it is optimal for the monetary rule for the open economy to be augmented, is explored by Taylor (2001). He showed that augmenting the rate can lead to lower variability of inflation and the output gap. Taylor (2001) considers the real exchange to be the candidate variable by which the rule can be augmented, since the condition of perfect capital mobility which gives rise to purchasing power parity (PPP), may be violated. Perfect capital mobility may deviate from fundamentals as a result of speculative activities and therefore the law of one price is not maintained at all times. Accordingly, external disturbances may not only act on the terms of trade as in Galí and Monacelli (2005), but also on the exchange rate according to Taylor (2001).

The method of investigating the null hypothesis that the Taylor rule for the open economy is isomorphic is influenced by Clarida (2000). They specify a target rate in relation to economic conditions, upon which a policy rate is smoothed and pursued in response to the target rate. The economic fundamentals are assumed to be captured in terms of the PPP. Deviations are assumed to occur where the real exchange rate deviate from the PPP owing to the fact that capital is not perfectly mobile. For example, speculation may occur causing the exchange rate to vary from fundamentals. We examine the real exchange rate in three ways, in terms of spot real exchange rate, deviation of the real exchange rate from its median or trend.

In applying our study to Trinidad and Tobago, our findings support Taylor (2001) that the augmented rule for the open economy reduces volatility of inflation and output gap. As such, the rule is not found to be isomorphic as asserted by Galí and Monacelli (2005) and Clarida (2000). Moreover our evidence does not support their conclusion that domestic inflation is the best measure of inflation. Instead, we find that the core measure of inflation rather than domestic inflation to be more stabilising as it yields the lowest variability of inflation and the output gap. We also find that given Trinidad

and Tobago is a small open economy, the reaction function is accommodative to US monetary policy when domestic and headline inflation measures are used.

The new style of monetary policy plays on the idea that the pass through of the policy rate impact on the market interest rate then onto demand in the economy. However, there are certain frictions that can be disruptive and therefore affect the smoothness of this transmission. As a result in chapter 5 we test the hypothesis that the pass through of the policy rate to the market rate is sensitive to frictions arising from excess liquidity and spillovers of international disturbances. The rational for this is that the predictability of the effects of changes in the policy repo rate by the central bank can be disrupted by these market frictions. We are interested in whether excess liquidity and spillover of international spillovers must be taken into account by the CBTT when they seek to make changes in the repo policy rate in a bid to affect the market lending rate.

The chapter is fashioned off Martin and Milas (2010) where they examined the pass through of the base rate in the theoretical construct of the economy by Galí and Monacelli (2005) with respect to the new Phillips curve to the IS equations. In their model, they examined the transmission from the base rate in the money market to the interbank rate which was represented by the 3 month Libor rate. The 3 month libor rate is used as the benchmark money market rate, which is therefore the floor to private sector cost of credit to the private sector. In developing their model they allowed for disruptions emanating from excess liquidity and risk in the UK market.

Here we extend beyond Martin and Milas (2010), by considering the transmission from the repo policy rate to the retail credit market rate. Accordingly, we use the repo policy rate as the base rate, but the prime lending rate is used in place of the 3 month Libor rate. The prime lending rate is used as the representative lending rate of commercial banks, given that they are the major financial intermediary in the economy

and loans are the dominant financial instrument. A major difference here is that the 3 month Libor rate is signifies the cost of credit to private sector financial institutions in the UK, while the prime lending rate as used for Trinidad and Tobago signifies the cost of credit commercial bank customers.

By extending the transmission from the policy repo rate to the market lending rate it allows us to investigate the effect of excess liquidity and spillover of international disturbances on the prime lending rate. Given the disruptive nature of excess liquidity on the pass through to the market rate, it is evident that banks are not forced to react to changes in the repo rate once they have excess liquid resources.

In addition, the spillovers of international disturbances may be likely owing to stability resulting from the managed float in Trinidad and Tobago, a liberalised capital market and strong dependence on trade and capital links with the US and UK markets. As a result, disturbances originating in these developed markets may spillover to the financial sector in Trinidad and Tobago.

The spillovers could take place through multiple transmission mechanisms. This can be through bank loans, foreign direct investment and through trade effects. It can arise through deepening financial and trade integration, through liberalisation of the financial sector and through strengthening of foreign direct investments. Owing to the various transmission mechanisms, spillovers can occur at various speeds. It can take place instantaneously, but lags can arise owing to the fact that international banks can lend to various points of the Trinidad and Tobago economy, causing financial flows from the domestic banking system to occur at differential flows. Moreover, it can take place through effects of trade and lagged effects on financial flows arising therewith on the banking system. From an examination of financial data between Trinidad and Tobago with the UK and the US, we averaged the time lag between spillovers and Trinidad and Tobago to be six months.

We found full pass through of the repo rate to the market rate. In addition our results showed that excess liquidity and spillovers are significant to the pass through. However we found that the magnitude of importance of the spillovers is not significant enough to offset the transmission of the repo rate to the market rate.

The findings emanating from chapters 4 and 5 must be taken with caution. Violation of statistical and model assumptions should be noted here GMM estimation techniques were used. In particular, the small data size poses severe limitations as use of GMM techniques require large data size. The inferences drawn can therefore only be treated as preliminary given the small sample size. Moreover, estimation is limited by the frequency and quality of data available. For example, real time data are not available for Trinidad and Tobago with respect to the variables used in the reaction functions. As such we used the highest frequency of data commonly available which turned out to be quarterly.

3.0 Conclusion

In summary, the major findings emanating from the thesis suggests that a country with underdeveloped money and capital markets can still achieve pass through of the repo policy rate through moral suasion. Secondly, the empirical evidence obtained rejects Galí and Monacelli (2005) hypothesis that the monetary rule that is optimal for the closed economy is isomorphic to the open economy. Instead we find that the augmented Taylor rule lead to lower variability of inflation and output gap. We also find that core inflation, rather than domestic inflation as Galí and Monacelli (2005) posited, was superior for stabilisation. We also contend that the measure of inflation rate is relevant to the choice of the variable to augment the rule by. Here we find that when the Federal Reserve rate is used as the variable to augment the rule by, the rule turned out to be accommodative when domestic and headline inflation rates are

considered. However when the real exchange rate is used in the reaction function of the central bank, the rule turns out to be aggressive with respect to inflation whether measured in domestic or CPI terms.

Finally, we find that external spillovers are significant to the pass through from the policy rate to the market lending rate in Trinidad and Tobago, but it is not significant enough to disrupt the transmission mechanism. Moreover, excess liquidity is found to potentially be offsetting to the transmission and should be taken into account in setting the policy rate, even though it did not offset the full pass through of the transmission mechanism. Further we contend that the full pass through is obtained owing to the use of moral suasion by the central bank.

Chapter 2

Literature Review of the Application of the Transmission of the Taylor Rule to the Open Economy

1.0 Introduction

The chapter reviews how the Taylor rule fits into the open economy Dynamic Stochastic General Equilibrium (DSGE) literature. As such, it begins by briefly reviewing the Taylor (1993) rule. However, given the fact that the Taylor (1993) rule was initially developed for a closed economy, the impetus towards the open economy following the seminal work of Obstfeld and Rogoff (1995) is examined. Their open economy theoretical framework is regarded to have kick started the incorporation of the Taylor (1993) rule into the DSGE framework. Accordingly, they introduce market imperfections through price stickiness and imperfect competition into the analysis. A general limitation of their model is that the transmission of disturbances is sensitive to the nature of price stickiness assumed. To this end, Galí and Monacelli (2005) explores the idea that the stickiness can be modelled using the Calvo (1983) model and go on to develop a theoretical model to express the macro-economy in terms of the IS and the new Keynesian open economy Phillips curve. It then uses this as a framework for analysing the implications of different monetary regimes for the open economy. A limitation of their analysis is that they do not include the exchange rate directly into the Taylor rule. However, Batini and Levine (2007) recognized that the exchange rate can have important expenditure switching effects. They along with Shi and Xu (2008), among many others, suggest that the exchange rate should be included where the

country is constrained by the availability of foreign exchange, as exchange rate stabilisation can be used to bring about the stabilisation of prices.

The novelty of our analysis is that we show how the Taylor (1993) rule can be crudely represented by a simple graphical framework. We begin by examining the rationale for monetary rules. This is followed by an outline of the Taylor (1993) rule in a closed economy context. We then seek to locate the rule in an open economy context. This allows us to briefly examine the seminal contribution of Obstfeld and Rogoff (1995). A deeper discussion of the study by Galí and Monacelli (2005) is then undertaken. To this end we explore the household's problem, the effect of openness on prices and international risk sharing. Further, we seek to define both the uncovered interest rate parity and the terms of trade. This is followed by a discussion of firms and their marginal cost and price setting. This sets the stage for a discussion of the interactions between households and firms from which we can derive the IS and open economy Phillips curves. The monetary policy function is then incorporated into the model. We then suggest a graphical framework to capture the canonical representation of the model. Some limitations of the Galí and Monacelli (2005) model are then noted before we conclude the chapter.

2.0 Rationale for monetary policy rules

Monetary rules are designed to close the monetary transmission gap running from the final target of monetary policy to the operating instrument, see Taylor (1995). In this regard, attention is paid to devising simple rules in a closed economy context, with the objective of minimising the variability of output and inflation, see Svensson (2003). Svensson (2005) points out that an advantage of a simple rule is that it allows the central bank to incorporate its limited knowledge of a narrow set of variables into the rule. As such, the policy instrument can be determined by the information available to the central bank with regards to economic fundamentals, expectations and the timing of economic shocks. In view of this, Haung et al. (2002) observes that simple rules have the

advantage of allowing for transparency and consistency so that rules can be easily understood by the market. Nevertheless, rules are considered to be the starting point of analysis rather than a substitute for judgement.

With interest rates being the main operating instrument of the major central banks, the literature has focused on developing reaction functions to this instrument.[2] The most popular of these rules since the 1990s, has been the Taylor (1993) rule. This rule is set as a function of available information on inflation in relation to its target and the output gap. The rule does not explicitly use money supply targets given the observation that large shocks in money demand can cause high volatility of interest rates and exhibit more statistically unreliable relationships between quantity variables, see Clarida et al (1999).[3] In contrast, financial market prices have been shown to exhibit more statistically reliable relationships. Since Taylor (1993), attempts have been made to incorporate rules concerning the open economy and incorporating market imperfections into the analysis.

3.0 Outline of the Closed Economy Taylor Rule

The original Taylor(1993) rule was can be expressed in the form:

$$i = \bar{i} + \pi + h(\pi_t - \pi_t^*) + \beta_y y \qquad 3.1$$

where i is the short-term nominal interest rate, π is the inflation rate as a percentage change in prices, y is the percentage deviation of real output from its trend both

[2] Clarida et al. (1998) pointed out that the reaction functions are equally applicable where the central bank targets a narrow reserve aggregate once the implied objective is the expected short-term interest rate.
[3] Taylor (1995) also pointed out that the definition of quantity variables also change overtime owing to changes in technology and regulations.

expressed in logs and $\bar{i}, \beta_y$, h and π^* are constants and are greater than zero.[4] According to Taylor(1993) $\bar{i}$ is the equilibrium real rate which is specified as close as possible to the assumed steady-state growth rate.

According to Rudebusch (2001), the relationship between i, π and y in Equation 1 can be generalised as:

$$i = \alpha + \beta_\pi \pi + \beta_y y \qquad 3.2$$

where $\alpha = \bar{i} - (\beta_\pi - 1)\pi_t^*$. α is a constant which can be interpreted as the short term real equilibrium interest rate, the parameters β_π and β_y represents the short-run preferences of the monetary authority in terms of their attitude towards the short-run trade-off between inflation and output (See Ball (1997) and Siklos and Wohar (2004)). In comparison to the original Taylor (1993) rule in equation 3.1, β_π is equal to $(1+h)$.

Taylor (1998) argues that if $\beta_\pi < 1$, then this would suggest that the real interest rate would fall when inflation increased, and this would lead to an expansion in demand thus fuelling further increases in inflation. In other words, the optimal rule should be one where the nominal rate rises sufficiently to increase the real rate, which occurs when the coefficient of inflation in the Taylor rule is greater than unity, see Clarida et al (1999).

[4] The specification largely follows Taylor (1998). For consistency with the rest of the chapter, the notation is adjusted from Taylor (1998) specification so that i replaces r as the nominal interest rate, $\bar{r}$ replaces r^f, and β_y replaces g. However, the parameter h is maintained from Taylor (1998).

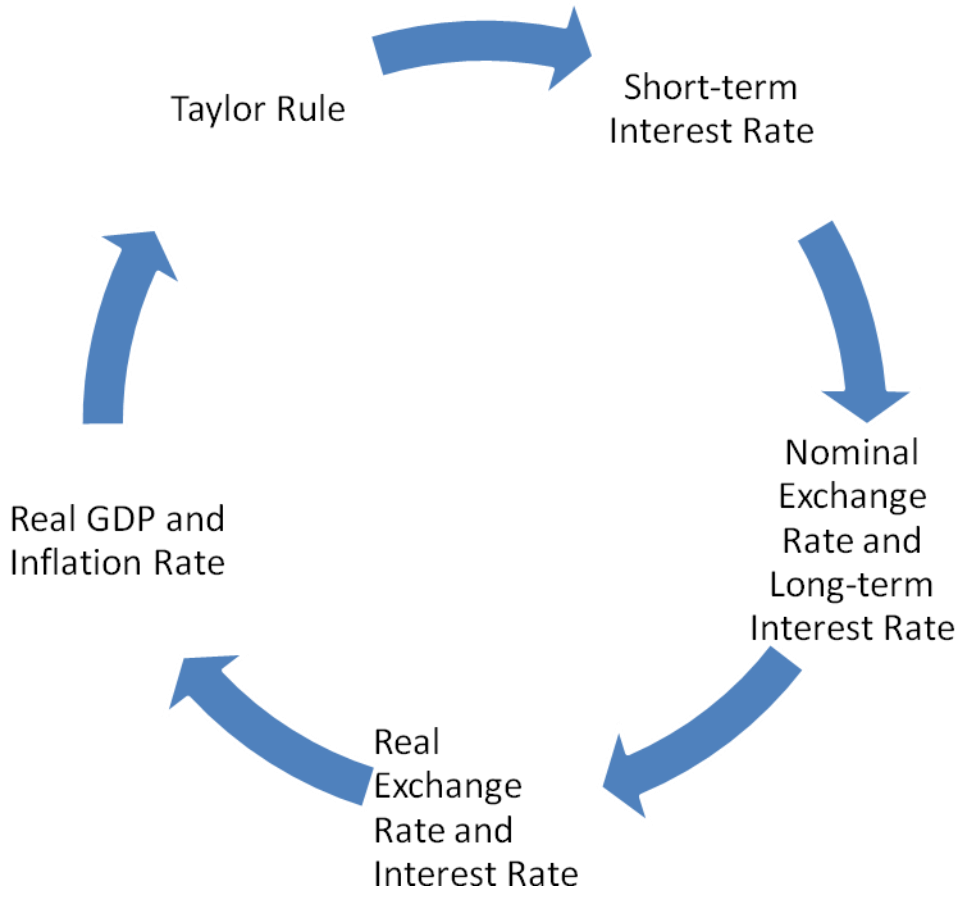
For the rule to lead to stabilisation, Taylor (1993) argues that $\beta_y > 0$ and $\beta_\pi > 1$ must hold. As Parrado and Velasco (2002) indicates, when the coefficient of inflation is greater than one in the Taylor rule, it suggest that the central bank is reacting aggressively to inflation by aggressively targeting inflation. In describing the rule for the US economy, Taylor(1993) set $\bar{i}$ at 2 per cent to capture the average real interest rate. π_t^* is the targeted rate of inflation of 2 per cent and $h = 0.5$.[5] He also takes Y^* to be the average growth trend in real GDP which he found was 2.2 per cent with respect to quarterly US data for the period 1984q1 to 1992q3. Thus he defined y as the per cent deviation of actual output over $Y^* = 2.2$.

4.0 Incorporation of the Taylor Rule into the Open Economy

Taylor (1995) attempts to incorporate aspects of the open economy in the construction of the rule by assuming that open economy parameters enter the transmission mechanism through external price variables. In effect, the exchange rate and or foreign interest rate are included alongside the short-term interest rate as the price variables in the Taylor rule model. Taylor (1995) then suggest that a possible transmission can be where the short-term interest rate impact on the exchange rate and term structure of interest rate both in nominal and real terms and therefore on inflation and output, see Figure 1. The Taylor rule then forms the bridge between policy outcomes arising from the open economy and the short-term interest rate.

[5] This formed the normative aspect of the Taylor rule as the coefficients were selected judiciously to push inflation back to its target and to steer the nominal interest rate in a countercyclical manner to output gaps, see Clarida et. al. (1999).

Figure 1: Transmission of Monetary Policy



5.0 Open Economy Transmission

The impetus towards the development of new models to examine the effect of openness have been attributed by Lane (2001) to the seminal paper by Obstfeld and Rogoff (1995). Using microeconomic foundations conditional on a two country model with imperfect markets and sticky prices, they explored the implications for the domestic economy of the external economic disturbances captured through the exchange rate and the current account balance.

The theoretical framework itself is instructive to subsequent attempts to model the open economy through microeconomic foundations. Sticky prices obtain as prices in this model are assumed to be set one period in advance, but fully adjusted afterwards. Moreover, this mode of price stickiness lends itself to predicting that spillovers from the external to the domestic economy in the short-run with respect to inflation, consumption and money balances, manifests itself into permanent long-run changes in the exchange rate. For example, following an unanticipated monetary expansion at home, Obstfeld and Rogoff (1995) shows in their model that the shock would lead to a permanent change in the exchange rate, given that purchasing power parity holds in the short run and long run.

In investigating the relationship between exchange rate dynamics and the current account, Obstfeld and Rogoff (1995) use a two country model in which consumers produce differentiated goods. Further, they assume that there were a continuum of producers on the interval $z \in [0,1]$ with domestic producers on the interval $[0,n]$ and foreign producers on the interval $(n,1]$. In addition, they define $c(z)$ as the home consumption by the individual of product z. Accordingly, Obstfeld and Rogoff (1995) define the aggregate consumption index as

$$C = \left[\int_0^1 c(z)^{(\theta-1)/\theta} dz \right]^{\theta/(\theta-1)} \quad 5.1$$

with C been the domestic consumption index and $\theta > 1$ representing the elasticity of demand with respect to the relative price of foreign to domestic goods. Similarly, the price index is defined as

$$P = \left[\int_0^n p(z)^{1-\theta} dz + \int_0^1 \left[p^*(z) \right]^{1-\theta} dz \right]^{1/(1-\theta)} \quad \textbf{5.2}$$

where P is the domestic-currency price of good z, P^* is the price of the same good overseas adjusted by e the nominal exchange rate, so that one price can be maintained.

It is also assumed that there is no segmentation of markets and that identical preferences exists in both home and foreign countries so that the law of one price is obtains such that

$$P = eP^* \quad 5.3$$

As a result, purchasing power parity is assumed to hold.

Moreover**, t**he individual z 's dynamic budget constraint in the model is:

$$P_t F_t + M_t = P_t (1 + r_{t-1}) F_{t-1} + M_{t-1} + p_t(z) y_t(z) - P_t C_t - P_t T_t \quad 5.4$$

where F_t is the stock of bonds, M_t is the stock of money held by a home resident in period $t+1$, $y(z)$ is the individual's output and T is the real taxes paid to the domestic government. Here, Obstfeld and Rogoff (1995) assume that the individual is endowed

with only one asset, a real bond and that the capital market is riskless. The total revenue obtained from the sale of good z is $p_t(z)y_t(z)$.

Obstfeld and Rogoff (1995) employ a money-in-utility-function approach to define the preferences of the individual z in terms of consumption C_s, real money balances $\left(\frac{M}{P}\right)$ and the disutility of work $\left(-\frac{\kappa}{2}y_s^2\right)$, such that

$$U_t = \sum_{s=t}^{\infty} \beta^{s-t}\left[\log C_s + \frac{\chi}{1-\upsilon}\left(\frac{M_s}{P_s}\right)^{1-\upsilon} - \frac{\kappa}{2}y_s^2\right] \qquad 5.5$$

where $0<\beta<1$ and $\upsilon>0$.

Thus, maximising utility subject to the budget constraint gives

$$c_t = \left[\frac{p_t}{P_t}\right]^{-\theta} C_t \qquad \textbf{5.6}$$

where c_t is the home individual demand for product z. Moreover, given the symmetry of the model, the demand function is similar for foreign residents.

Obstfeld and Rogoff (1995) then show that a differential between domestic and foreign consumption in the short run, such as what could arise from a monetary shock, can have permanent effects on consumption differences such that

$$\hat{C}-\hat{C}^* = \bar{\hat{C}}-\bar{\hat{C}}^* \qquad \textbf{5.7}$$

where $\wedge$ denotes the percentage change from the baseline value in the short run and $\bar{\wedge}$ denotes the percentage change in long run value. In addition, the effect of an

unanticipated differential in money in both economies is captured by the money demand equation:

$$\left(\hat{M}-\hat{M}^*\right)-\hat{e}=\frac{1}{\upsilon}\left(\hat{C}-\hat{C}^*\right)-\frac{\beta}{(-\beta\,\upsilon)}\left(\bar{\hat{e}}-\hat{e}\right) \qquad \textbf{5.8}$$

assuming that interest parity holds in both the short run and long run, so that $\hat{e}$ is the exchange rate determined by the purchasing power parity in the short-term and $\bar{\hat{e}}$ likewise for the long term.

Obstfeld and Rogoff (1995) consider the Dornbusch (1976) exercise of an unanticipated rise in domestic money supply relative to money supply in the foreign economy to obtain

$$\bar{\hat{E}}=\left(\bar{\hat{M}}-\bar{\hat{M}}^*\right)-\frac{1}{\upsilon}\left(\bar{\hat{C}}-\bar{\hat{C}}^*\right) \qquad \textbf{5.9}$$

Here all variables are constant as they are expressed in the steady state. Substituting $\bar{\hat{e}}$ in 5.8 gives

$$\hat{e}=\left(\hat{M}-\hat{M}^*\right)-\frac{1}{\upsilon}\left(\hat{C}-\hat{C}^*\right) \qquad \textbf{5.10}$$

since 5.7 is assumed to hold and the supply shock is permanent so that

$$\hat{M}-\hat{M}^*=\bar{\hat{M}}-\bar{\hat{M}}^* \qquad \textbf{5.11}$$

Once $\bar{\hat{e}} = \hat{e}$ then short-term changes in the exchange rate is immediately carried forward to long term changes in the rate, as prices do not adjust in the short run. Thus from 5.8, this suggests that money differentials between economies are the same as consumption differentials between economies, so that economic agents expect a constant exchange rate.

It must be noted that Obstfeld and Rogoff (1995) model is constructed around the idea that price stickiness occurs as prices are set one period in advance, thus giving rise to short run and long run transmission effects. However, another form of price stickiness that can be assumed is with respect to the use of Calvo pricing, which is employed by Galí and Monacelli (2005).

6.0 The Galí and Monacelli (2005) Model

In contrast to Obstfeld and Rogoff (1995), Galí and Monacelli (2005) assume that there is a continuum of infinitesimally small open economies, with each been unable to influence world prices.[6] Their theoretical analysis is based on the assumption of two sectors, households and firms. In addition, they assume that capital markets are complete. Moreover, all goods are assumed to be tradable and prices are given in terms of domestic currency. Goods markets are assumed to be monopolistic and sticky prices are assumed to exist, with Calvo-type staggered price setting used to model price setting behaviour by firms. This allows them to analyse the impact of external disturbances where there exist market imperfections and nominal rigidities under alternative monetary regimes. In general, rigidities are assumed to exist as a result of market imperfections, price stickiness and product differentiation arising from the assumption of monopolistic competition.[7]

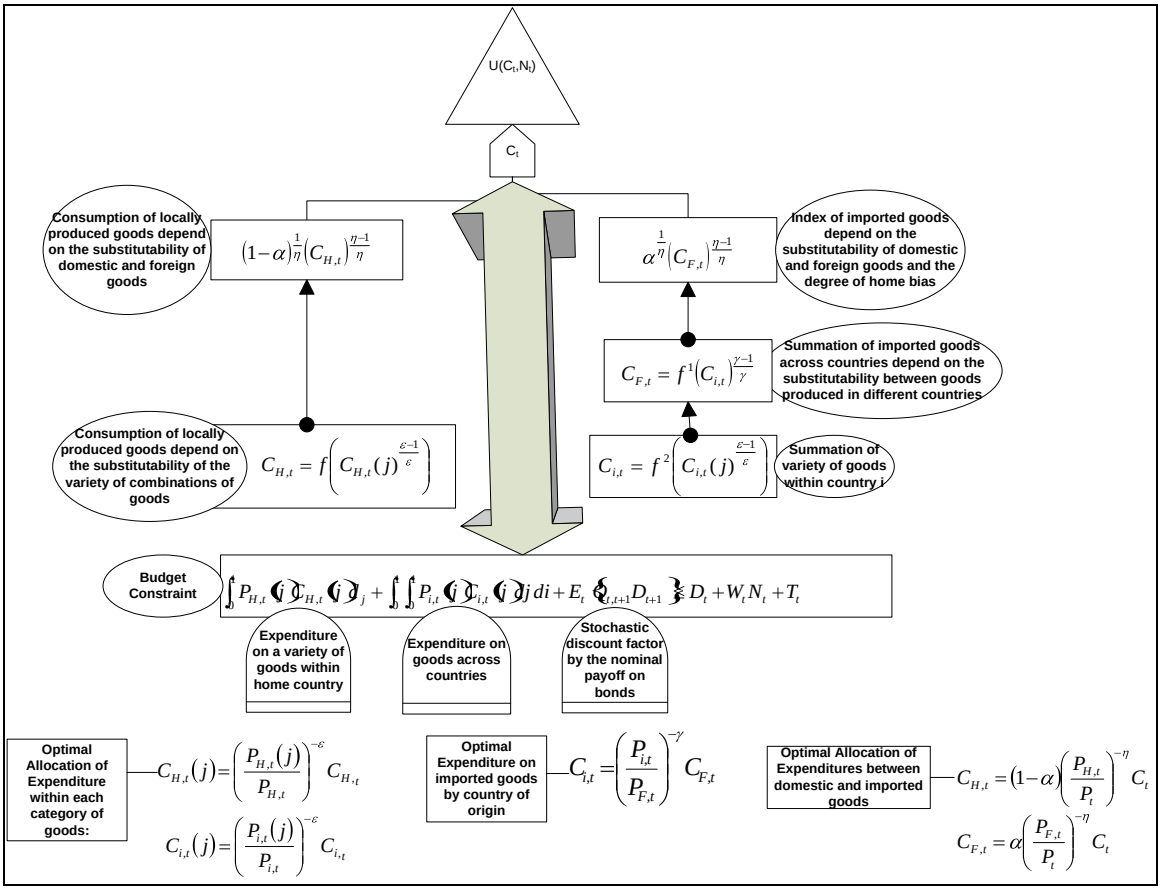
[6] Justiniano and Preston (2006) points out that the analysis of the continuum of economies would be similar if the analysis is conducted with respect to a small-large country pair.
[7] In their related model, Clarida et al (2002) further assume that rigidities exist with regards to wage determination in the labour market.

Galí and Monacelli (2005) show that the complex equations describing the economy can be reduced to two main expressions, the open economy new Keynesian Phillips curve which captures the implications of inflation and open economy IS curve which captures the effect of the real interest rate on the output gap. The coefficients of the variables in these two equations are influenced by the transmission of disturbances from the world economy to the domestic economy which in turn is affected by the substitution between varieties of goods and substitution between imported and domestic goods. Monetary policy exercised through the manipulation of the short-term policy rate can then be applied to see what are its implications for stability of the economy.

6.1 The Household's Problem

The derivation of the consumption demand equations in Galí and Monacelli (2005) is outlined in Box 1. The consumption of domestically produced goods depends on the elasticities of the consumption of domestic goods relative to imported goods and on the elasticity of substitution between a variety of goods. In addition, the consumption of imported goods is influenced by the substitutability of domestic and foreign goods, the substitutability between goods produced in different countries and the substitutability of a variety of goods produced within each country. Essentially, the utility function is maximised subject to a budget constraint, taking into consideration the various elasticities. This allows for the derivation of demand equations with respect to each category of goods within country, on imported goods across countries and on a variety of imports.

Box 1 Development of Demand functions



Galí and Monacelli (2005) assume that external disturbances impact on a representative household which seeks to maximise its utility over its lifetime. Accordingly, consumer preferences for foreign goods largely governs the transmission of external shocks to the domestic economy. The utility function of the representative consumer is specified as

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t) \qquad 6.1$$

where E is the expectations operator, β^t is the household's time discount factor as the household seek to maximise the expected present discount value of utility. C_t is a composite consumption index defined as a function of consumption of domestic goods and imported goods, and N_t is hours of labour.[8]

Aggregate consumption is decomposed into the consumption of domestically produced goods and the consumption of externally produced goods so that

$$C_t \equiv \left[(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \qquad 6.2$$

where $C_{H,t}$ and $C_{F,t}$ are indexes of the consumption of domestic and foreign produced goods respectively, expressed as a CES function. The openness of the economy is given by α, which is the weight on imported goods as we shall discuss below. [9] The elasticity of substitution between the demand for domestic and foreign goods is given by $\eta > 0$. The model immediately suggests that external disturbances enter the economy through the extent of consumer preferences for foreign goods and the elasticity of substitution between foreign and domestic goods, assuming constant elasticity of substitution.[10]

[8] The consumption function is based on the lifecycle hypothesis. It should be noted that the real money supply is not included in the utility function as in Obstfeld and Rogoff (1995) model. This is due to the fact that GM do not consider currency in their study as in OR.

[9] An issue which arises here is the degree of home biasness, which Justiano and Preston (2006) explicitly specified in their model. Here it is assumed that consumers may exercise preference for goods purely because they are produced at home. To capture the degree of home bias, Galí and Monacelli (2005) allowed $\alpha = [0,1]$ to be an indicator of this. Another issue that has received attention with respect to the consumption function, is the degree of habit persistence which has been modelled by allowing for the lagged adjustment of consumption.

[10] This is similar to Obstfeld and Roggof (1995) where it was assumed that utility maximizing consumers exercised their preference to allocate their expenditure between foreign and domestically produced goods

Consumption of domestic and imported goods is given by the equations

$$C_{H,t} \equiv \left(\int_0^1 C_{H,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad 6.3$$

and

$$C_{F,t} \equiv \left(\int_0^1 C_{i,t}^{\frac{\gamma-1}{\gamma}} di \right)^{\frac{\gamma}{\gamma-1}} \quad 6.4$$

$$C_{i,t} \equiv \left(\int_0^1 C_{i,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad 6.5$$

where $\varepsilon > 1$ is the elasticity of substitution between a variety of differentiated goods produced by monopolistic firms within country i while the elasticity of substitution of goods produced across countries is given by γ.[11] Moreover, it is assumed that there is a constant elasticity of substitution between differentiated goods in the utility function. It should be noted that to obtain the aggregate of imported goods, the j variety of goods are summed in two dimensions, between all country i's to obtain $C_{F,t}$ (6.1.4) and within each country i to obtain $C_{i,t}$ (6.5). Accordingly, $C_{i,t}$ is obtained from the summation of a variety j of goods imported from country i.

The representative household faces the decision problem of how to maximise its utility derived from a basket of goods subject to the budget constraint. The budget constraint is formulated so that households can spend no more than their return on capital (D_t)

[11] $\varepsilon > 1$ is a standard assumption in the general equilibrium framework. See for example Dixit and Stiglitz (1977), Walsh (2003) and Justiano and Preston (2006).

plus their income from labour $W_t N_t$ with W_t being the normal wage rate plus or minus lump-sum taxes and transfers (T_t) all expressed in terms of domestic currency. As a result, Galí and Monacelli (2005) specify the representative household budget constraint in the model as:

$$\int_0^1 P_{H,t}(j) C_{H,t}(j)\,dj + \int_0^1 \int_0^1 P_{i,t}(j) C_{i,t}(j)\,dj\,di + E_t\{Q_{t,t+1} D_{t+1}\} \leq D_t + W_t N_t + T_t \qquad 6.6$$

where $Q_{t,t+1}$ is the stochastic discount factor for one period ahead nominal payoffs of a riskless bond held by the household. Woodford (2003) points out that the stochastic discount factor arises as the value of the household portfolio in the future depends on the state of the world in the future. As a result when the portfolio choice is made, the household assumes that price would vary by a random factor. Moreover, utility in the future is valued less than current utility, hence causing the random factor to be discounted.

Here it is assumed that the household has the choice of allocating its income on a variety of domestic goods represented by the first term on the left hand side, a variety of imported goods captured by the second term on the left hand side and the final term on left hand side which represents a portfolio of shares in firms. As such, $P_{H,t}$ is the price index of the variety j of domestically produced goods with $j \in [0,1]$ such that $P_{H,t} \equiv \left(\int_0^1 P_{H,t}(j)^{1-\varepsilon} dj \right)^{\frac{1}{1-\varepsilon}}$; the price of a variety j of imports from country i is given by $P_{i,t}(j)$ such that the price index $P_{i,t} \equiv \left(\int P_{i,t}(j)^{1-\varepsilon} dj \right)^{\frac{1}{1-\varepsilon}}$ with $i \in [0,1]$. Galí and Monacelli (2005) also assume that the representative household can make a complete set of contingent claims that are traded internationally so that D_{t+1} is the return on the portfolio at $t+1$ in the future.

Maximising the utility function subject to the budget constraint yields the following demand equations:

$$C_{H,t}(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}} \right)^{-\varepsilon} C_{H,t} \qquad 6.7$$

$$C_{i,t}(j) = \left(\frac{P_{i,t}(j)}{P_{i,t}} \right)^{-\varepsilon} C_{i,t} \qquad 6.8$$

Equation 6.7 indicates that the proportion of expenditure on combination j is inversely related to its price relative to that of other home produced goods depending on the elasticity of substitution. Similarly, based on the elasticity of substitution, equation 6.8 shows that within country i there would also be an inverse relationship between the price of variety j and its consumption demand depending on the elasticity of substitution between varieties of differentiated goods. In addition, import demand by the home country for goods produced in country i would depend on the substitutability between goods produced by different foreign countries, so that

$$C_{i,t} = \left(\frac{P_{i,t}}{P_{F,t}} \right)^{-\gamma} C_{F,t} \qquad 6.9$$

with the price of aggregate imported goods given by $P_{F,t} \equiv \left(\int_0^1 P_{i,t}^{1-\pi} di \right)^{\frac{1}{1-\pi}}$ and consumption expenditure on imports is $\int_0^1 P_{i,t} C_{i,t} di = P_{F,t} C_{F,t}$.

As a result, the consumption mix between domestic and imported goods is given by

$$C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \qquad 6.10$$

$$C_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t \qquad 6.11$$

where

$$P_t \equiv \left[(1-\alpha)(P_{H,t})^{1-\eta} + \alpha(P_{F,t})^{1-\eta}\right]^{\frac{1}{1-\eta}} \qquad 6.12$$

is the consumer price index (CPI). This suggests that if domestic and foreign prices are equal, then α measures openness, as it captures the proportion of expenditure on imported goods, with $\alpha = 0$ implying a closed economy. In addition, the relative consumption expenditure on imported goods is based on the elasticity of substitution between imports and domestic goods.

Combining the expenditure on domestically produced goods and expenditure on imported goods the budget constraint in equation (6.6) can therefore be simplified to:

$$P_t C_t + E_t\{Q_{t,t+1} D_{t+1}\} \leq D_t + W_t N_t + T_t \qquad 6.13$$

As a special case, preferences can be assumed to take the form of a constant relative risk aversion utility function, such that

$$U(C, N) \equiv \frac{C^{1-\sigma}}{1-\sigma} - \frac{N^{1+\varphi}}{1+\varphi} \qquad 6.14$$

where σ is the coefficient of relative risk aversion which can be given as $\sigma = -cU''/U'$ and φ represents the inverse elasticity of the labour supply, that is the φ is the effect of domestic output on employment.[12] An important property of 6.14 is that the coefficient of relative risk aversion is assumed to be constant and increments of the marginal utility remains positive by dividing by the power. It should also be noted that the intertemporal elasticity of substitution is given by $\frac{1}{\sigma}$.

Two demand functions can be derived using this utility function. To do so, (6.14) can be inserted into (6.1) and maximised subject to the budget constraint in (6.13), to derive and express the first order optimality conditions such that

$$C_t^{\sigma} N_t^{\varphi} = \frac{W_t}{P_t} \qquad 6.15$$

and

$$\beta\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\left(\frac{P_t}{P_{t+1}}\right) = Q_{t,t+1} \qquad 6.16$$

The equation obtained in (6.15) suggests that the current allocations by households on consumption and labour hours are equated with the real wage. At the same time the domestic household intertemporal real consumption is equated with the investment expenditure on an internationally traded bond in domestic currency.

Dividing (16) throughout by $Q_{t,t+1}$ the stochastic Euler equation becomes

[12] The definition of the coefficient of risk aversion is called the Arrow-Pratt definition.

$$\beta R_t E\left\{\left(\frac{C_{t+1}}{C_t}\right)^{-\sigma}\left(\frac{P_t}{P_{t+1}}\right)\right\}=1 \qquad 6.17$$

with $R_t = \frac{1}{E_t\left\{Q_{t,t+1}\right\}}$ being the gross return on the riskless one period discount bond.[13]

The log-linearised versions of (15) and (17) are

$$w_t - p_t = \sigma c_t + \varphi n_t \qquad 6.18$$

and

$$c_t = E_t\left\{c_{t+1}\right\} - \frac{1}{\sigma}\left(i_t - E_t\left\{\pi_{t+1}\right\} - \rho\right) \qquad 6.19$$

such that $\rho \equiv \beta^{-1} - 1$ and CPI inflation is $\pi_t \equiv p_t - p_{t-1}$.

6.2 Effects of Openness on Prices

The bilateral nominal terms of trade can be defined as $S_{i,t} = \frac{P_{i,t}}{P_{H,t}}$, that is, the ratio of the price of goods imported from country i in relation to the price of home produced goods. The relative demand by the consumer for domestic and foreign goods is assumed to impact on the bilateral terms of trade. Given the large number of countries, the effective terms of trade is defined as:[14]

[13] The Euler equation is an intertemporal optimizing equation in which there are dynamic constraints, see Michael Wickens (2008).
[14] The effective terms of trade can be thought of as the average of the bilateral terms of trade.

$$S_t \equiv \frac{P_{F,t}}{P_{H,t}} = \left(\int_0^1 S_{i,t}^{1-\gamma} di \right)^{\frac{1}{1-\gamma}} \quad 6.20$$

which in log-linear terms can be approximated as

$$s_t = \int_0^1 s_{i,t} di \quad 6.21$$

Galí and Monacelli (2005) then relate CPI inflation to the terms of trade by assuming that purchasing power parity holds. According to Wickens (2008), purchasing power parity holds where the purchasing power of consumers in the home country is the same as those in the rest of the world. Assuming purchasing power parity with $P_{H,t} = P_{F,t}$, the CPI index described in (12) can be related to the terms of trade and approximated by

$$p_t \equiv (1-\alpha) p_{H,y} + \alpha P_{F,t} = p_{H,t} + \alpha s_t \quad 6.22$$

The relationships described in (21) and (22) are exact when $\eta = \gamma = 1$ and the log of the effective terms of trade is $s_t \equiv p_{F,t} - p_{H,t}$. Equation (6.22) therefore suggests that a change in the terms of trade has important effects on the movement of CPI inflation such that:

$$\pi_t = \pi_{H,t} + \alpha \Delta s_t \quad 6.23$$

where π_t is CPI inflation and domestic inflation is $\pi_{H,t} \equiv P_{H,t} - P_{H,t-1}$.

The exchange rate is introduced by assuming that it is market determined and the law of one price hold at all times with respect to import and export prices. As a result the price of the homogeneous variety j is assumed to be set in the currency of the

domestic producer. Hence $P_{i,t}(j) = \varepsilon_{i,t} P^i_{i,t}(j)$ for $i, j \in [0,1]$, where $\varepsilon_{i,t}$ is the bilateral nominal exchange rate defined as the price of country i's currency in terms of the price of the home country currency. Note that $P^i_{i,t}(j)$ is the price of variety *j* imported from country i and expressed in terms of the producer price of that country. As a result, the law of one price is maintained as firms exercise producer cost pricing. This suggests that there is no market segmentation so that a single price exists in the world for tradable homogeneous goods expressed in the same currency. Thus a single world price index adjusted by the nominal effective exchange rate can be obtained such that

$$P_{F,t} = \int_0^1 (\varepsilon_{i,t} + p^i_{i,t})\, di = e_t + p^*_t \qquad 6.24$$

where the log of the nominal effective exchange rate is given by $e_t \equiv \int_0^1 e_{i,t}$, the log of the domestic price index of country i is given by $p^i_{i,t} \equiv \int_0^1 p^i_{i,t}(j)$ with the world price index is given by $p^*_t \equiv \int_0^1 p^i_{i,t} di$. As a result, the log of the terms of trade formula can be written as

$$s_t = e_t + p^*_t - p_{H,t} \qquad 6.25$$

Galí and Monacelli (2005) went on tos find the relationship between the terms of trade and the real exchange rate. The bilateral real exchange rate is defined as the nominal exchange rate by the ratio of the CPIs between an external economy and the domestic economy, with both prices expressed in terms of domestic currencies such that: $\wp \equiv \frac{\varepsilon_{i,t} P^i_t}{P_t}$. The log of the real effective exchange rate can therefore be defined as

$q_t \equiv \int_0^1 q_{i,t} di$, where $q_{i,t} \equiv \log \wp_{i,t} = e_{i,t} + p_t^i - p_t$ which takes the form of the nominal exchange rate by the terms of trade. Thus

$$q_t = \int_0^1 (e_{i,t} + p_t^i - p_t)\, di \qquad 6.26$$

$$= e_t + p_t^* - p_t \qquad 6.27$$

Substituting (24) into (27) gives

$$q_t = s_t + p_{H,t} - p_t \qquad 6.28$$

from which

$$q_t = (1 - \alpha) s_t \qquad 6.29$$

where (22) is substituted into (28).

The equation suggests that there is a positive relationship between the terms of trade and the real exchange rate. For example, if the price of home goods falls (increases) relative to the price of imported goods, then this would cause the terms of trade to increase (fall), as can be seen by considering the definition of the terms of trade where $s_t \equiv p_{F,t} - p_{H,t}$. The importance of equation 6.29 is that it shows that the real exchange rate would also increase (fall), assuming that α does not change so as to offset the result.

6.3 International Risk Sharing

The absence of impediments to trade between economies in the Galí and Monacelli (2005) model can be offset by the fact that consumption may be disrupted by the risk of market failure. To this end, Corsetti et al. (2008) note that the assumption of complete markets is necessary in order to smooth trade. Wickens (2008) points out that the assumption of complete markets implies that each risk can be fully insured by the market. As a result, there can be a unique equilibrium price for each transaction as all risks arising from different states of nature are fully insured.

Galí and Monacelli (2005) assume that households trade consumption risk internationally as international financial markets are assumed to be complete. International risk sharing was assumed to allow for the insuring of risk of every type, see Obstfeld and Rogoff (1996). As a result there is the smoothing of consumption across time and states of nature so that risk does not dampen consumption and consumption is maintained in congruence with the world economy.

International risk sharing is obtained in the Galí and Monacelli (2005) model by including the nominal bilateral exchange rate so that the first order condition in (16) can be rewritten as

$$\beta\left(\frac{C_{i+1}^{i}}{C_{t}^{i}}\right)^{-\sigma}\left(\frac{P_{t}^{i}}{P_{t+1}^{i}}\right)\left(\frac{\varepsilon_{t}^{i}}{\varepsilon_{t+1}^{i}}\right)=Q_{t,t+1} \qquad 6.30$$

The key difference between (16) and (30) is that whereas (16) equates the intertemporal consumption in the domestic economy with the price of the internationally traded bond in domestic currency, (30) equates the intertemporal real consumption in an external economy in terms of domestic currency against the same price of the internationally traded bond held in domestic currency.

It should be noted that the bilateral exchange rate is included since it is assumed that firms are engaged in producer pricing, so that the export price is adjusted by the bilateral exchange rate to account for what consumers in country i pay. Moreover, equation (6.30) suggests that the price of future consumption demand adjusted by the real exchange rate risk is equated with the price of the bond. As such, by combining (16) with (30), consumption becomes

$$C_t = \vartheta_i C_t^i \wp_{i,t}^{\frac{1}{\sigma}} \qquad 6.31$$

where ϑ_i is a constant which depends on initial conditions where the environment is identical and symmetric such that each country do not initially hold net foreign assets. In this particular case it is assumed that $\vartheta_i = \vartheta = 1$. As such risks are traded away with $\wp = S_i = 1$ so that purchasing power parity holds for all economies. Perfect foresight is assumed, thus allowing $C = C^i = C^*$. The perfect foresight assumption is used to remove the complexities associated with uncertainty. As a result, the consumers are assumed to make decisions on the basis of the intrinsic logic of the model as opposed to through the use of arbitrary assumptions on consumer expectations, see for example Obstfeld and Rogoff (1996).

Equation (6.31) can be approximated around a steady state and integrated over i to obtain

$$c_t = c_t^* + \frac{1}{\sigma} q_t \qquad 6.32$$

where $c^* \equiv \int_0^1 c_t^i di$ represents the log of the index of world consumption.

Substituting (29) into (32) gives

$$c_t = c_t^* + \left(\frac{1-\alpha}{\sigma}\right)s_t \qquad 6.33$$

For equality (6.33) to hold, it is important that $\eta \neq 1$.[15] Thus according to Galí and Monacelli (2005), the assumption of complete markets allows for a simple relationship between domestic consumption with world consumption and the terms of trade.

6.4 Uncovered Interest Parity and the Terms of Trade

The interest rate arises in the model from the trading of bonds. The interest rate differential from the trading of a locally denominated bond and a foreign denominated bond is derived within an uncovered interest rate parity framework. Both bonds are riskless with the domestic price of the foreign currency denominated bond being $\varepsilon_{i,t}\left(R_t^i\right) = E_t\left(Q_{t,t+1}\varepsilon_{i,t+1}\right)$ and that of the domestic currency denominated bond is $\left(R_t\right)^{-1} = E_t\left(Q_{t,t+1}\right)$. Thus, assuming uncovered interest rate parity, the differential between domestic and external return in terms of domestic currency can be expressed as

$$E_t\left(Q_{t,t+1}\left[R_t - R_t^i\left(\varepsilon_{i,t+1}/\varepsilon_{i,t}\right)\right]\right) = 0 \qquad 6.34$$

Assuming perfect foresight steady state, then approximating (6.34) by log linearizing with respect to i gives

$$r - r^* = E_t\left(\Delta e_{t+1}\right) \qquad 6.35$$

[15] If there is perfect substitution between import and domestic prices, such that $\eta = 1$, then this would necessitate a different form of the CPI and consumption indices. As such, the CPI and consumption indexes would from equations 6.12 and 6.2 to become $P_t = \left(P_{H,t}\right)^{1-\alpha}\left(P_{F,t}\right)^{\alpha}$ and $C_t = \frac{1}{(1-\alpha)^{(1-\alpha)}\alpha^{\alpha}} C_{H,t}^{1-\alpha}$ respectively.

where r^* is the world interest rate.

Substituting (6.25) into (6.35) gives

$$s_t = \left(r_t^* - E_t\,\pi_{t+1}^*\right) - \left(r_t - E_t\,\pi_{H,t+1}\right) + E_t\,s_{t+1} \qquad 6.36$$

Solving forward, (6.36) becomes

$$s_t = E_t\left\{\sum_{k=0}^{\infty}\left[\left(r_{t+k}^* - \pi_{t+k+1}^*\right) - \left(r_{t+k} - \pi_{H,t+k+1}\right)\right]\right\} \qquad 6.37$$

which suggests that the terms of trade are influenced by current and anticipated real interest rate differentials.

6.5 Firms

6.5.1 Technology

In the Galí and Monacelli (2005) model, firms are assumed to be identical in cost and operate in monopolistic markets. Each firm produces a continuum of differentiated goods using linear technology. As a result, the production function is specified as:

$$Y_t(j) = A_t N_t(j) \qquad 6.38$$

where $j \in [0,1]$ and A_t is stochastic disturbance to technology which is assumed to follow an autoregressive process.[16] As such, $a_t \equiv \log A_t$ which can be specified as an

[16] See Woodford (2003).

AR(1) process such that $a = \rho_a a_{t-1} + \varepsilon_t$. The linear technology suggests that there is a one to one correspondence between output and incremental increases in labour supply.

Also, the first order approximation of the production function in equation (6.38) is:

$$y_t = a_t + n_t \qquad 6.39$$

In addition to technological innovations, external shocks are assumed to impact through the pass through of external prices on inflation via its effect on the marginal cost.[17] To see this assume that the typical domestic firm has real marginal cost

$$mc_t = -v + w_t - p_{H,t} - a_t \qquad 6.40$$

with $v \equiv -\log(1-\tau)$ where τ is the employment subsidy. The subsidy plays the role of offsetting the distortion in the real wage created by monopolistic competition in the goods market. The real marginal cost is essentially the discrepancy between the marginal supply cost and the product price, that is the nominal marginal cost divided by the price level, see Rudd and Whelan (2002). In this case it would be the wage rate in relation to the product price, subsidy and technological level in the last period.

Summing all the differentiated goods of the firm, its output Y_t is $Y_t = \left[\int_0^1 Y_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}}$. Accordingly, Galí and Monacelli (2005) relate the production

[17] This is also elaborated on by Justiniano and Preston (2006).

function directly to the employment index where $N_t \equiv \int_0^1 N_t(j)dj = \frac{Y_t Z_t}{A_t}$ with $Z_t \equiv \int_0^1 \frac{Y_t(j)}{Y_t} dj$.

6.5.2 Price Setting

Borrowing from Calvo (1983), Galí and Monacelli (2005) assume that price adjustment is staggered thus causing price rigidities. These price rigidities give rise to the short-run trade-off between inflation and output.

In each period, a randomly selected number of firms are assumed to set new prices optimally at $\bar{p}_{H,t}$ to maximise their expected profits. For each firm, the probability of price being sticky is given by the constant θ so that there is a constant probability of $1-\theta$ that it would receive the signal to re-optimize its nominal price. [18] Where the firm re-optimises it does so in a bid to minimise the variance between its price and the optimum price. Using a log-linear rule, the log of the forward looking new domestic price ($\bar{p}_{H,t}$) in each period is a function of the proportion of firms that re-optimise. As a result the new price can be approximated by

$$\bar{p}_{H,t} = \mu + (1-\beta\theta)\sum_{K=0}^{\infty}(\beta\theta)^K E_t\{mc_{t+k}\} + P_{H,t} \qquad 6.41$$

where $\mu \equiv \log\left(\frac{\varepsilon}{\varepsilon - 1}\right)$ is the log of the optimal markup on the steady state.

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[18] A variant of the Galí and Monacelli model as assumed by Justiniano and Preston (2006), is that the remaining firms set price $P_{H,t}(i)$, using an indexation rule where $\log P_{H,t}(i) = \log P_{H,t-1}(i) + \delta\pi_{H,t-1}$.

Here it is assumed that the firm which re-optimises its price take a forward looking view of its real marginal cost and therefore re-optimises its price taking these expectations into account.[19] The firm takes a forward view of the real marginal cost since it expects the newly set price to exist for a while before it can be changed. Accordingly $\bar{p}_{H,t}$ is set as a weighted average of expected future marginal costs. For the flexible price limit which is obtained where $\theta \to 0$, Galí and Monacelli (2005) points out that the markup rule would be

$$\bar{P}_{H,t} = \mu + mc_t + p_{H,t} \qquad 6.42$$

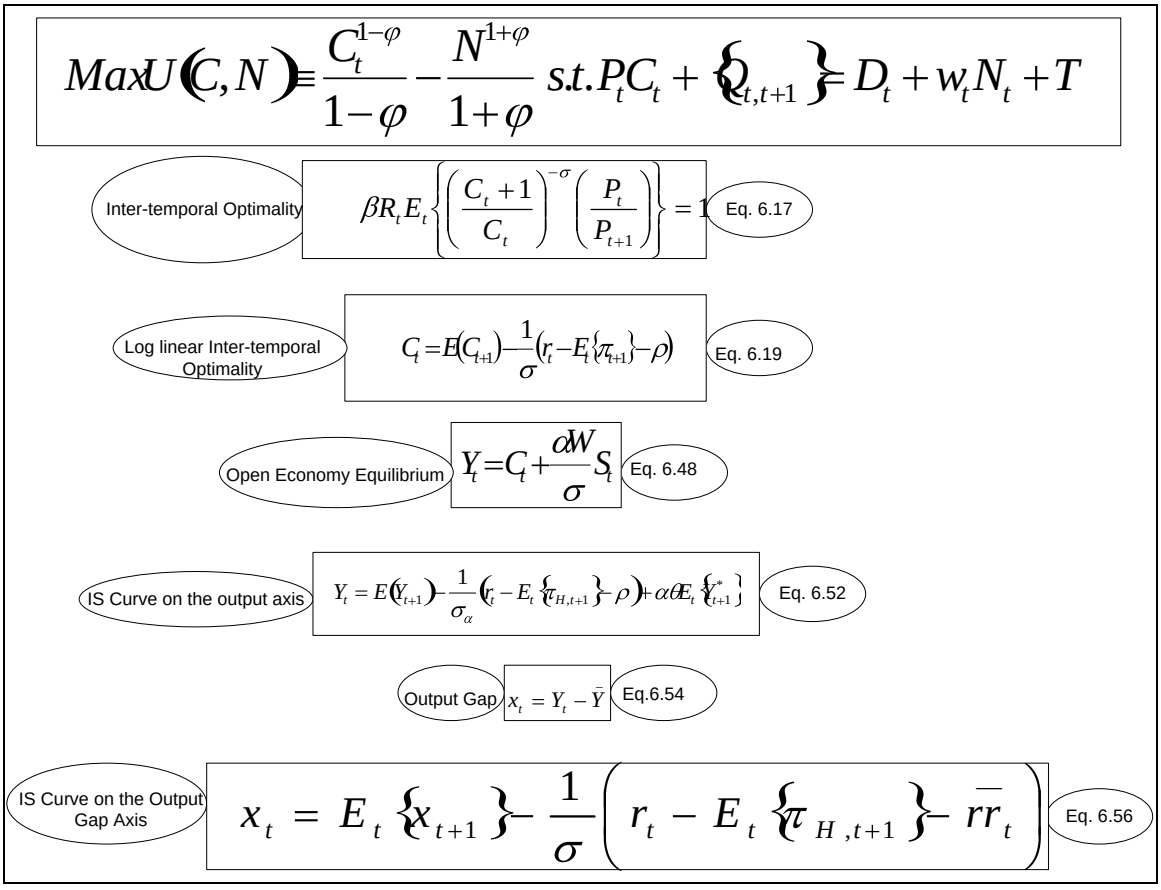
6.6 IS and Phillips curves

6.6.1 Examination of the Demand side

The critical steps used to derive the IS curve in the Galí and Monacelli (2005) model are outlined in Box 2. Essentially, the log linear specification of the inter-temporal optimality is substituted into the open economy equilibrium in order to derive the IS curve.

[19] Eichenbaum and Fisher (2003) also assumes that those firms which do not reoptimise their price update their price based on the long-run average gross rate of inflation.

Box 2: Critical Equations for the Derivation of the IS Curve



In order to find market clearing between output and consumption, the production of variety j in the home country ($Y_t(j)$), can either be consumed at home $C_{H,t}(j)$ or in country i. As a result, for a given variety

$$Y_t(j) = C_{H,t}(j) + \int_0^1 C^i_{H,t}(j)\,di$$

$$= \left(\frac{P_{H,t}(j)}{P_{H,t}} \right)^{-\varepsilon} \left[(1-\alpha) \left(\frac{P_{H,t}}{P_t} \right)^{-\eta} C_t\,di + \alpha \int_0^1 \left(\frac{P_{H,t}}{\varepsilon_{i,t} P^i_t} \right)^{-\gamma} \left(\frac{P^i_{F,t}}{P^i_t} \right)^{-\eta} C^i_t\,di \right] \quad \text{.....(6.43)}$$

where $C_{H,t}(j)$ is the demand for variety (j) in the domestic economy and the second equality follows from (9) to (11). Here $C^{i}_{H,t}(j)$ is the demand by country i for variety j produced in the domestic economy. Hence consumption of output is divided between the domestic and external economy. It should be noted that in the domestic economy the consumption of variety j is inversely related to the price elasticity of substitution between the variety of locally produced goods, the terms of trade and the price elasticity of domestically produced goods to total goods available in the domestic economy. With respect to the external demand for the home country produce, the demand for combination j is dependent on the degree of openness of the home economy, as well as the price elasticity of substitution across external economies and within economy i.

Galí and Monacelli then show that the market clears when

$$Y_t = \left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t \left[(1-\alpha) + \alpha \int_0^1 (S^i_t S_{i,t})^{\gamma+\eta} \wp^{\eta-\frac{1}{\sigma}}_{i,t} di\right] \qquad 6.44$$

given that $Y_t \equiv \left[\int_0^1 Y_t(j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}}$, S^i_t is the effective terms of trade of country i and $S_{i,t}$ is the bilateral terms of trade of domestic goods to foreign produced goods. This suggests that home output clears where it is equal to home expenditure on domestic and externally produced goods.

Where $\sigma = \eta = \gamma = 1$ and the typical household reflects symmetrical preferences across countries then the CPI index becomes [20]

[20] Wickens (2008) suggests that perfect substitutes as would be obtained where $\sigma = \eta = 1$, would imply constant terms of trade and a single world price.

$$P_t = \left(P_{H,t}\right)^{1-\alpha}\left(P_{F,t}\right)^{\alpha} \quad 6.45$$

The CPI equation noted in (6.22) is now expressed as a Cob Douglas function by imposing the restrictions of constant and perfect elasticity of substitution. As a result, α is constant and now acts as the elasticity of substitution between imports and domestically produced goods. As noted in (6.12), α then becomes the proportion of domestic consumption allocated to imports and therefore the elasticity of imports to domestic consumption.

As a result, dividing by $P_{H,t}$, (6.45) becomes

$$\frac{P_t}{P_{H,t}} = \left(\frac{P_{F,t}}{P_{H,t}}\right)^{\alpha} = S_t^{\alpha} \quad 6.46$$

Consequently, where $\sigma = \eta = 1$ the market clears in (6.47), given that the terms of trade are unity, with output in the economy equal to the real composite consumption index in an open economy context such that

$$Y_t = C_t S_t^{\alpha} \quad 6.47$$

Galĺ and Monacelli (2005) point out that a first order log linear approximation can be derived around a symmetric steady state such that

$$y_t = c_t + \alpha\gamma s_t + \alpha\left(\eta - \frac{1}{\sigma}\right)q_t = c_t + \frac{\alpha\omega}{\sigma}s_t \quad 6.48$$

where $\omega \equiv \sigma\eta + (1-\alpha)(\sigma\eta - 1)$[21]. Accordingly, $\omega = 1$ when $\sigma = \eta = 1$. This suggests that under these circumstances the open economy demand is extended purely by the degree of openness and the terms of trade when compared to the closed economy. As such elasticity effects disappear from the equilibrium obtained in (48). However, the elasticity effects enter the equilibrium when $\omega > 1$ (<1) if and only if $\sigma\eta > 1$ (<1). Another point to observe is that the terms of trade is considered here to improve where $P_{H,t} > P_{F,t}$ or $s_t < 0$, since this suggests that what is received for a unit of domestic good is higher than what the country must pay for the same unit of import. As such improvements in the terms of trade would have a negative effect on output, or according as suggested by Clarida (2007) it leads to a negative substitution effect.

Moreover, world market equilibrium can be expressed as

$$y_t^* \equiv \int_0^1 y_y^i di = \int_0^1 c_t^i di \equiv c_t^* \qquad 6.49$$

where y_t^* and c_t^* are indexes of world output and world consumption in log terms respectively.

Combining (6.47) with (6.19) gives

$$y_t = E_t\{y_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - \rho) - \frac{\alpha\omega}{\sigma} E_t\{\Delta s_{t+1}\} \qquad 6.50$$

$$= E_t\{y_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{H,t+1}\} - \rho) - \frac{\alpha\Theta}{\sigma} E_t\{\Delta s_{t+1}\} \qquad 6.51[22]$$

[21] The steady state refers to the long run path when all past shocks have fully worked through the system.

[22] To substitute ω in 6.50 with Θ in 6.51, $\omega = \sigma\eta + (1-\alpha)(\sigma\eta - 1)$ can be expanded to be equal to $\sigma\eta - 1 - \alpha\sigma\eta + \alpha = \sigma\eta(2-\alpha) + \alpha - 1$. Multiplying ω by $\frac{-1}{-1}$ and adding and subtracting 2 on the

$$= E_t\{y_{t+1}\} - \frac{1}{\sigma_\alpha}(i_t - E_t\{\pi_{H,t+1}\} - \rho) + \alpha\Theta E_t\{\Delta y^*_{t+1}\} \quad 6.52^{23}$$

where

$$\sigma_\alpha \equiv \frac{\sigma}{(-\alpha) + \alpha\omega} > 0 \quad 6.53$$

which is impacted on by the degree of openness, substitutability between domestic and foreign goods and $\Theta \equiv (-\alpha)(\sigma\eta - 1) = \omega - 1.$

Equation (6.52) shows that all things being equal an increase in openness, increases σ_α thus reducing the slope parameter, $\frac{1}{\sigma_\alpha}$.[24] This would suggest that output would be more responsive to a change in the real interest rate.

6.6.2 Derivation of the IS curve

The output gap is defined as

$$x_t \equiv y_t - \bar{y}_t \quad 6.54$$

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right hand side gives $\omega = \frac{[\sigma\eta(2-\alpha)-(1-\alpha+2-2)]}{-1} = \frac{[\sigma\eta(2-\alpha)-(2-\alpha)-2+1]}{-1} = (2-\alpha)(\sigma\eta - 1) + 1$. This implies that $\Theta \equiv (2-\alpha)(\sigma\eta - 1) = \omega - 1$.

[23] Given that c_t is the perfect foresight steady state consumption, it is constant in the longrun. Thus in the longrun, Δs_t directly impact Δy_t in equation 6.48, all things been equal. Thus Δy_t is substituted in 652 in place of Δs_t.

[24] It can also be noted that the further $\sigma\eta$ increases above one, the flatter the slope of equation (52) becomes. However, Galí and Monacelli (2005) controls for this possibility by assuming that $\sigma = \eta = 1$, so that the slope is solely dependent on the degree of openness.

where the domestic natural level of output is expressed as $\bar{y}$. Galí and Monacelli (2005) derived $\bar{y}$ as

$$\bar{y}_t = \Omega + \Gamma a_t + \alpha\psi y_t^* \qquad 6.55$$

with $\Omega \equiv \frac{\nu - \mu}{\sigma_\alpha + \varphi}$, $\Gamma \equiv \frac{1+\varphi}{\sigma_\alpha + \varphi} > 0$ and $\psi \equiv -\frac{\Theta\sigma_\alpha}{\sigma_\alpha + \varphi}$.

As shown by (6.55), all things being equal, the natural level of output is increasing in world output. The equation is critical as it suggests that the natural rate would expand if there are technological progress, an increase in openness and or growth in world output. This is also supported by Wickens (2008) who notes that in an open economy, output can be expanded beyond domestic consumption as a result of an expansion in investments thus allowing output to increase, resulting in the export of surpluses. Moreover, imported capital goods can boost further production.

From (6.52), a version of the IS curve with respect to the output gap can be derived as

$$x_t = E_t\{x_{t+1}\} - \frac{1}{\sigma_\alpha}\left(r_t - E_t\{\pi_{H,t+1}\} - \bar{rr}\right) \qquad 6.56$$

where the natural rate of interest is given by

$$\bar{rr}_t \equiv \rho - \sigma_\alpha\Gamma(1-\rho_a)a_t + \alpha\sigma_\alpha(\Theta + \Psi)E_t\{\Delta y_{t+1}^*\} \qquad 6.57$$

From (6.52), the slope of the IS becomes flatter as openness increases. According to Clarida (2007), the monetary authority gets more bang from every change in the real

interest rate the more open the economy is. Consequently, we can draw the IS curve flatter for the open economy.

6.7 Supply Side of the Economy

The derivation of the Phillips curve can be traced through the intratemporal elasticity condition as shown in Box 3. The movement from the closed to open economy Phillips curve is dependent on the specification of the marginal const with respect to firms. Galĺ and Monacelli (2005) arrive at the open economy Phillips curve through a series of substitutions into the closed economy Phillips equation.

Box 3: Critical Equations for the Derivation of the Open Economy Phillips Curve

$$Max U(C,N) \equiv \frac{C_t^{1-\varphi}}{1-\varphi} - \frac{N^{1+\varphi}}{1+\varphi} \quad s.t. P_t C_t + \{Q_{t,t+1}\} = D_t + w_t N_t + T$$

Constant Relative Risk Aversion Utility Function Eq.6.14

Intra-temporal elasticity condition

Eq 6.18

$$W_t - P_t = \sigma C_t + \varphi n_t$$

Phillips Curve Format

Eq. 6.58

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \lambda \hat{mc}_t$$

Closed Economy Marginal Cost

Eq. 6.60

$$mc_t = -\nu + w_t - P_{H,t} - a_t$$

Open Economy Marginal Cost

Eq. 6.63

$$mc_t = -\nu + (\sigma_\alpha + \varphi) y_t + (\sigma - \sigma_\alpha) y_t^* + (1+\varphi) a_t$$

Eq. 6.64

$$\hat{mc}_t = (\sigma_\alpha + \varphi) x_t$$

New Keynesian Phillips Curve

Eq. 6.65

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \kappa_\alpha x_t$$

In broad terms the real marginal cost and expected inflation are assumed to have a critical influence on the current inflation rate. As a result domestic inflation is described as

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \lambda \hat{mc}_t \qquad 6.58$$

where

$$\lambda \equiv \frac{(1-\beta\theta)(1-\theta)}{\theta} \qquad 6.59$$

and mc_t is the log deviation of the real marginal cost from its steady state value. The probability of an individual firm reopotimising is assumed to be independent of the probability of the time lapsed since the last price adjustment. Here it is assumed that the old price is relevant to the firm up to the period it is reoptimised. Note that λ is like the odds of a firm reoptimising its price so that the inflation level is higher when the odds of a firm reoptimising its price increases.

The real marginal cost in the closed economy can be expressed through the equation

$$mc_t = -v + (w_t - p_{H,t}) - a_t \qquad 6.60$$

Equation (6.60) can be expanded with substitutions to arrive at the open economy real marginal cost with respect to the impact of the terms of trade and the wealth effects of trade on domestic consumption as well as the world output.[25] Adding $-p_t + p_t$ gives,

$$mc_t = -v + (w_t - p_t) + (p_t - p_{H,t}) - a_t \qquad 6.61$$

$= -v + \sigma c_t + \varphi n_t + \alpha s_t - a_t$ substituting from equations (6.18 and 6.22)

$$= -v + \sigma y_t^* + \varphi y_t + s_t - (1+\varphi) a_t \text{ substituting from (6.33, 6.40 and 6.49)} \qquad 6.62$$

The last equality suggests that the real marginal cost is increasing in world output, domestic output and the terms of trade.

[25] The terms of trade and the wealth effects are analogous to the substitution and income effects referred to by Clarida (2007).

Alternatively, the substitution effects captured through the addition and subtraction of σ_α into the open economy, can be introduced to the real marginal cost equation such that

$$mc_t = -v + (\sigma_\alpha + \varphi)\hat{y}_t + (\sigma - \sigma_\alpha)\hat{y}_t^* - (1+\varphi)a_t \qquad 6.63$$

This suggests that the effect of a change in domestic output on real marginal cost is dependent on the substitutability between domestic and foreign goods and the wealth effect as a result of changes in employment which is spurred by changes in the wage rate.[26] Note that the inclusion of the substitution effect would dampen the effect of an increase in world output on the marginal cost once $\sigma_\alpha < \sigma$. It is also important to note that a change in world output comes through the substitution effect captured as σ_α which is dependent on the degree of openness. At the limit if $\sigma = \sigma_\alpha$ as would be obtained when $\alpha = 0$, then there would be no spill-over from changes in world output to marginal cost in the domestic economy.

In terms of the output gap, its relation with the real marginal cost becomes

$$\hat{mc}_t = (\sigma_\alpha + \varphi)\hat{x}_t \qquad 6.64$$

So that the NKPC is

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \kappa_\alpha x_t \qquad 6.65$$

with $\kappa_\alpha \equiv \lambda(\sigma_\alpha + \varphi)$.

[26] The wealth effect referred to by Galí and Monacelli (2005), is analogous to the income effect referred to by Clarida (2007).

Critical here is the magnitude of the slope coefficient κ_α. The size of the slope depends on the substitution and wealth effects of changes in the output gap on account of openness of the economy and the degree of substitutability between goods. However, all things been equal, σ_α increases with expansions in the degree of openness given equation (6.53) providing that $\sigma\eta > 1$. This therefore suggests that the slope κ_α would be influenced by the degree of openness given its influence on σ_α such that the slope of the new Keynesian curve becomes flatter as the degree of openness increases.[27] Nevertheless, by allowing $\sigma = \sigma_\alpha$, k_α reverts to that of the closed economy so that the slope would be dependent on the relative sizes of the intertemporal substitutability and the wealth effects akin to the closed economy. From an examination of (63) it should be noted that external output does not act through the wealth channel on the real marginal cost of the domestic economy. Rather a change in external output comes though the substitution effect. However, a change in domestic output comes through the combination of the wealth and substitution effect.

6.8 The Monetary Reaction Function

A monetary reaction function is needed to close the model as shown in Figure 1 in chapter 2. For monetary policy to be optimum Galí and Monacelli (2005) contends that it should replicate the flexible price equilibrium in order to achieve a stable equilibrium. This equilibrium is a steady state one in which the markup on real marginal costs are stabilized to their long-run level thus allowing domestic prices to be stabilized. To attain such an equilibrium, all of the distortions assumed in the formulation of the IS and new Keynesian Philips curve were removed. These frictions were with respect to:

1) Employment/wage distortion caused by market power of firms. To remove this, Galí and Monacelli (2005) applied an employment subsidy τ which is

[27] In Clarida (2007) the Phillips curve becomes flatter when the income effects outweigh the terms of trade effects.

incorporated in equation (6.39). As a result the employment subsidy neutralizes the market power of the firms.

2) Terms of trade distortion arising from imperfect substitution between domestic and foreign goods. Equation (6.48) suggests that an implication of this is that an improvement in the terms of trade where $P_{H,t} > P_{F,t}$, would have a negative effect on output once $\omega \geq 1$. Galí and Monacelli (2005) removes this distortion by assuming that the law of one price holds and they therefore consider the special case where $\sigma = \eta = \gamma = 1$. This therefore allows for perfect elasticity of substitution so that the substitution effect is cancelled out.

3) This left only the price stickiness distortion to be addressed. This friction is addressed through the implementation of monetary policy.

Galí and Monacelli (2005) noted that the traditional Taylor rule is a possible form of the reaction function, where the central bank is assumed to adjust the short-term interest rate in response to the deviation of inflation or the output gap from their target values. Here it is assumed that the central bank only cares about domestic inflation and the output gap and manages it through the short term nominal interest rate according to the Taylor rule.

Consequently, the central bank is assumed to be committed to the Taylor rule in an economy where the only remaining rigidity is price stickiness. Inflation persistence is ruled out as the central bank implements the Taylor rule around an inflation rate that is zero on average around a steady state equilibrium such that

$$x_t = x_{H,t} = 0 \tag{6.65}$$

This leaves r to respond to short term deviations of output or inflation from their long run equilibrium path while the natural rate of interest is impacted on by the degree of openness. In the model, openness impact on the sensitivity of inflation and output deviations to changes in the short-term interest rate. The monetary authority can therefore be assumed to follow the traditional Taylor rule, where

$$r_t = \bar{rr} + \phi_\pi \pi_{H,t} + \phi_x x_t \qquad 6.66$$

Importantly, the exposure to external disturbances in this economy is realised through changes in the structural relationships that govern the IS and new Keynesian Phillips curve, rather than through their direct inclusion of such disturbances or exchange rates into the Taylor rule equation.

7.0 Implications of the IS and PC for the monetary reaction function

One way of analysing the importance of the Galí and Monacelli (2005) open economy IS and PC equations for the Taylor rule, is to see how openness extends the ideas espoused for the closed economy Taylor (1993) rule. For this reason, it is instructive to see how the open economy ideas add to the closed economy graphically depicted in Carlin and Soskice (2005). To this end, we first replicate the closed economy model outlined by Carlin and Soskice (2005).

Unlike Carlin and Soskice (2005) model, inflation persistence is not assumed as Galí and Monacelli (2005) rules out average inflation bias with inflation mean reverting to zero. The version of the Phillips curve specified by the former is based on the assumption that inflation is persistent so that inflationary bias is assumed to exist. Inflation bias is assumed to exist where expected inflation is greater than the inflation target. As a

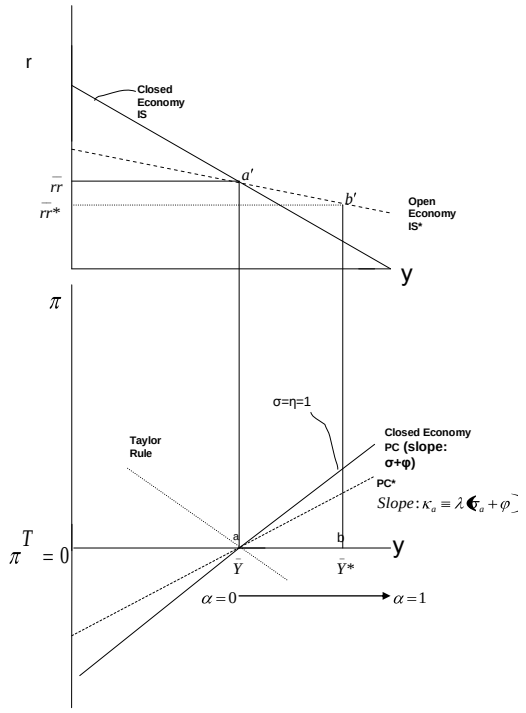
result the inertial rate of inflation is the shift factor of the Phillips curve.[28] Monetary policy is therefore assumed to act with a lag of at least one year.

To discover the implications of the Galí and Monacelli (2005) model, we superimpose our interpretation of the open economy equations. Our benchmark model as outlined in Carlin and Soskice (2005) is laid down with the use of bold lines. The IS curve is drawn separately and placed in the diagram above the Phillips curve to emphasize the implications of the latter for changes in the real interest rate. The natural rate of output ($\bar{Y}$) is drawn vertical to capture the long-run equilibrium output. In this way, the difference between actual output and the natural rate in (54) captures the output gap on the horizontal axes of both diagrams.

In the Galí and Monacelli (2005) model, inflation bias is assumed to be removed by government through an employment subsidy that is geared to offset the effects of market power on price. Consequently the Phillips curve is based on a forward looking assumption as current inflation is related to expectations of future inflation. They therefore make use of the expectations hypothesis.

[28] By inertial inflation it is assumed that continuous change in prices take place on the basis of last period contract.

Figure 2 Equilibrium Determination and Monetary rule



We summarise the canonical representation of the Galí and Monacelli (2005) model in Figure 2. Under the assumptions outlined in the study, three key results can be llustrated in the Figure:

a) Increased openness allows the natural rate of output shown a Y^* to expand beyond that of the closed economy, see equation (6.55).

b) The open economy IS and open economy Phillips curves shown as IS* and PC* are flatter than their closed economy counterparts, once $\sigma_\alpha < \sigma$, see equations (6.52) and (6.65).

c) The open economy Phillips curve collapses to that of a closed economy Phillips curve once $\sigma_\alpha = \sigma$, see equation (6.53).

8.0 Limitations of the Galí and Monacelli (2005) model

Two principal limitations with respect to the Galí and Monacelli (2005) model can be noted. Firstly, the incorporation of the external economy disturbances is incomplete. This is partly due to the fact that it does not allow for supply spillovers from the external economic cycles of the trading partners of the domestic economy to the marginal cost of domestic firms. By assuming perfect intertemporal substitution and perfect substitution between domestic and foreign goods, they arrive at the law of one price.. As a result, by substituting $\sigma = \eta = \gamma = 1$ in (6.53) and (6.63) it can be seen that the terms of trade would be kept at unity and there is no spillover from external output to the marginal cost of firms in the domestic economy so that the marginal cost is shaped solely by domestic factors.

Later, Clarida (2007) showed that supply spillovers from external output to potential domestic output and the real interest rate can be obtained by relaxing the perfect elasticity of substitution assumption when $\sigma > 1$. He supported this by suggesting that as foreign output rises the terms of trade improves for the domestic economy which pulls up the domestic output as labour reacts positively to higher rewards. Thus according to Carida (2007) the substitution effect takes place which boost domestic potential output.

Secondly, the manner of incorporation of the exchange rate into the model is limited for the following reasons:

1. It assumes that the only price target of policy makers is the inflation target. It does not therefore consider the idea of policy makers targeting a hybrid of

inflation and exchange rate deviations. As a result different exchange rate regimes with varying degrees of floats were not considered.

2. It assumes that the domestic currency is internationally acceptable as the means of payment. This however, is not the case for emerging markets.

3. It ignores the expenditure switching effect of the exchange rate. This is particularly as a result of the assumption of perfect substitution such that the exchange rate is dependent on the parity relationship with respect to the terms of trade.

Batini and Levine (2007) develop on the first two points. On the first point, they investigate the use of the Taylor rule under different degrees of exchange rate flexibility in emerging economies and consequently recommend the inclusion of the exchange rate in the reaction function. They note that exchange rates may be unstable in emerging markets as these economies may often suffer external shocks and may be prone to suffering reversals in foreign exchange earnings. Moreover, the availability of foreign exchange is a constraining factor to the maintenance of a stable exchange rate. Thus according to them, where exchange rate stabilization is therefore the choice of exchange rate policy, the country should consider the inclusion of the exchange rate into the Taylor rule in a bid to stabilize both inflation and the exchange rate.

To construct their model, they assumed the existence of a two-block market: the emerging market and the rest of the world (ROW). The emerging market bloc consists primarily of households, firms and government. For the household sector they assumed that households exhibit a preference not only for consumption and labour, but also for real domestic and real foreign end of period currency balances. Here, money acts as a substitute to both consumption and leisure. The demand for money balances are for transaction purposes which are influenced by the exchange rate movements. As such, foreign currency balances are required to allow the home country to engage in transactions with the rest of the world.

The production side in the emerging market is vertically integrated with respect to three types of firms, wholesale, retail and capital producing firms. Retail firms buy wholesale goods sell and sell differentiated goods to households in domestic currency. Capital producers generate new capital and sell to wholesale firms. Their gross investments utilize domestic and foreign final goods. The wholesale firms borrow from households through the use of domestic and foreign currency denominated bonds. However, changes in the exchange rate impacts on the cost of financing investments as firms must repay path of their debt in foreign currency. In addition, movements of the exchange rate also impact the expected discount profits of capital producing firms.

With respect to the importance of the expenditure switching effect of the exchange rate, Shi and Xu (2008) contends that in an economy where the propensity to import consumption and capital goods is high, such as is typical of emerging markets, expenditure switching effects of exchange rate movements tend to be weak. Instead, inflationary effects tend to dominate output effects. An implication of this is that the monetary authorities may find it desirable to include the stabilisation of the exchange rate into the reaction function in order to foster price stabilisation.

9.0 Conclusion

There is yet to be a complete theory of the transmission of open economy shocks as theoretical findings are sensitive to the assumptions made. Having started from the closed economy form, the open economy open economy DGSE models have focussed on applying monetary rules to the canocal framework containing the IS and open economy new Keynesian curve. A dilemma in this respect, concerns whether it is sufficient to account for the effects of monetary policy on the open economy by simply allowing the slopes of the PC and IS while maintaining the same Taylor (1993) form which was predicated on closed economy version or whether the effects of the open

economy should be captured by incorporating another variable into the Taylor rule, such as the exchange rate. Here Galĺ and Monacelli (1995) suggest that the former where the open economy effects can be seen through changes in the slopes in the PC and IS equations. Nevertheless, Batini and Levine (2007) show that by altering the utility function to include domestic and foreign currency, there is a case for inclusion of the exchange rate in the monetary reaction function.

Though Batini and Levine (2007) and Shi and Xu (2008) show the importance of the exchange rate in the monetary reaction function, one of the weakest part of the theoretical work is with respect to the application of the Taylor rule to managed floats where countries may vary in terms of the type of managed float they exercise. For example, the literature have not dealt with the situation where the central bank is the near monopoly supplier of foreign exchange in the economy. Indeed, **t**he various models reviewed still do not investigate the implications of a managed float where government is the major supplier of foreign exchange to the market.

Chapter 3

Practical issues in transitioning to market based monetary policy

1.0 Introduction

In this chapter we examine the economic conditions in the Trinidad and Tobago economy as it seeks to transition to the use of market based monetary policy for which the Taylor-type rule may be applied. Based on the IMF (2004) typology, we suggest that the country is at the second stage of money market development. According to this typology, markets at stage zero are those that are seeking to establish the functions of the central bank. At stage 1, countries develop financial intermediaries through which the central bank use rule based instruments. Those that are seeking to transition to market based monetary policy are at stage 2, which includes the development of the interbank market and money market instruments. Stage 3 is the advanced stage that is typical of advanced industrialised countries such as the UK and the US where money markets are diversified and the central bank rely on the use of money market instruments. Accordingly, the Trinidad and Tobago economy is still in the process of transitioning towards a money market based monetary policy. We compare and benchmark the progress towards market based monetary policy with that of the UK and the US.

The novelty of this chapter is that we show that whereas the developed countries are able to use the market mechanism to induce financial institutions to respond to changes in the policy rate of the central bank, developing countries such as Trinidad and Tobago use moral suasion to achieve the same result, owing to a lesser stage of market development. In particular, changes in the Central Bank repo rate acts as a signal to market players, of how the central bank would like the commercial banks to adjust their interest rates. The central bank is able to evoke this response through moral suasion. We have not seen this point emphasized in previous work.

From chapter 2, it is noted that Taylor (1993) developed the rule directly for the US, a large and relatively closed economy. Later, the analysis is extended to open economies by Galí and Monacelli (2005) and Batini and Levine (2007) who developed open economy IS and Phillips equations to analyse the economy and derive optimal monetary policy rules with either fixed, flexible and managed exchange rates.

Taylor (1998) contends that the results obtained from the application of the Taylor (1993) rule under these circumstances is insufficient to base decision making on, since the historical experiences of the economy should not be ignored. He therefore sought to complement the model-based approach with a historical analysis. Here, we examine the particulars of the managed float as practiced by Trinidad and Tobago, in order to discover the underlying features of this economy that are pertinent to the application of the Taylor type rule.

To begin the discussion, we examine the economic background of Trinidad and Tobago, noting its degree of openness to trade and capital flows through foreign direct investment (FDI). We also examine the importance of FDI and the energy sector to exports and government tax revenues. We next turn our attention to price stability, showing the difference between headline and core inflation as well as domestic inflation. We note that inflationary pressures results in the economy from factors such

as non-energy deficits, wage pressures, excess liquidity owing to the inability of the real side of the economy to absorb increases in energy inflows and the upward trend in food import prices.

We then examine how Trinidad and Tobago measures inflation. The inflation rate is measured in terms of consumer price index, which can be divided into headline and core inflation. Also, we capture domestic inflation in terms of the producer price index. This allows us to represent imported inflation as the difference between headline and domestic inflation. The data show that CPI and imported inflation were elevated to higher levels in post 2003.

In addition, we use a VECM to plot impulse response functions with respect to shocks in exchange rates and import prices. Here we find that shocks in the exchange rate have a large and persistent effect on import prices. What is important also is that these shocks rise between two to four months. Shocks in import prices also cause the exchange rate to depreciate within two to four months, but the effect is mild compared to the effect of the exchange rate on import prices.

We then show that the cycles of the Trinidad and Tobago output gap roughly coincide with the US economic cycle. Following this, we examine the important issue as to how the central bank manages the exchange rate. We show that the central bank principally stabilises the exchange rate through judicious supply of foreign currency to the foreign exchange market.

This is followed by an examination of monetary policy geared towards inflation management. The new style of monetary transmission conducted by the central bank is examined. Noting the perennial problem of excess liquidity, we discuss how the central bank engages in liquidity management. Here we note a direct causal relationship between increased energy receipts and excess liquidity in the economy.

This causes the central bank to rely on a combination of old and new instruments to arrest the excess liquidity problem, since the repo rate is more effective when liquidity is tight. However, in order to deemphasise the dependence on traditional instruments, we note the steps taken by the central bank to accelerate development of the money and capital markets. We also highlight the instruments traded in the money market, in which the 90 day Treasury bill rate was the most regularly traded. Here we give a detailed overview on the frequency of trading of the Treasury bill. We also outline the use of the repo rate by the Central Bank of Trinidad and Tobago (CBTT).

We then compare the transmission mechanism in Trinidad and Tobago with that in the UK and US, noting that the UK and US have multiple transmission mechanisms which reflect their deeper financial markets. In contrast to Trinidad and Tobago, the transmission mechanisms in these countries are based on flexible exchange rates, more developed securities market and developed capital markets. The result is that Trinidad and Tobago has limited market capacity to grapple with high liquidity that arises from rising oil prices. The major difference here is that the CBTT is forced to use moral suasion to guide the market as a result of underdeveloped financial markets.

Further, we show that the Treasury bill rate in Trinidad and Tobago is highly correlated with and dependent on the Treasury bill rate in the US, so there is the absence of monetary independence with respect to determination of the rate of the principal instrument traded in the Trinidad and Tobago money market. The study is then concluded.

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2.0 Economic background in Trinidad and Tobago

2.1 Economic Backdrop

Trinidad and Tobago is a twin island republic located in the Caribbean. The smallness of the economy can be gleaned from the fact it consists of a landmass of 5,130 square kilometres and a population of just over 1.3 million. In 2008, Trinidad and Tobago was ranked by the World Bank as number 56 in the world in terms of income per capita when the Atlas methodology was used and number 53 when purchasing power parity was used.[29] Accordingly, per capita income was US$16,590 and 24,240 international dollars respectively. As a result, the country is classified as a high middle income country, reflecting one of the highest levels of wealth in Latin America and the Caribbean.

The economy is very open, exhibiting a high dependence on external trade. Total trade in terms of exports and imports was significant in relation to GDP, ranging between 75 per cent to just over 100 per cent over the period 1997 to 2009, see Table 1. The import GDP ratio ranged between 32 per cent and 53 per cent during the period, but exports were higher in relation to GDP: over 40 per cent in most cases.[30] The UK economy can also be considered to be open, with the degree of openness been over 0.83. This is in contrast to the US where openness ranged between 11 and 14 per cent. As such, the Trinidad economy can be considered open relative to the US economy, but not the UK.

[29] Statistics obtained from the World Bank Database. The ranking is based on 210 countries.

[30] This is similar to the UK economy where the aggregate exports plus imports also accounted for a high proportion of GDP.

Table 1 Openness of Trinidad and Tobago economy relative to US and UK (%)

Year	Dependence of Trinidad and Tobago on Foreign Trade		TT Openness	UK openness	US Openness	Growth in energy prices (%)
	Imports to GDP	Exports to GDP	(Exports plus Imports)/GDP	(Exports plus Imports)/GDP	(Exports plus Imports)/GDP	
1997	53	44	97	85	12	
1998	50	37	87	82	11	-0.29
1999	40	41	81	87	11	0.28
2000	41	52	92	102	11	0.56
2001	40	48	88	97	10	-0.11
2002	41	43	83	90	10	-0.02
2003	34	45	79	85	10	0.17
2004	37	48	84	83	11	0.31
2005	36	60	95	91	11	0.38
2006	35	75	110	95	12	0.19
2007	37	63	99	86	13	0.10
2008	37	69	106	97	14	0.40
2009	32	43	75			-0.37

Source: Trinidad and Tobago data were tabulated from the CBTT database. The Uk and US GDP data were obtained from the World Bank national accounts data and OECD National Accounts data. UK and US trade data were obtained from the IFS online database.

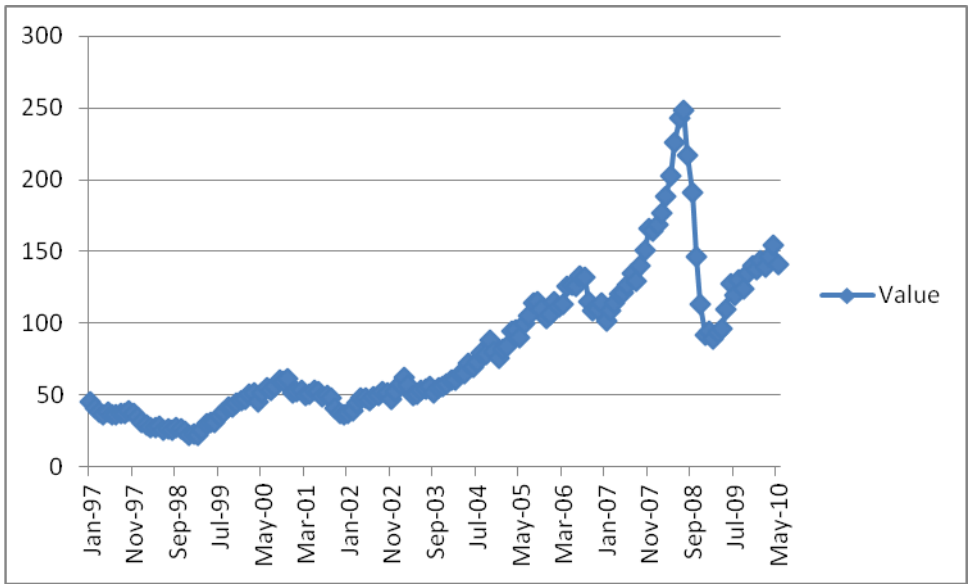
The Trinidad and Tobago economy exhibit a heavy dependence on trade and is therefore susceptible to disturbances occurring in external economies. Exports are highly concentrated in favour of energy. The primary energy base is diversified into oil, natural gas and LNG. In addition, the country also export petrochemicals, including methanol, ammonia, urea and nitrogeneous fertilizers. Other exports include steel rods and billets, light manufactures and services. As such, exports were dominated by raw materials and intermediate goods, which accounted for over 85 per cent of total exports between the period 1997 and 2009.

Export revenues are boosted by rising energy prices, see Figure 3. Following an upward trend in oil and natural gas prices, the exports of fuels grew in importance to total exports, rising from 46.0 per cent in 1997 to 70 per cent in 2009.[31] The percentage of

[31] Statistics were tabulated from the Annual Economic Survey, Trinidad and Tobago.

exports to GDP is highly correlated with energy prices as the correlation in yearly terms was 0.80 for the period 1997 to 2009. This is evident when exports to GDP ratio fell in 2009 as the average energy price index dipped sharply by 37 per cent for 2009, after steady increases since 2003.

Figure 3 Energy Price Index



Source: IMF **Notes** -- Commodity Fuel (energy) Index, 2005 = 100, includes Crude oil (petroleum), Natural Gas, and Coal Price Indices.

Stemming from its strong performance on the external current account, Trinidad and Tobago accumulated by far the largest gross international reserves in the Caribbean Community (CARICOM), as its official reserves grew 6.8 times from 1997 to 2009 to reach US$ 8.7 billion or 13.1 months of import cover by the end of 2009.[32] The bulk of the reserves were in the hands of the central bank.

[32] See the Report on the Economic Performance and Convergence of the CARICOM Region (For the period June – December 2010).

2.2 Foreign Direct Investment

The energy sector benefitted from foreign direct investments. Moreover, foreign direct investment (FDI) is the major form of external capital inflows. Generally FDI was higher in the first part of the overall sample period starting as high as 17.4 per cent of GDP, see Table 2. Total FDI into Trinidad and Tobago from the US is higher than that emanating from the UK. However, FDI into the UK was elevated for the period 1999 to 2003, reaching over 36.8 per cent of total FDI. FDI into the US was as high as 74 per cent by 2005. It is instructive to note however, that FDI in Trinidad and Tobago fell back dramatically for both the UK and US in 2008, amidst the global crises.

Table 2 Foreign Direct Investment (FDI) from the US and UK to Trinidad and Tobago as a percentage of GDP

	Total FDI in Trinidad and Tobago to GDP (%)	**US FDI to total FDI (%)**	**UK FDI to total FDI (%)**
1997	17.42	48.3	5.5
1998	12.07	71.7	13.6
1999	9.41	42.7	36.1
2000	8.30	46.5	37.5
2001	9.41	44.6	36.8
2002	8.73	44.6	36.8
2003	7.11	46.5	36.8
2004	7.48	69.9	17.0
2005	4.60	73.8	17.5
2006	4.78	71.0	17.0
2007	3.95	69.2	19.2
2008	10.73	14.4	5.2

Source: Tabulated from the Trinidad and Tobago Central Bank Database.

External energy revenue inflows were greater than what the real side could absorb in the short run. Instead, in most cases funds that could not be immediately absorbed through investments in the real side, tended to be accumulated as excess reserves held

by the banking system. As a result there was a high positive correlation between inflows of foreign energy inflows and the build up of excess reserves.

2.3 Derived Government Revenues and Expenditure

The energy sector grew in importance in financing of fiscal revenues as it grew from just under 23 per cent in 1997 to as high as 62 per cent by 2005/6 budget period and then hovered close to 50 per cent thereafter, see Table 3. The sector benefitted largely from the upward trend in energy prices.

Table 3 Importance of Fuel Exports as a percentage of GDP and Impact on Government Deposits in Trinidad and Tobago

Year	Importance of fuel to total exports (%)	Contribution of energy to fiscal revenue (%)	Growth in Government Deposits at the Central Bank (%)	Non-oil fiscal balance
1997	46.07	22.7		-5.7
1998	43.82	17.7	-43.3	-6.3
1999	54.10	20.8	64.6	-7.8
2000	61.76	34.4	119.1	-7.5
2001	59.93	27.6	24.5	-6.7
2002	60.08	27.1	3.4	-6.4
2003	64.64	36.9	25.5	-7.4
2004		36.0	24.4	--7.7
2005/6	70.20	61.9	99.3	-9.4
2006/7	76.18	55.5	35.9	-14.4
2007/8	66.07	57.1	-53.2	
2008/9	69.97	47.7	60.1	

Source: Tabulated from Central Bank database

The government benefitted greatly from tax revenues accruing from the energy sector. The bulk of government revenues were derived from this sector and it came essentially

through corporation taxes levied on the energy companies. This in turn allowed the government to build up deposits at the central bank. Government was then able to essentially draw from its deposits to increase fiscal expenditure.

The period of the study was generally one in which there was strong economic growth that was accompanied by substantial annual increases in fiscal expenditure, see Table 4. Nevertheless, up to 2007, fiscal expenditure as a ratio of GDP remained fairly constant between 22 and 24 per cent. By 2008, the global economic crises which began in mid 2007 would have led to a slowdown in the economy and fiscal revenues declined.

Table 4 Trinidad and Tobago Growth and Fiscal Expenditure

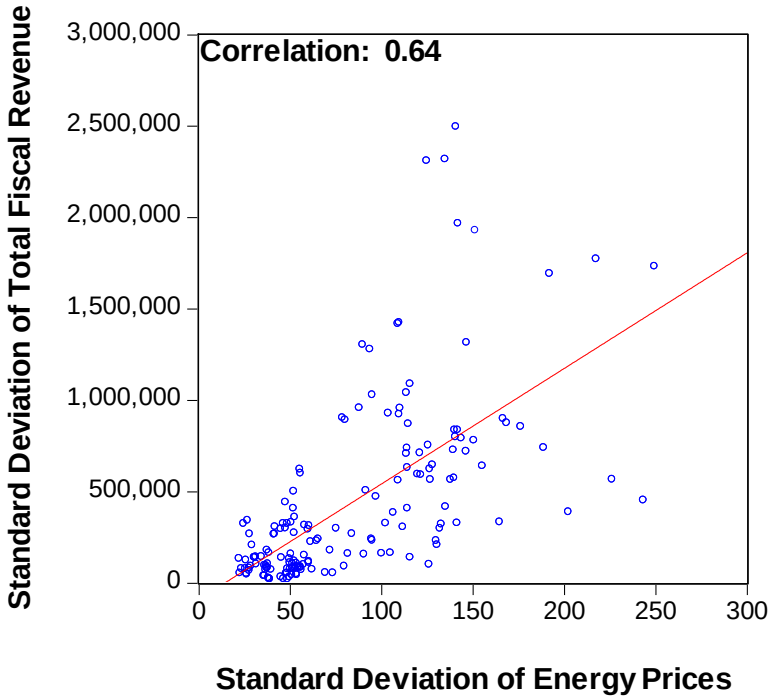
	Real GDP Growth	Growth in Fiscal Expenditure	Total Fiscal Expenditure to GDP
1997	7.32		24.4
1998	7.48	6.8	24.6
1999	8.98	12.5	24.6
2000	7.25	8.2	22.2
2001	4.2	10.4	22.9
2002	7.92	8.8	24.3
2003	14.4	10.8	21.3
2004	7.8	21.5	22.0
2005	5.8	21.7	22.3
2006	13.5	20.2	23.3
2007	4.6	5.9	21.6
2008	2.3	11.3	19.5

Source: Tabulated from the Trinidad and Tobago Central Bank Database

It can be noticed in Figure 4 that the volatility in energy prices is positively associated with variations in government revenues which in turn are government deposits in the central bank. This confirms that government deposits tended to fluctuate strongly with energy prices, which in turn was externally driven. Accordingly, fluctuations in

government deposits were largely driven by factors exogenous to the Trinidad and Tobago economy.

Figure 4 3-Month Rolling Standard Deviation for the period March 1997 to October 2010



Source: Tabulated from Central Bank of Trinidad and Tobago Website.

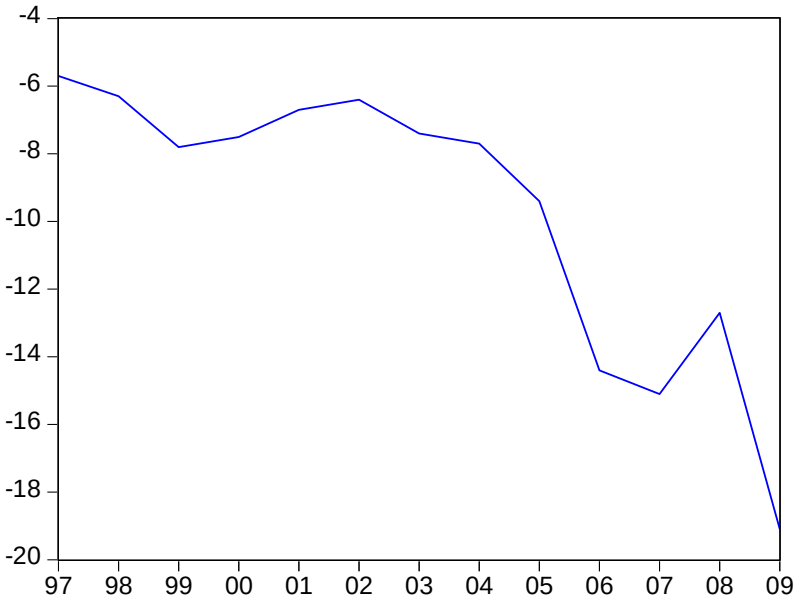
As a result, the drawdown in government deposits in the central bank in turn was equivalent to non-energy fiscal deficits. This was due to the fact that government made draw downs to supplement fiscal spending and therefore to counter non-energy fiscal deficits. The non-energy fiscal deficits were inflationary since it implies increase spending power in the economy without reducing purchasing power parity.[33]

[33] There are also concerns that non-energy fiscal deficits are not sustainable as it depends on non renewable energy output.

2.4 Inflationary Pressures

Major inflationary pressures in Trinidad and Tobago can be attributed to non-energy fiscal deficits, import prices particularly with respect to food, wage pressures, wage demand pressures and persistent excess liquidity. The non-energy fiscal deficits arise as a result of government reliance on drawdown's of deposits to finance its expenditure outlay. Accordingly Inflationary pressures mounted as fiscal outlays lead to increases in non-energy fiscal deficits, see Figure 5. The non-energy fiscal deficits are inflationary as government is using revenue derived from energy receipts to finance expenditure. Since the money does not arise from domestic economic activity and therefore correspond to debt instruments in the economy, it actually is outside money that can lead to increases in prices.

Figure 5 Non-energy Fiscal Deficit

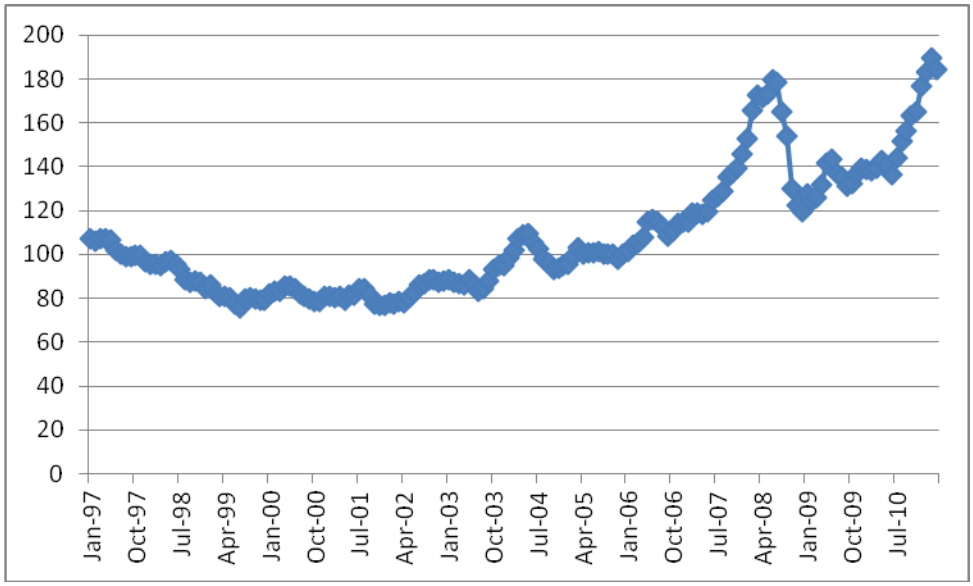


Source: Plotted from data extracted from CBTT Database.

The rise in import prices can have a profound effect on inflation owing particularly to rising prices of inputs and final consumption goods. This is particularly noticeable with

imported food inflation, see Figure 6. These prices have been volatile and rising since the mid 2000 period. The central bank therefore is under severe pressure to contain headline inflation.

Figure 6 World Food Price Index

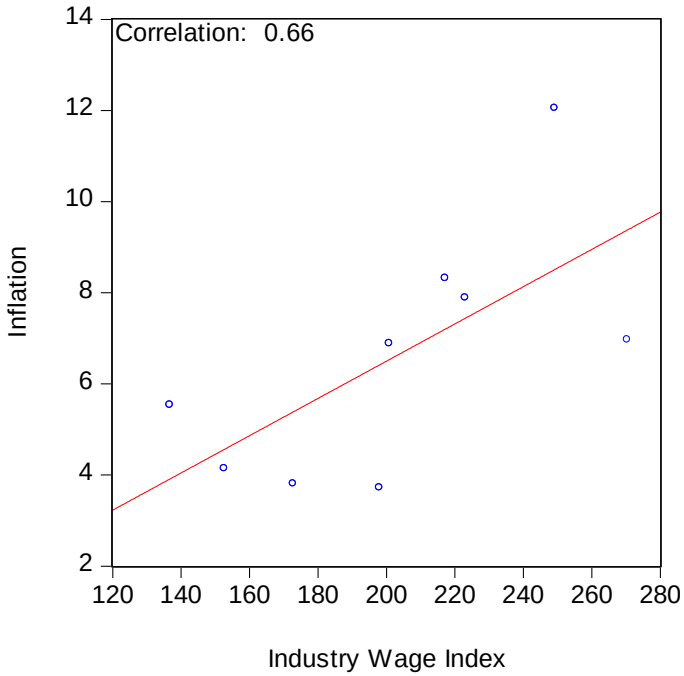


Source: Extracted from Mundi data.

Wage rate increases tend to be associated with increases in headline inflation, see Figure 7. Wages tend to be a large part of production costs, and therefore an increase in the wage rate has an impact on cost push inflation.[34] Moreover, retail prices can move in tandem with wage rate increases, where the market structure allows firms to raise their prices to capture consumer surplus. For these reasons we can expect a strong positive correlation between inflation and the wage rate.

[34] See Inflation. Public Pamphlet Education Series No. 2, CBTT.

Figure 7 Inflation Wage Nexus 1997 to 2010



Source: Inflation data were obtained from CBTT database. Wage index data obtained from Trinidad and Tobago central statistical office.

The results also suggest that there is a positive effect of energy prices on inflation. Rising energy prices lead to buoyant demand conditions in the economy. However, in the face of supply bottlenecks excess liquidity builds up. In effect, excess liquidity is driven by the inability of the economy to absorb increased energy revenues accruing to the government. Moreover, government expenditure leads to increases in the transmission of funds to the banking system in excess of demand for loanable funds, thus resulting in an involuntary accumulation of excess liquidity. In effect the correlation between energy price and excess liquidity is 0.38 immediately and 0.75 with a lag of 8 months, see Table 5.

Table 5 Correlation of current energy price and autoregressive lags in excess liquidity

	Auto regressive lags in excess liquidity										
	0	1	2	3	4	5	6	7	8	9	10
Current change in energy price	0.38	0.41	0.46	0.52	0.58	0.64	0.70	0.73	0.75	0.70	0.66

Source: Author's calculations using data derived from CBTT database.

As a result the structural nature of liquidity in the market is often associated with government spending in the economy stemming from the monetization of energy windfalls. Other factors that are critical to inflationary pressures include a rise in import prices; and credit expansion.[35]

Previous monetary policy reports of the CBTT also attribute rising inflation to other factors including the pass through of wage costs to the consumer, the oligopolistic distributive market structure, increased demand in the context of declining excess capacity, rising construction costs, increases in real estate prices, increases in rents and rising transportation costs.

3.0 Variables for Macroeconomic Stability

3.1 Measures of Inflation indexes

The CBTT uses the year on year percentage changes of the Retail Prices Index to measure inflation. This overall index is calculated as the weighted cost of a basket of consumer goods and services, as exhibited in Table 6.[36] The weight is defined by the

[35] See the Monetary Policy Report, April 2007, published by the CBTT.
[36] The Retail Price Index used by the CBTT excludes non-consumer prices such as the prices of capital goods, and the prices of goods and services consumed by enterprises and government. See "Inflation", Public Education Pamphlet Series NO. 2, published by the CBTT.

CBTT as "(t)he expenditure share of an item in the market basket". They determine the weight by "...calculating the relative proportion of expenditure of households on an item to the total expenditures of households on all items using data from the Households Budgeting Survey" *Inflation*, Public Education Series, Pamphlet 2, pp15.

Table 6 Composition of Retail Price Index 1997-2006

Expenditure Categories	Weight
Food and Non-Alcoholic Beverages	18
Alcoholic Beverages and Tobacco	2.5
Clothing & Footwear	5.3
Home Ownership	*18*
Rent	*2.4*
Water, Electricity, Gas and other Fuels	*5.8*
Furnishings, Household Equipment and Routine Maintenance of the House	5.4
Health	5.1
Transportation	16.7
Communication	4.1
Recreation and Culture	8.5
Education	1.6
Hotels, Cafes and Restaurants	3
Miscellaneous Goods and Services	3.6
ALL ITEMS	**100**

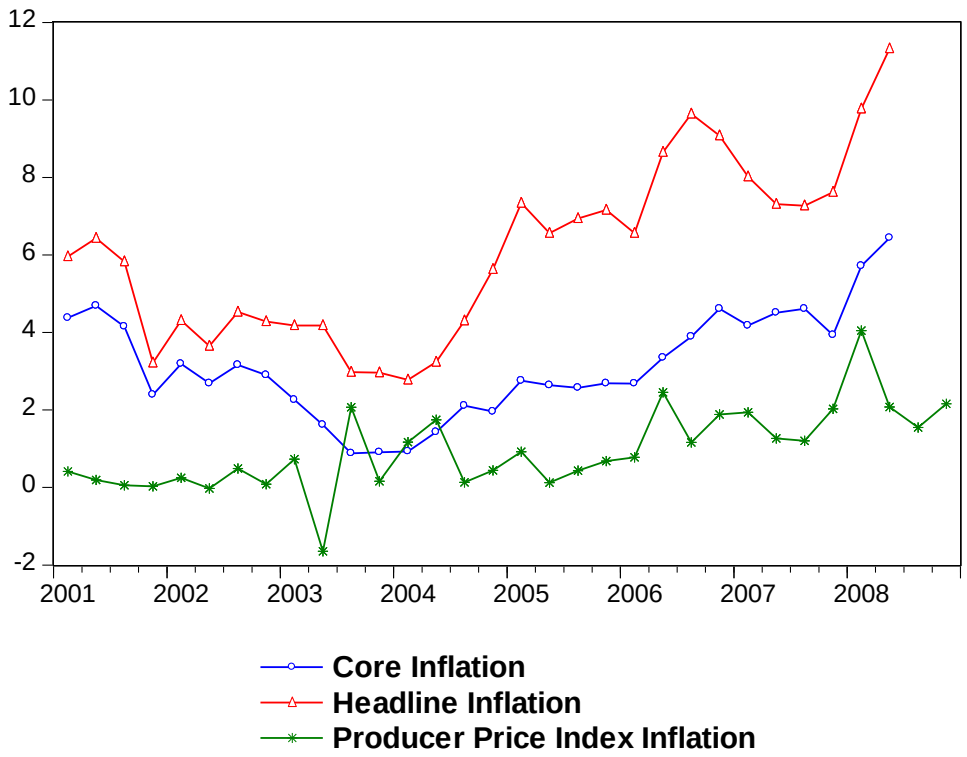
Source: Trinidad and Tobago Central Statistical Office's Website :http://www.cso.gov.tt

The CBTT essentially targets headline inflation. The targeted rate is made known to the public through the publication of the public education pamphlet on inflation and various issues of the Monetary Policy Reports published by the CBTT. In keeping with this objective, the October 2005 monetary report places the target as between 4 and 5 per cent, while the April 2007 report which was written at a time when the actual rate shot up to just under 10 per cent, outlined a short term target of 7 per cent and a medium term target of 5 per cent. Two facts must be observed about the targeted

rate: 1) The target inflation rate is specified and published by the CBTT rather than enshrined through an Act of parliament and 2) the bank does not practice strict inflation targeting given other subsidiary goals the bank is allowed to pursue. These other goals include ensuring an orderly foreign exchange market and ensuring that there are adequate foreign exchange reserves.

All the measures of inflation, CPI measures and domestic inflation are highly correlated, see Figure 8. The CPI measures are headline and core inflation. The main difference between these measures is that core inflation is adjusted to exclude food prices given that this is deemed to be the most volatile element in the CPI index and its effects are expected to be temporary.

Figure 8 Trinidad and Tobago Inflation Rate



Source: Plotted from data obtained from CBTT database.

We use PPI as the proxy for domestic price index, given that it captures the price of domestically produced goods. The producer price index gives the change in prices from the producer perspective. However, it is not a perfect proxy of domestic prices. Domestically produced goods in the context of a small open economy still contain a degree of imported inputs. Assuming that domestic firms import inputs from foreign firms then domestic prices are influenced by inflation and the exchange rate from which inputs originate. Another important limitation is that the producer price index allows for the price received by producers for goods exported. Here, if we allow for the producer to use producer currency pricing, then the price received for exports would be in concurrence with domestic prices. Thus, the producer price index would be an indicator of domestic prices, depending on the degree of producer pricing by domestic firms. Thus, two limitations of the producer price index as a proxy for domestic inflation would be in terms of the degree of imports of inputs to produce goods and in terms of the degree of producer pricing.

The producer price index as used in Trinidad and Tobago consists of production of food and drink which includes food processing, bakeries, vegetable oils, and animal fats industry and production of alcoholic beverages. The index also includes the chemicals and non-metallic industry which includes the manufacture of tiles, ready mix concrete, wood and furniture industry, and printing and publishing industry. The chemical industry also includes the manufacture of glass and plastic product for the construction industries. The PPI also includes assembly-type and related industries, garment and footwear industries. It is important to note that the producer price index is impacted on by the imported price of raw materials inputs into production.

The inflation rate can be subdivided into domestic and imported components such that

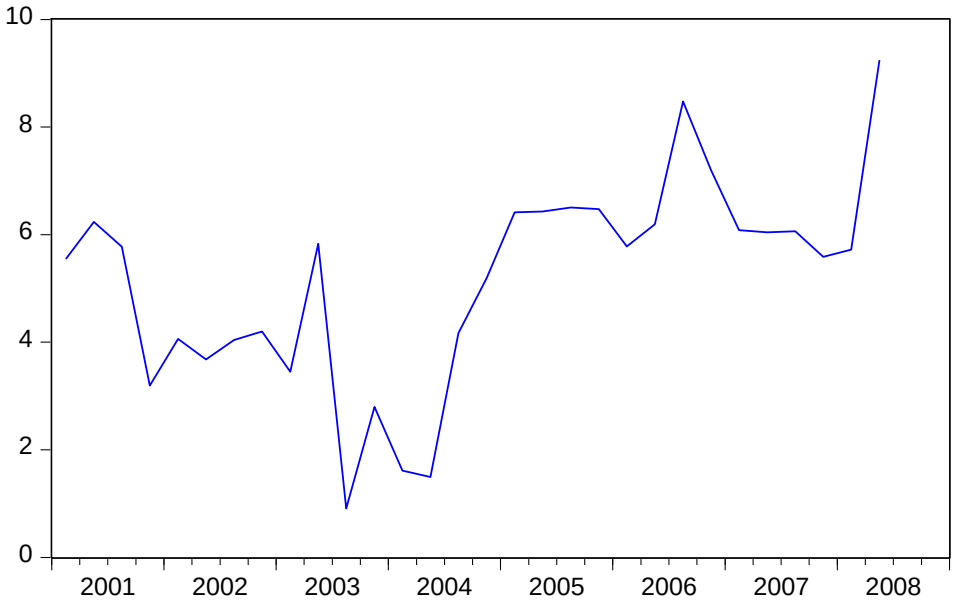
$$\pi_t = (1-\alpha)\pi_t^d + \alpha\pi_t^f$$

where α is the weight on foreign inflation component of overall expenditure, $(1-\alpha)$ is the weight on domestic component of overall expenditure, π_t is the CPI headline inflation, π_t^d is domestic inflation and π_t^f is imported inflation. Consequently, imported inflation is

$$\pi_t^f = \frac{1}{\alpha}\pi_t - \frac{(1-\alpha)}{\alpha}\pi_t^d$$

We plot imported inflation in Figure 9.

Figure 9 Imported Inflation



Source: Plotted from author's own calculations.

3.2 Exchange Rate Pass-Through to Imported Inflation

We use a VECM to examine the pass through of a change in the nominal exchange rate with imported inflation. The advantage of using VECM is that it preserves long-term information and incorporates short run factors in the presence of non-stationarity.

Long term information is preserved by using cointegration of the level series and short run information is incorporated the differencing of the series to achieve stationarity. Another advantage of using VECM is that dynamic simulation can he achieved through the use of impulse analysis.

The VECM can be represented as

$$\Delta y_t = \delta + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Phi_i^i \Delta y_{t-1} + \varepsilon_t$$

where Δy_t is $y_t - y_{t-1}$; $\Pi \equiv \alpha\beta'$ with α being the adjustment coefficient to restore movement towards equilibrium, and β is the co integrating vector; $\varepsilon_t \sim N(0, \Sigma)$. Here $\Sigma = \text{cov}(\varepsilon_t)$. Thus the error correction mechanism is given by Πy_{t-1} and the model incorporates the long term into the short term adjustments. The speed of adjustment is given by α.

The measure of the impulse response function is obtained from Φ_i which is a moving average of coefficients. Accordingly, $\Phi_{jk,t}$ represents the response of variable j to a unit impulse of variable k in the i-th period.

3.3 Unit root test

We conduct unit root tests on imported inflation and the real exchange rate. This is particularly important since both variables must be integrated of the same order in order to be cointegrated. We use three unit root tests to investigate the stationarity of the time series with respect to imported inflation and real exchange rate. These tests are the augmented Dickey-Fuller, the DF-GLS and Phillips Perrron, see Tables 7 and 8.

Table 7 Imported Inflation

	Level Series			1st Difference		
Unit Root Test	Intercept	Trend and Intercept	No trend and intercept	Intercept	Trend and Intercept	No trend and intercept
Augmented Dickey-Fuller	-0.94	-2.67	0.24	-5.57***	-5.49***	-6.19***
DF-GLS	0.77	-2.56		5.68***	-6.02***	
Phillips Perron	-0.94	-2.79	0.21	-6.27***	-6.21***	-5.19***

Notes: Study uses Newey-West band selection using Bartlett Kernel. *** signify the rejection of the null hypothesis of a unit root at 1%.

Table 8 Real Exchange Rate

	Level Series			1st Difference		
Unit Root Test	Intercept	Trend and Intercept	No trend and intercept	Intercept	Trend and Intercept	No trend and intercept
Augmented Dickey-Fuller	0.86	-1.24	3.05	-10.82***	-10.97***	-9.57***
DF-GLS	1.75	-1.62		-10.75	-10.99	
Phillips Perron	1.18	-2.88	3.71	-11.61***	-13.06***	-9.38***

Notes: Study uses Newey-West band selection using Bartlett Kernel. *** signify the rejection of the null hypothesis of a unit root at 1%.

The unit root tests unanimously show that imported inflation and the real exchange rate are each I(1). Accordingly the results reject the assertion that the series are stationary at levels, in favour of the alternative that the series are stationary after first differencing. We therefore use

one lag to examine the degree of pass through and the speed with which a change of the exchange rate influence imported inflation, see chart 3.

The cointegrating vector is found to be

$$\beta_{t-1} = ere_{t-1} - 0.02\pi^{D}_{t-1} - 6.19C$$

where β_{t-1} is the cointegrating vector.

Using the bivariate VECM to investigate the association between the exchange rate (ER) and domestic inflation rate (π^{D}_{t-1}), the VECM equation is

$$\Delta ERE = -0.79\beta_{t-1} - 0.08ERE - 0.17\Delta ERE_{t-2} - 0.01\pi^{D}_{t-1} - 0.01\pi^{D}_{t-2} + 0.00$$

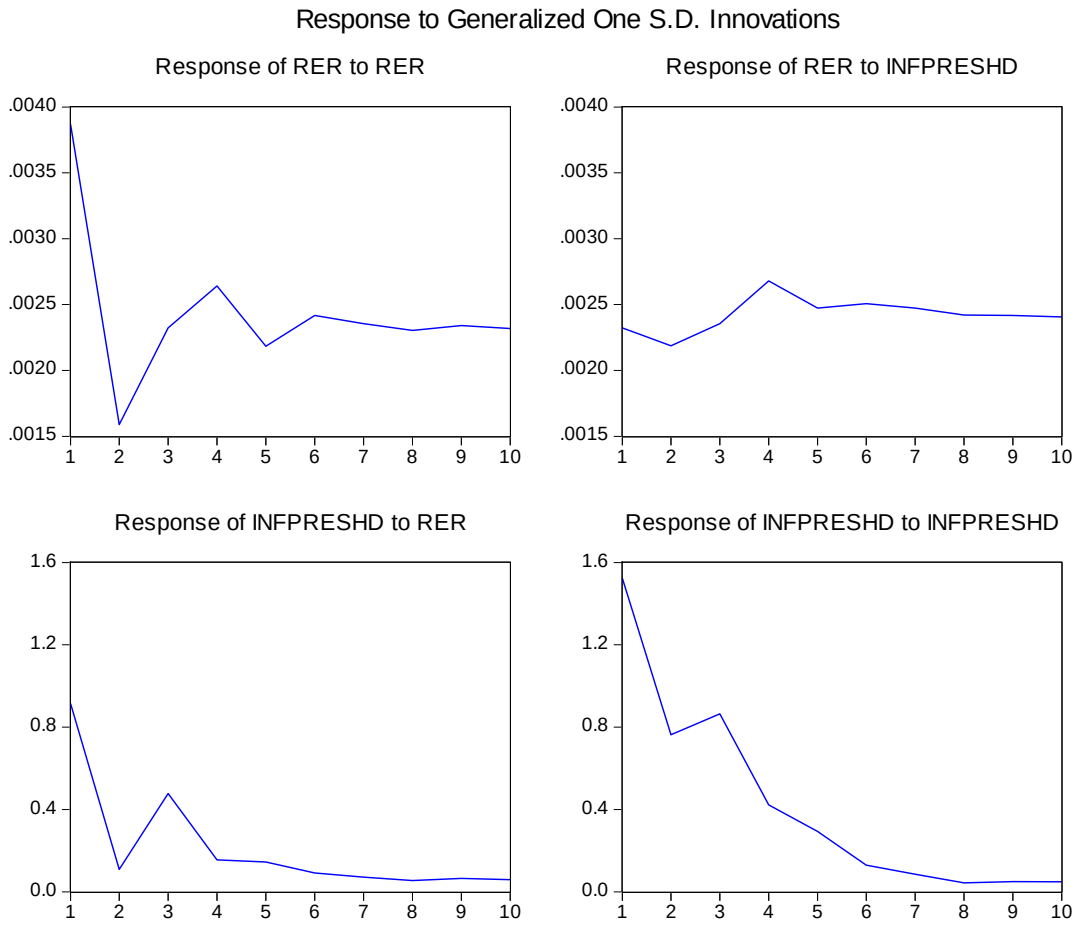
$$\bar{R}^2 = 0.40,$$

$$\Delta\pi^{D}_{t} = 14.91\beta_{t-1} - 5.65\Delta ere_{t-1} - 3.60\Delta ere_{t-1} - 0.16\Delta\pi^{D}_{t-1} + 0.05\Delta\pi^{D}_{t-1} + 0.16$$

$$\bar{R}^2 = 0.38$$

We then examine the impulse response functions for the bivariate VAR, see Figure 10.

Figure 10 Impulse Response Function



Source: Generalised Impulse response functions calculated on data obtained from CBTT Database.

The evidence shows that a shock in the exchange rate maximises the effect on imported inflation immediately after which shocks linger on, see bottom left hand graph in Figure 10. This is in contrast to the UK and US markets where it is noted by the bank of England Monetary Policy Committee and the US Federal Reserve that even though a change in the exchange rate have a direct effect on import prices, the effect is often delayed taking many months to take effect on domestic prices and even longer to impact on spending patterns. This is even though shocks to imported prices can have an indirect effect on the prices of domestic goods, since domestic goods compete with

the prices of imported goods. In contrast, our results show that the pass through of a change in the exchange rate in Trinidad and Tobago is much faster and more persistent than in the UK and US markets.

The graph at the top right hand side shows that shocks in inflation persists on the exchange rate. Moreover, the effect of the shock on the real exchange rate do not decline, but remain virtually level. Consequently, the results show permanent effects on the real exchange rate.

3.2 Output Gap

Theoretically, the output gap is a measure of the difference between actual and potential output. The output gap can be indicative of inflationary pressures. The Hodrick and Prescott (1997) (HP) method is frequently used in the literature for finding the output gap to measure the output gap, given that in many countries the gap is not measured on a real time basis.[37] Real time output gap data are not available for Trinidad and Tobago.

The HP measure is based on a two-sided measure that captures past and future trends in the time series. To develop the HP measure, a time series (y_t) can be decomposed into a trend component (g_t) and a cyclical component (c_t).

$$y_t = g_t - c_t$$

The trend measure is the component that would minimise the equation in

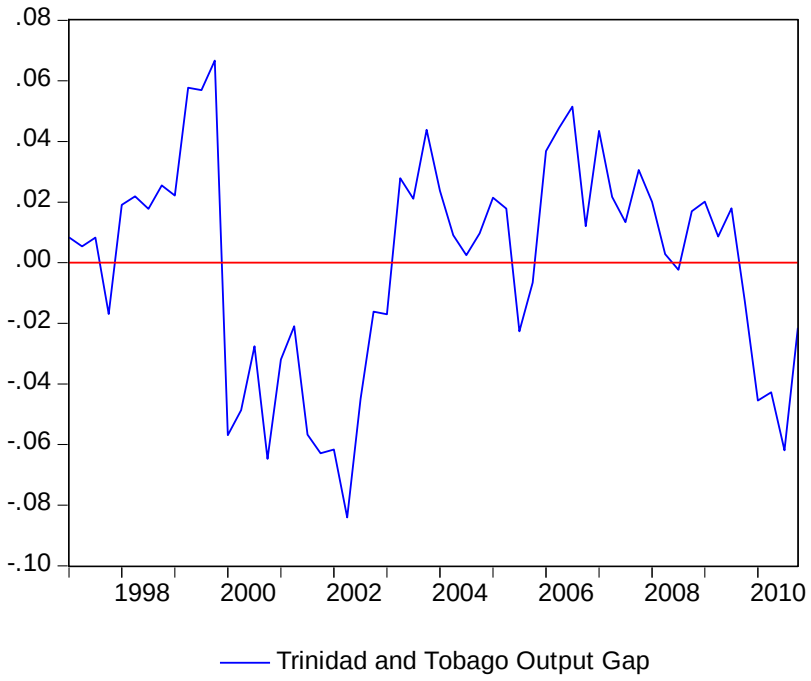
[37] A few countries which use real time data are UK, U.S. and New Zealand. Mishkin (2007) for example, pointed to conceptual and measurement difficulties in the operationalisation of this concept. One set of challenges include the inaccuracy that results when real time data are used, given that macro data are frequently revised. He also sited measurement difficulties, since different output gap measures produces differences in volatility of output gap and inflation.

$$\text{Min}\sum_{t=1}^{T}(y_t - g_t)^2 + \lambda \sum_{t=2}^{T-1}[(g_t - g_{t-1}) - (g_t - g_{t-1})]^2$$

λ is a positive number to penalise the variability of the trend in growth. The time series becomes smoother for larger value of λ, becoming linear at the limit where $\lambda = \infty$. Hodrick and Prescott (1997) suggest that for quarterly data λ should be set at 1,600.

The output gap is plotted for Trinidad and Tobago, using the conventional measure where the gap is defined as the log difference between actual output and its trend, see Figure 11. Inflationary pressures may be likely to be built up where the output gap is positive, while deflationary pressures may exist where actual output is below equilibrium level. This allows us to examine two distinct periods: where the output gap was predominantly positive for most of the periods 1997 to 1999 and 2002 to the end of 2008. Interestingly the output gap was negative for the period 2009 through to 2010. The latter showed a slowdown in aggregate demand and therefore an easing in inflationary pressures in keeping with occurrences in the world economy. The global slowdown was triggered in the US since mid 2007 and spread to other developed countries thereafter.

Figure 11 Trinidad and Tobago Output Gap



Source: Graph drawn from author's calculation using CBTT database.

4.0 Exchange Rate Management

The sale of foreign exchange by the CBTT fulfil the dual role of assisting to reduce excess liquidity and minimising the volatility of the exchange rate. Excess liquidity may not necessarily tend towards exchange rate instability since the latter would be impacted on by other factors such as external capital inflows. Moreover, the lumpiness of foreign exchange inflows generated by the earnings of the export sector when accompanied by uninterrupted domestic demand for foreign exchange, often can lead to temporary shortages in the foreign exchange market which can cause the rate to fluctuate within narrow bands. The fluctuations tend to be within narrow bonds, partially owing to confidence by the market on the ability of the central bank to back the exchange rate. At times the central bank intervenes in the market through net sales

to authorized dealers to satisfy the demand of individuals and firms. Authorised dealers are dominated by commercial banks, but they include to a lesser extent some non-banks and bureaux de change. The CBTT defines authorised dealers in foreign exchange as "entities licensed by the central bank and include commercial banks and the non-bank financial institutions". See Central Bank website: http://www.central-bank.org.tt/the_bank/index.php?pid=1007.

To smooth the demand and supply for foreign currency, the central bank in 1993 instituted a sharing arrangement between commercial banks. This allowed for foreign exchange receipts emanating from major foreign exchange earners in the energy sector to be shared between all banks. An advantage of this system of sharing is that it smoothens the supply of foreign currency between banks and allowed the central bank to intervene to stabilise the market where necessary.

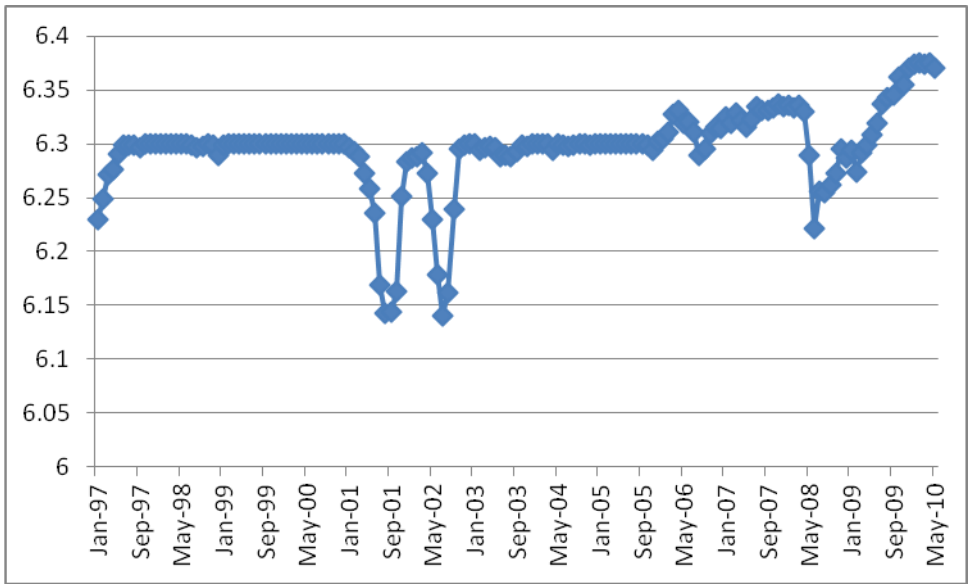
In spite of the declaration of a floating exchange rate in 1993, the nominal exchange rate remained fairly stable, centred around TT$ 6.3 to US$ 1.00 but occasionally fluctuating within a narrow band of TT$ 6.15 and TT$ 6.31 between 1993 to 2009, see Figure 12.[38] The IMF in its article IV consultation of 1999, recognised the float as being heavily managed. Under this arrangement, the capital market was fully liberalised and restrictions on payments and current international transactions and transfers were eliminated, but the authorities actively intervened in the market to ensure a degree of stability in the exchange rate market.

The stable exchange rate is supported by a steady increase in gross international reserves reinforced by consistent current account surpluses after 1998, assisted by rising energy prices for most of the period. With the central bank being a major

[38] The International Monetary Fund (2007) estimated that the real exchange rate was undervalued in 2005 by between 15-20 per cent, and is likely to be sustained given improved terms of trade, gains in labour productivity and subdued real wages. However, the report noted that CBTT is reluctant to allow for full flexibility, owing to already existing substantial large capital outflows and the segmentation of the foreign exchange market.

primary supplier of foreign currency in the economy it was able judiciously to supply foreign currency in the market to maintain a virtually fixed exchange rate.

Figure 12 Trinidad and Tobago Exchange rate (TT$ in terms of a unit of US$)



Source: Drawn from data obtained from CBTT database.

The bulk of foreign exchange came through the central bank rather than through commercial banks, see Table 9. The dominance of the CBTT with respect to foreign assets can be gleaned by the fact that the intake of foreign exchange by the central bank was in most cases over 70 per cent of total foreign exchange earnings with respect to assets and foreign account balances of the combined holdings of the central bank and commercial banks.[39]

[39] See 2006 Annual Economic Survey.

Table 9 Size of Central Bank Holding of Foreign Currency to the Banking System

Year	Percentage of central bank foreign assets to total foreign assets in the banking system. (a)	Percentage of Net International Reserves held by the central bank to total foreign position of the banking system. (b)
1997	62.9	80.1
1998	66.0	77.6
1999	69.5	86.7
2000	73.6	91.2
2001	76.4	101.4
2002	74.2	97.3
2003	69.3	101.8
2004	66.8	82.9
2005	74.0	89.9
2006	72.5	81.1
2007	77.3	85.8
2008	81.0	86.5

Source: Tabulated from the CBTT Monetary Statistical Digest 2004 and 2008.

Notes: Column (a) is calculated as percentage $\frac{Central\ Bank\ Foreign\ Assets}{Central\ Bank\ Foreign\ Assets + Commercial\ Bank\ Foreign\ Assets}$ and column.

(b) is calculated as a percentage of $\frac{Central\ Bank\ Net\ International\ Reserves}{Central\ Bank\ Net\ International\ Reserves + Commercial\ Banks\ Net\ Foreign\ Position}$.

5.0 The Conduct of Monetary Policy in Trinidad and Tobago

Since Trinidad and Tobago liberalised its exchange rate in April 1993, the country took active steps to convert to the use of market determined instruments of monetary policy. In particular, the country sought to develop a market structure that would allow for the short term interest rate to move through the term structure of interest rate and therefore ultimately impact on demand. As such, the country took active steps to develop both money and capital markets. The central bank defined the money market as " (A) market for short-term debt instruments maturing in one year or less."[40] At

[40] See "The Implementation of Monetary Policy in Trinidad and Tobago ". CBTT (2005). pp 20.

the same time, the central bank defined the capital market as a market in which long-term debt securities and corporate equity are issued and traded.[41]

From the latter part of the 1990s, the principal methods of liquidity management favoured by the CBTT are open market operations; periodic issuance of bonds; sale of foreign exchange to commercial banks. These methods are supplemented by secondary reserve requirements; special deposit facility; reserve requirements; and secondary market.

The liberalisation of the exchange rate was accompanied by a transition from the use of direct instruments to indirect instruments, as the principal means of fighting inflation. To implement this style of monetary programming, the CBTT sought to absorb excess liquidity through open market operations. This involved the regular use of auctioning of Treasury bills and the occasional use of bonds. At the same time, the bank made use of short-term interest rates, and in more recent times introduced the repo rate as the policy rate.

5.1 Liquidity Management

The CBTT defines liquidity as: "the level of cash or near cash assets of financial institutions readily available to meet day to day transactions needs."[42] The Trinidad and Tobago economy exhibits persistent periods of excess liquidity. Here excess liquidity is defined in terms of excess reserves held by banks above statutory reserve requirements for commercial banks and non bank institutions.

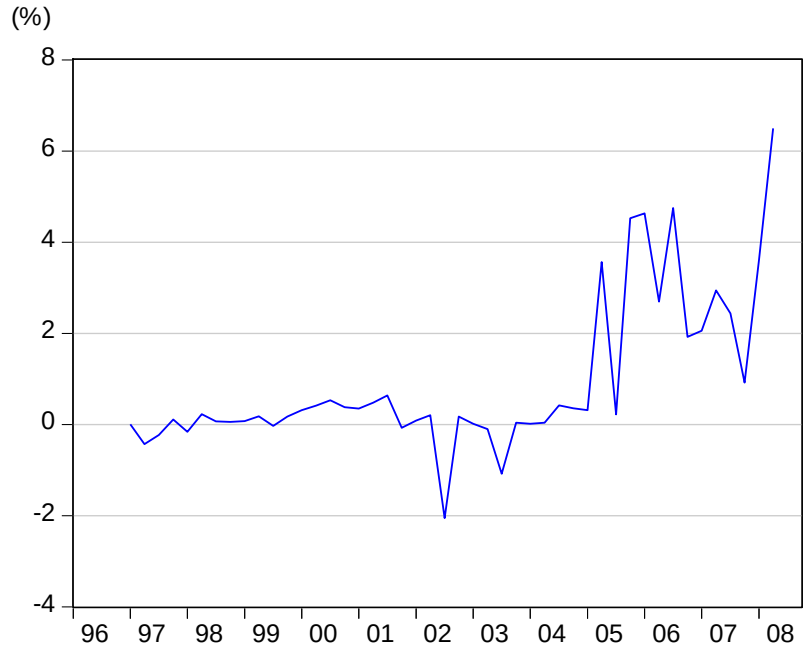
Chronic excess liquidity presents a potentially major source of difficulty to the implementation of the new style of monetary policy, since it may have implications for

[41] See "The Implementation of Monetary Policy in Trinidad and Tobago", Issue 1, CBTT (2005), pp18.

[42] See, "Inflation", Public Education Pamphlet Series No. 2 published by the CBTT, 2006.

inflation, the transmission of interest rate changes and it potentially weakens the predictability of the relationship between interest rate and real-side factors. The major indicator of excess liquidity used by the CBTT is excess reserves, that is, deposits in the central bank held by commercial banks in excess of the prescribed deposit liabilities of the CBTT. However, excess liquidity held by commercial banks can also be gleaned from special deposits, the volume of repos and activity in the interbank market. From an examination of Figure 13 it is evident that the CBTT has had to grapple with excess liquidity in most periods of the study.[43]

Figure 13 Trinidad and Tobago Excess Reserves



Source: Plotted using data obtained from CBTT database.

[43] Walsh (2003) observed that excess reserves in the US in June 2002 would have been 3.3 per cent.

The CBTT sought to forecast the demand and supply of liquidity in order to decide on when and the extent to which it needed to intervene in the market.[44] On the supply side, the demand for foreign currency and foreign exchange were assumed to impact on the money supply. However, the major injection of liquidity to the banking sector occurred as a result of government drawdown on its deposits at the central bank to finance fiscal expenditure.[45] This is attributable to the fact that government is the primary earner of foreign exchange in the economy as shown in Table 9. As a result, net fiscal injection is reflected in terms of a drawdown in the deposit base or through foreign inflows received by government, such that:

$$Net\ Domestic\ Fiscal\ Injection = \Delta\ in\ Government\ Balances +/-\ all\ Foreign\ Flows$$

.

The plus or minus signs in the equation depends on whether there are net foreign inflows or net outflows. Where there are net inflows, the sign used is negative. The rationale for this is that since the emphasis is on domestic fiscal injections, the foreign inflows were eliminated from government activities, in that foreign inflows were subtracted from government balances. Conversely, net outflows, are added back in to minimise their effect on the government balance.

Given the primacy of energy prices to the government deposits, it can be surmised that a possible transmission mechanism on the real side can be

[44] Important variables to the forecast of liquidity in the banking system were listed by CBTT as: net domestic spending; financing operations of government; changes in commercial bank reserves; net sales of foreign exchange and central bank holdings; inflation; money supply; exchange rates; interest rates; credit; liquid assets of commercial banks; capital flows and market sentiment.

[45] This is in contrast to the typical case in emerging markets where the central bank extends net credit to the government and therefore creates liquidity, exercise net purchases of foreign exchange from the banking system or exercise net credit to the banking system.

$$energy\ price \uparrow \rightarrow government\ deposits\ in\ central\ bank \uparrow \rightarrow government\ expenditure \uparrow \rightarrow Government\ Investment \uparrow \rightarrow Output \uparrow$$

and on the monetary side,

$$energy\ price \uparrow \rightarrow government\ deposits\ in\ central\ bank \uparrow \rightarrow government\ expenditure \uparrow \rightarrow money\ Supply \uparrow \rightarrow excess\ liquidity \uparrow$$

.

On the demand side, financial institutions may demand reserves to meet settlement balances and statutory requirements. However, in Trinidad and Tobago, there is a high degree of demand for reserves beyond the statutory limits, which according to the CBTT, can be attributable to many factors, including the length of the settlement period associated with the payment system, volatility of claims and receipts as well as the sophistication of the market, including the secondary market. However, the calculation of the reserve balance as the average of the daily holding of reserves for the reserve week lends itself to the smoothing of short-term interest rate in spite of the daily volatility of the reserve balance.

The government gains revenues accruing to energy companies principally through taxation. Energy companies are taxed quarterly. These taxes feed into deposits of the central government in the central bank. When government drawdown on these deposits to do fiscal injections, it adds high powered money to the stock of money supply and therefore creates excess liquidity. Consequently, excess liquidity can build up in the short term owing to limited investment options.

The Central Bank responded aggressively to excess reserves in the banking system in a bid to tighten liquidity so as to make the new style of monetary policy effective and to

be able to influence lending. The new style of monetary policy was ushered in in 1993 when the country shifted from a fixed exchange rate to a floating exchange rate. With the new style, the central bank now took measures to move towards market determined interest policy rate as opposed to selected interest rate and direct credit controls through regulatory devices.

To a large extent the repo rate acts as a signalling rate since commercial banks may not have needed to utilise the repurchase window. The idea with respect to the use of the repo policy rate was to deepen market sophistication by encouraging the development of the interbank market. Accordingly, the central bank uses the sale of open market securities and sales of foreign exchange as a component of the weapons of monetary policy.

In spite of the movement towards the new style of monetary policy, the central bank still has to rely on a blend of the new style with the old style of monetary policy in order to grapple with persistent high excess liquidity. The old style includes sterilisation through the creation of special interest bearing accounts inclusive of special deposit facility, secondary reserve requirements and primary reserve requirements.[46] The interest bearing special deposit account can be rolled over from time to time in order to contain liquidity. In addition, the central bank relies on the use of excess reserves requirement to assist in containing excess liquidity.

Bonds are issued by the government sector to either finance government activities or for liquidity purposes. In all cases, given the persistent high level of liquidity, these bonds were oversubscribed each time they were issued. Where bonds are issued for liquidity purposes, the proceeds from these bonds were locked away from use. In contrast, bonds issued to finance government activities lent itself to a temporary

[46] Sterilising can take place either through the floatation of bonds or creating a special interest bearing account at the central bank in which the proceeds are deposited in a block account that is frozen.

reduction in excess liquidity, but the reductions were nullified as government spent from the proceeds.

5.2 New Approach to monetary Management

Trinidad and Tobago is still trying to fully evolve to the use of indirect instruments for the conduct of monetary policy. The economy is going through the second stage of developing the money market by the trading of government Treasury bills as the primary instrument for the determination of money market interest rate. Treasury bills were first introduced by the creation of the Treasury Bill Act of 1960. The Act was initially set up to meet government short-term financing needs, given the non-synchronisation of revenue and expenditure. However following steps towards financial liberalisation, by the mid 1990s, Treasury bills became an essential monetary policy tool, especially for obtaining market determined money market rates.

The Treasury bill is traded as a government security as opposed to a central bank security. They possess the property of been risk free as government payment on these instruments are guaranteed. Consequently, interest on the short-term instruments set the floor for pricing of assets. For these reasons, the Treasury bill is attractive to the market so that there is a ready demand on the market for this instrument.

The 91 day Treasury bill was the original tenor introduced by the 1960 Act. Higher tenors were subsequently introduced, but the 91-day tenor remains the most frequently traded as it was traded on a biweekly basis. Open market operations are used for the competitive determination of the Treasury bill rate. Open market operations of Treasury bills are sold only to primary dealers and these dealers have the responsibility of making the secondary market.

The prudential criteria for the selection of primary dealers includes the fact that they must be supervised by a regularity authority in Trinidad and Tobago, that they have demonstrated sound financial capacity, that they reflected adequate management capabilities, that they are active market participants and that they are in good standing with the primary regulatory authority. Moreover, the primary dealers are expected to be active participants in auctions in the money and capital markets, are expected to service the needs of the retail market and they were expected to provide market information. In turn, the CBTT expects to gain from the primary dealers, market information on interest rate developments, liquidity in the banking system, reserve needs, general demand and supply of money market securities and any other money market activities particularly with respect to new instruments.[47]

Secondary markets are desirable since, among other things, it provides for liquidity to the primary market.[48] Having used the Treasury bill to kick start the development of the money market, the central bank has taken steps to develop a secondary market. To develop the market the central bank appointed primary dealers to act as counterparties to the Central bank. These dealers are to fulfil the role of primary dealers in the primary market for Treasury bills and Treasury notes.[49] By 2008, 10 primary dealers have been appointed, the majority of which are commercial banks.[50]

Treasury bills are traded through an auction system which was automated in 2004, prior to which it was done through underwriting where the underwriter had the

[47] See Guidelines for Second Tier Primary Dealers for Open Market Operations. (mimeo).
[48] The Central Bank defines the Secondary Market as "(t)he part of the capital market in which securities that have already been issued in the primary market are bought and sold". P37, Government Securities Market in Trinidad and Tobago, Public Education Pamphlet Series No. 4.
[49] The Central Bank defines Primary Market as "(t)he part of the capital market that deals with the issuance of new securities.". P37, Government Securities Market in Trinidad and Tobago, Public Education Pamphlet Series No. 4.

[50] The counterparties for the development of the secondary market for government bonds were termed Government Securities Intermediaries (GSIs).

responsibility of seeking investors for investment in government bonds. However, in spite of the automated system, the primary dealers were expected to make the secondary market by buying and selling bonds.

The Treasury Bill is issued on a discount basis. The discount basis meant that the final price at which the bill is purchased was the bid price less the discounted price, The discounted price is calculated such that:

$$Discount = Principal \times Rate \times Time/100$$

so that the final price was calculated as

$$Price = Face\ Value - Discount$$

For the competitive market the style of the auction of Treasury bills is a multi-price auction system.[51] Under this style, the bids at the highest price are first allotted, followed by the bids at the next highest price and so on. As a result, each successful bidder pays their bid price. A window is opened to the public for them to place non-competitive bids and this is based on the weighted average purchase price of the successful bidders. As a result, the non competitive bid price could be used as the representative market determined Treasury bill rate.

[22] This is in contrast to price discovery of bonds, where the auction system is a single price auction where "successful bidders pay the "cut-off" price of the lowest successful bid". P15. Public Education Pamphlet Series (2009). The Government Securities Market in Trinidad and Tobago. CBTT.

5.3 Conduct of Open Market Operations

The CBTT defined open market operations as the sale and purchases of government securities (Treasury bills and Treasury notes) by the central bank.[52] The primary objective of open market operations was to sterilize liquidity derived from foreign exchange inflows and fiscal injections. Open market operations currently take place through the sale of government securities by the CBTT to primary dealers. All the commercial banks were selected as primary dealers owing to the fact that they satisfy the prudential criteria.

The instruments traded for the conduct of open market operations are Treasury bills – government securities with maturities of under one year; Treasury notes – government securities with maturity of between one to five years and securities owned by the CBTT.[53] Among these, the 90 day Treasury bills are the most regular. These securities are usually traded almost in two week intervals and primary dealers were able to place competitive bids. In addition to the primary dealers, the CBTT is also engaged in establishing a list of second tier primary dealers and they were expected to actively bid on eligible auctions.

5.3.1 Auction of open market instruments

Regular open market operations using 3 month Treasury bills has been used since 1996 to absorb excess liquidity. These bills are issued every other Wednesday in denominations of TT$1000.00, while Treasury bills with 6 month maturity are traded

[52] See the Implementation of Monetary Policy in Trinidad and Tobago. Issue 1. (2005), Public Education Pamphet Series. pp 20.
[53] Treasury bill limits was first set in 1971 by parliament, while treasury notes were first introduced in 1995.

once every other month. Treasury bills are quoted in terms of the discount rate. In view of chronic excess liquidity, the CBTT broadened its instruments to absorb liquidity. Towards the end of 2005, the CBTT increased its 6-month and 12-month securities, along with two year securities in a bid to sterilize liquidity.

Electronic auctions were introduced in December 2004 along with a real-time gross settlement system. With regards to auctions, bids are made online, and allocation is automatically performed at the close of each auction. Here investors make competitive bids and specify the rates or yields they are willing to receive for the use of their funds. Successful competitive bidders pay the price equivalent to the rate or yield they bid.[54] The weighted average Treasury bill rate is subsequently published and quoted as the Treasury bill rate for that tenor.

Where bonds are traded, the single price auction method is used. In the single price system, investors making competitive bids specify the rate or yield they were willing to receive for the use of their funds. Successful bidders pay the price equivalent to the highest accepted rate or yield regardless of the rate or yield they bid. [55]

5.3.2 REPO rate

The reverse repurchase agreement (repo rate) was introduced as a device to signal the monetary stance of the CBTT, in May 2002.[56] For the central bank, the repo rate is the rate at which the "central bank purchases a security from a commercial bank with an agreement that the bank repurchases the security at a higher price on a specified date."[57] Accordingly, the bank defines the repo rate as "The rate that the central bank

[54] Definition is taken from www.treasurydirec.gov
[55] Definition is taken from www.treasurydirec.gov
[56] The reverse repurchases (REPO) are generally overnight transactions placed at the end of the day..
[57] Definition taken from "The Implementation of Monetary Policy in Trinidad and Tobago" CBTT, Public Education Pamphlet Series, Issue 1, September 2005.

charges commercial banks for the use of overnight funds."[58] This security is a short-term security which provides temporary liquidity to commercial banks when liquidity is tight. In keeping with its use as a signalling device, the CBTT made one month ahead announcement of the rate. As a result, the CBTT conveys its policy intentions, as the repo is the means by which the CBTT can charge commercial banks for overnight funds. Thus, the manipulation of the repo rate is supposed to be transmitted through the interest rate term structure and the credit channel, onto the real side of the economy and thence to inflation.

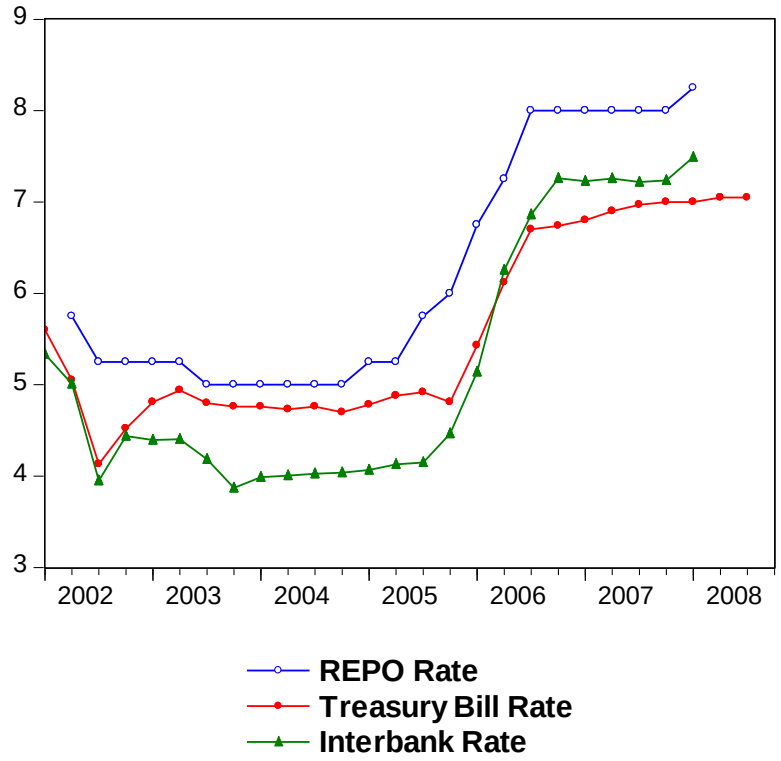
The repo instrument was introduced in 2002 so that prior to its introduction the CBTT influence on the market interest rate came through the manipulation of liquidity. Given that the repo is more effective where commercial banks may be forced to resort to the central bank for temporary financing to meet the reserve requirements, the absorption of excess liquidity remained critical to monetary policy.[59] Thus, whereas theoretically the CBTT can raise the repo rate where it would like to restrict credit flows, it must combine this with aggressive absorption of liquidity in order to dry up excess liquidity.[60] Indeed, the likelihood that the policy rate would transmit throughout the term structure of interest rate, depended on tight liquidity in the banking sector so that banks under such circumstances would be encouraged to first borrow from the interbank market before opting to borrow from the CBTT. Figure 14 gives a plot of the money market rates available for the money market.

[58] Taken from The Implementation of Monetary Policy in Trinidad and Tobago" CBTT, Public Education Pamphlet Series, Issue 1, September 2005. Pp 20.

[59] The existence of persistent excess liquidity allows commercial banks access to idle funds, thus reducing the dependency of commercial banks for external financing by borrowing from the central bank.

[60] The dependence by commercial banks on financing from the central bank can further be weakened where the locally based foreign-owned banks have access to external funds located at the overseas headquarters, and therefore the resident operations would not need to borrow from the domestic central bank.

Figure 14 Trinidad and Tobago Money Market Rates



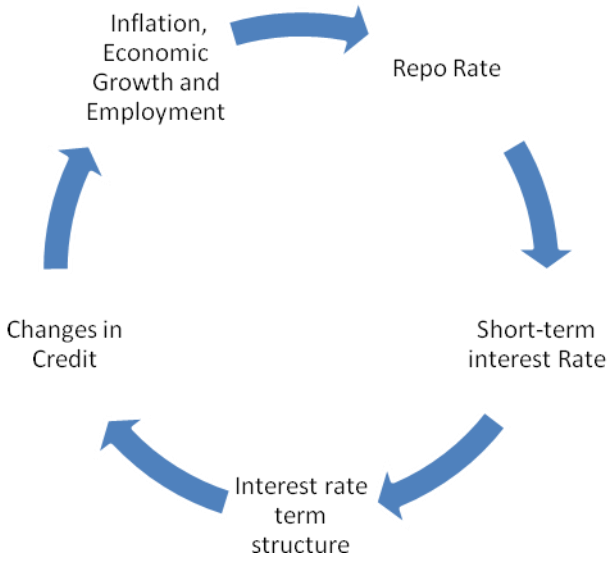
Source: Plotted from data obtained from CBTT database.

The transmission mechanism that the CBTT considers do not consider the effect of international spillovers of disturbances emanating from major trading partners and sources of foreign direct investment to Trinidad and Tobago. The effectiveness of the pass through of the repo rate in the context of international spillovers may be an empirical matter. We therefore pursue this investigation in chapter 5.

5.4 Monetary Transmission Mechanism

Under the new style of monetary policy, the CBTT targets reserve money rather than the balance sheets of financial institutions.[61] As a result, the bank sought to make the transition to the use of indirect instruments.[62] In this new style, the CBTT assumes that short-term interest rate transmitted throughout the term structure, ultimately impacted on spending by households, wealth accumulation and on saving, see Diagram 1. As a result, the credit channel forms the conduit between interest rate and the real side of the economy and inflation.

Diagram 1 Monetary Transmission Assumed by the TTCB



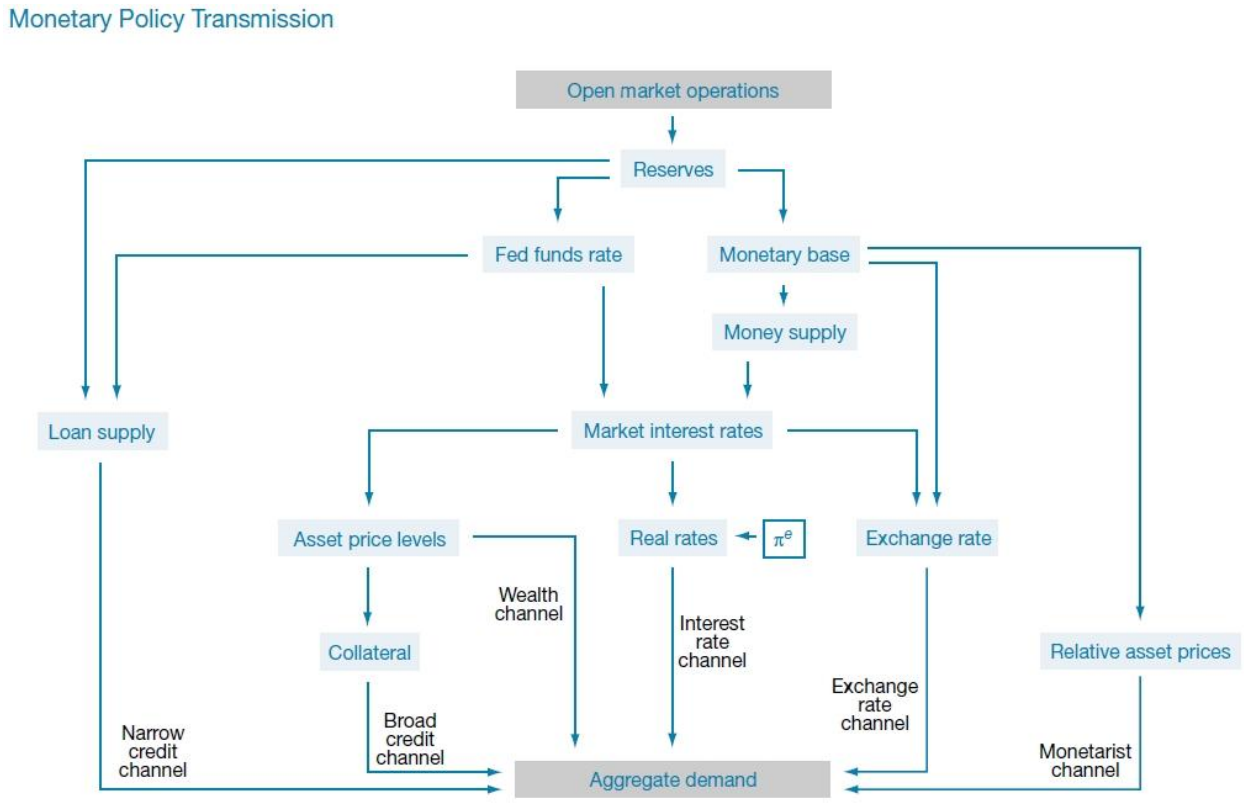
Notes: This transmission mechanism is outlined in the "The Implementation of Monetary Policy in Trinidad and Tobago" Public Education Pamphlet Series, no. 1 of the CBTT, September 2005.

[61] A detailed outline of monetary instruments used by the CBTT can be found in :Monetary and Financial Management in Trinidad and Tobago, CBTT (2005).

[62] See Birchwood (2001) for a discussion on the speed of transition to indirect monetary policy by Central Banks in the Guyana, Jamaica and Trinidad and Tobago. The study used a fixed effects panel estimation and concluded that a gradual approach aimed at fine-tuning the economy be adopted with the implementation of the indirect monetary policy.

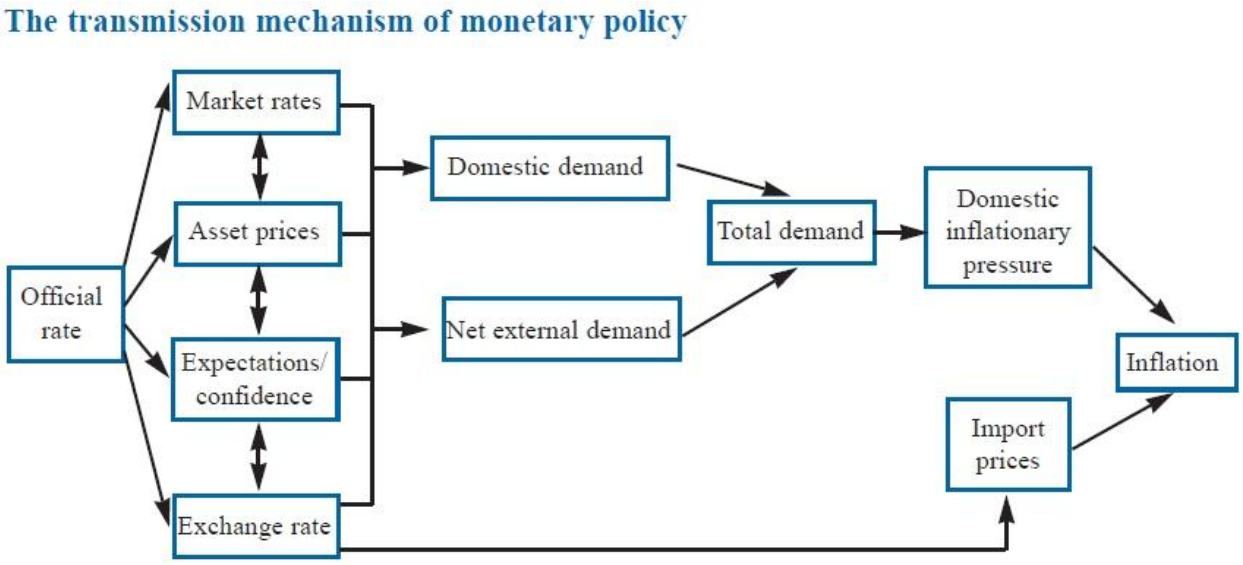
We compare the transmission in Trinidad and Tobago with that of the developed economies, to see how the transmission mechanisms differ. Given that Trinidad and Tobago is at stage two of the IMF (2004) typology of the transition to the new style of monetary policy, it is instructive to compare its transmission mechanism with that of the UK and US where the style is more firmly established, see Diagrams 2 and 3. These UK and US economies reflect deeper financial markets and they deliberately incorporate several transmission mechanisms into the transmission from the policy interest rate to inflation and output. As a result a schema of the transmission framework for these countries is deliberately eclectic to reflect multiple transmission mechanisms through which the policy rate can impact on inflation and the output gap.

Diagram 2 US Transmission Mechanism



Source: Kuttner and Mosser (2002).

Diagram 3 UK Monetary Transmisssion Mechanism



Source: The Monetary Policy Committee, Bank of England. Mimeo.

The official policy rate for the US is the Federal Reserve rate while for the UK it is the repo rate. Both the US and UK choose the interest rate at which the private sector can borrow high powered money at. The repo rate is obtained by lending in the interbank market with respect to trading of gilt sale and repurchase agreements in two week intervals.

The transmission in the UK and US can be realised through direct effects of the policy rate on the wholesale money market. This consists of money market rates and interbank deposit rates. The transmission also takes place through effects of expectations on the economy particularly with respect to savings and investment decisions, through changes in asset prices and the exchange rate. As a result, for the UK the transmission goes from the official policy rate through to four alternative channels: 1) market rates, asset prices, 2) expectations related to the economy and 4) exchange rate. The market rates include deposit rates and mortgage rates.

Expectations are a strong influencing factor on asset prices and the exchange rate. The type of expectations includes financial market expectations, expectations with respect to labour market dynamics, sales and profits. Mishkin (2007) points to several transmission mechanisms running from the policy rate to asset prices. These asset prices include Tobin q-theory, Firm Balance Sheet Effects, Household Liquidity Effects, Household Wealth Effects, Real Estate Prices and exchange rate effects.

Monetary transmission is not precise in the advanced industrialised countries, since while they may have greater control over the policy and deposit rates in the intermediation markets, they have less control over expectations associated with asset prices and exchange rates. The interpretation of changes in market rates is subjective and therefore results in uncertainty. The transmission mechanisms are built solely on the demand side, so that inflationary pressures arise through the demand side.

5.4.1 Comparison of Transmission Mechanism in Trinidad and Tobago with that of the UK and US

5.4.1.a Moral Suasion

The transmission mechanism mechanisms attributed to the developed economies show that they are able to use the markets with various transmission mechanism to realise the transmission of the policy rate to inflation. Moreover, according to the monetary policy committee of the Bank of England (Mimeo), the Bank of England is able to use its monopoly with respect to “high powered money” or base money. Given the relatively low development of the financial markets and instruments in Trinidad and Tobago compared to the developed economies, the country is more reliant on the use of moral suasion to navigate the transmission of the policy repo rate. Moral suasion can be used in two senses, 1) in terms of an appeal to altruistic sentiments and

2) in terms of the threat of coercing market players to comply with the wishes of the regulator. The second meaning is appropriate here.

Here, we suggest that the CBTT is able to use its monopoly as a regulator to imply a threat to financial institutions with regards to possible future legislation. This entails the policy maker working closely with the financial institutions they wish to apply moral suasion to. This is in contrast to the developed countries where the central banks rely on market forces to transmit the policy rate through the system. Moreover, we also suggest that by working closely with the commercial banks, the central bank is able to use information sharing as a sanction to encourage/reward commercial banks to be accommodating to changes in the repo rate.

The literature on the use of moral suasion as a policy tool has been sparse. A notable exception is Romans (1966). According to him, moral suasion is effective where "cost of noncompliance is made to exceed the cost of compliance." They argued that under specific conditions, the use of moral suasion can be feasible. Two principal conditions they noted were the necessity for there to be public support for the desired policy action, and the population should be small. To apply their study directly to this study, we interpret the public to be in terms of the population of financial institutions regulated by the central bank. As a result, the financial institutions must buy into the policy measure that the central bank wishes them to follow.

Trinidad and Tobago has a small number of banks: only eight banks are regulated by the CBTT. This is in contrast to the US where 89,697 national commercial banks operate, or the UK where 21 commercial banks and 55 building societies operate. A large market can make it difficult for moral suasion to be effective as policy makers may not be able to meet regularly with individual banks or to stage negative sanctions against those that do not comply. Where the market is small we suggest that, while it

may not be ideal for efficient market pricing, the smallness may be ideal for the application of moral suasion.

As a result of the smallness of the market in Trinidad and Tobago, they are able to meet with the commercial banks as a group and individually. In addition, compliance by the majority in a small market increases the opportunity cost of the minority who do not comply. Moreover, if commercial banks do not respond as the central bank signals with respect to changes in the repo rate, commercial banks would expect that the central bank can resort to a range of other tools. However, they know that tools such as reserve requirements are more costly to commercial banks when compared to responding to the signal of the repo rate. Since non-remunerated reserve requirements act as a tax on deposits of commercial banks, it would be more likely for a profit maximising bank to cooperate with the central bank by responding to the policy signal emitted by the central bank.

Breton (1978) contends that the central bank is able to encourage commercial banks to cooporate by engaging in information sharing with the latter. For the CBTT, information sharing takes place through regular meetings by the central bank with the commercial banks, three to four times a year, for them to understand the central bank's thinking on monetary developments and for the central bank to obtain feedback from them. The meeting takes place at the management level of the commercial banks and at the technical level which include the level of traders.

5.4.2 Differences between Transmission Mechanisms

It is interesting to note that the exchange rate is not included in the transmission mechanism by the Trinidad and Tobago. This may be due to the fact that the bank concentrates its efforts at managing its exchange rate to keep it stable, so that it would

not have to contend with changes in the exchange rate. This is in contrast to the UK and US where the rate is a vital part of the transmission mechanism.

Another important difference to note is the high importance of the securities market in the advanced industrialised markets, with respect to the transmission of the policy rate, when compared to Trinidad and Tobago. With banks in Trinidad and Tobago exhibiting high excess liquidity spurred by limited alternative investments, there is excess demand for government instruments. The limited investment alternatives arise from the shallowness of the financial markets to accommodate the supply of investment funds and low liquidity, given low supply of companies registered in Trinidad and Tobago.

Still another difference to note is that the transmission mechanism in the advanced industrialised economies is based on a more sophisticated market system where there exist developed secondary markets for the trading of existing securities and capital markets for the trading of long term instruments which allow for the development of yield curves. For Trinidad and Tobago the capital market is thin, given the small number of players in the markets. In addition the interbank market in Trinidad and Tobago tends in most cases to contain banks with balance sheets on the same side of excess liquidity, thus diminishing the functioning of the market to generate interbank trade.

The relatively low development of the financial markets and instruments in Trinidad and Tobago compared to the sample of advanced industrialised countries in the study, has left the country more reliant on moral suasion rather than through coercion of market forces to influence the pass through of the policy rate. The CBTT use its monopoly as a regulator given its latent threat to exercise negative sanctions if financial institutions do not react favourably to the signals conveyed through changes by the central bank in the policy rate.

The CBTT noted, however, that the implementation of the new style required greater development of the money market, given its rudimentary level of development from since the time of independence. As noted by Alexander et al (1995), developing countries often lack deep financial markets with competitive institutions, substantial infrastructure, and a sophisticated legal and regulatory framework. They noted that the deepening of the market was kick started in many countries through the staging of regular auctions of government securities in a bid to influence bank reserves, where the Central Bank was then able to vary the net amount auctioned. The CBTT has therefore been taking steps to develop the money and capital markets to allow for the new style of monetary policy.

6.0 Simple test for the scope for independent determination of money market rates in Trinidad and Tobago

Given that Trinidad and Tobago practiced a managed floating exchange rate with limited exchange rate volatility, the independence of its money market can be questioned given the trilemma argument. Here the trilemma argument is that a country would lose its independence to conduct monetary policy where the exchange rate is fixed and the capital market is open. In this case we examine whether the trilemma argument can be applied to the money market.

Following Obstfeld et al (2004), we did a simple check on whether the managed exchange rate as practiced by Trinidad and Tobago leaves sufficient scope for independent determination of representative Treasury bill rates through auctioning in the money market. In doing so, we investigate whether changes in the domestic Treasury bill rates between Trinidad and Tobago and the US are synchronised.

We first note that the correlation between the Trinidad and Tobago 3-month Treasury bill rate and the US Federal Reserve rate for the period 1st quarter of 1997 and the

third quarter of 2011 is 0.76. This shows that there is a strong tendency for both interest rates to move in the same direction. However, the degree to which a change in the Trinidad and Tobago 90-day Treasury bill rate contemporaneously reflected a change in the Federal Reserve rate can be observed using OLS estimation, given the time series properties of the data. Using Obstfeld et al (2004) estimation specification, the estimation model used is

$$\Delta i_t^D = \beta \Delta i_t^{USFR} + \varepsilon_t$$

where Δi_t^D is the change in the domestic short term interest rate, which in this case is the Treasury bill rate and i_t^{USFR} is the change in the US Federal Rate. Obstfeld et al (2004) contended that theoretically, if there is perfect capital mobility and a fixed exchange rate peg then $\beta = 1$ should be obtained so that interest rate parity should be derived.

The regression is conducted using quarterly data for the first quarter of 1997 to the third quarter of 2008, see Table 10. In this case, both the US Federal Reserve Rate and the Trinidad and Tobago 3-month Treasury Bill Rates are integrated of order one, so that the regression is conducted on the first differences of the series in order to maintain variable stationarity. The regression results show that

Table 10 Dependent variable is a change in the Trinidad and Tobago Treasury Bill Rate

	Coefficient	Standard Error	t-statistic
Change in Federal Reserve Rate	0.35	0.17	2.00**

Notes: $\bar{R}^2$ = 0.08, Durbin Watson Statistic: 1.66, Standard Error: 0.65. OLS regression.
Quarterly data: 46 data points; 1997q2 to 2008q3. ** is significant at a 5% level.

The significant β coefficient of 0.35 suggests that changes in the 90-day Treasury bill rate in Trinidad and Tobago do not instantaneously and strongly reflect changes in the

Federal Reserve rate. Employment of the Wald test shows β to be significantly less than one, thus suggesting that capital mobility is not perfect or the exchange rate is not a hard peg, so that there is some degree of autonomy for the determination of the Treasury bill rate through the auction process. This is further evidenced by the fact that the Trinidad and Tobago short-term interest rate reflected significantly higher volatility when compared to the US short term rates.[63]

7.0 Links between the Trinidad and Tobago Treasury Bill rate with the US Treasury Bill rate

The CBTT closely monitors the spread between Trinidad and Tobago and US Treasury bill rates, since it used this as an indicator of the demand for foreign currency in its bid to gauge the likelihood of exchange rate pressures. [64] Accordingly, in the view of the CBTT, the narrowing of spreads is likely to lead to increased demand for foreign currency by domestic agents, particularly for those wishing to invest in US financial instruments.[65]

In actuality, the Trinidad and Tobago 3-month Treasury bill rate is significantly higher than both the US federal funds rate and US 3-month Treasury bill rate when examined over the period 1997 to 2010, see Figure 15.[66] For the period 1997 to 2009 the

[63] The standard deviation of the Tobago Treasury bill rate was 2.90 compared to a standard deviation of 1.91 and 1.74 with respect to the U.S. Federal Reserve Rate and U.S. 3-month Treasury bill Rate.

[64] Farrell (1990) pointed out that this policy was exercised since in 1966, as the TTCB recognized that capital movements were closely linked to interest rate differentials between the base economy, which was the UK at the time, and Trinidad and Tobago. In those early years the exchange rate was tied to the pound sterling, and the CBTT deliberately set out to ensure that the interest rate on the newly created Trinidad and Tobago local currency deposits was higher than that of the pound sterling.

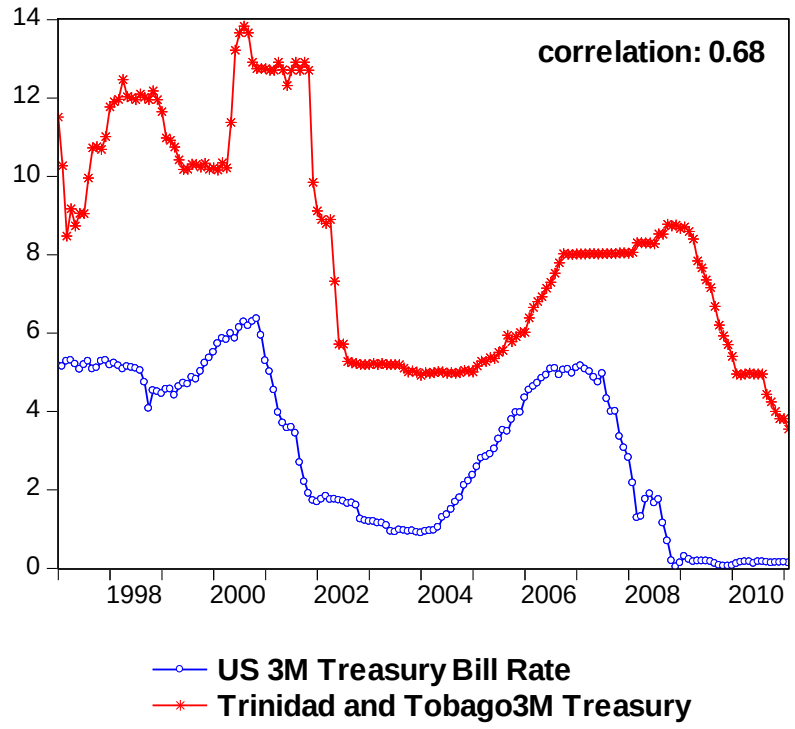
[65] See the Monetary Policy Report, April 2007, for an elaboration on this.

[66] Use of the ANOVA test statistic showed that for the period, the mean Trinidad and Tobago 3-month Treasury Bill Rate of 7.69 per cent was significantly higher than the mean US Federal Reserve rate and mean U.S. Treasury bill rate which were 3.72 and 3.17 respectively.

correlations between the Treasury bill rates for Trinidad and Tobago and the US was 0.74 and with the Federal Reserve rate is 0.99.

The evidence shows that there is a high correlation between the three month Trinidad and Tobago Treasury bill rate with that of the US Treasury bill rate.

Figure 15 Relation between US and TT Treasury Bill Rates



Source: US Treasury bill rate obtained from http://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield and Trinidad and Tobago Treasury bill rate obtained from CBTT database.

We then apply Granger Causality test to see whether the domestic Treasury bill rate pattern is informed by the US Treasury bill rate.

For the estimation of the Granger Causality, x Granger cause y if the addition of x is statistically significant to improving the explanation of y.

Consider autoregressive bivariate regressions

$$y_t = \alpha_0 + \sum_i^p \alpha_i y_{t-i} + \sum_i^p \beta_i x_{t-i} + u_t \quad (1)$$

and

$$x_t = \alpha_1 + \sum_i^p \beta_i x_{t-i} + \varepsilon_t \quad (2)$$

The null hypothesis is that x do not Granger cause y in equation 1, if
$\beta_1 = \beta_2 = \cdots = \beta_p = 0$

The F statistic can be obtained by using

$$y_t = a_0 + \sum_0^p \gamma y_{t-1} + \varepsilon_t$$

The residual sum of squares can be compared for equations 1 and 2 to obtain
$RSS_1 = \sum_{t=1}^T \hat{u}_t^2$; $RSS_0 = \sum_{t=1}^T \hat{\varepsilon}_t^2$

The F statistic is formed as

$$S_1 = \frac{(RSS_0 - RSS_1)/p}{RSS_1/(T-2p-1)} \sim F_{p,T-2p-1}$$

If the test statistic is greater than the critical value then the null hypothesis is rejected and we conclude that x Granger cause y.

As shown in Table 11, when the test is applied to the predictability of the TT Treasury bill rate based on the US Treasury bill rates we obtain

Table 11 Granger Causality Test

Pairwise Granger Causality Tests
Date: 04/23/11 Time: 17:14
Sample: 1997M01 2011M02
Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
US TB Rate does not Granger Cause TT TB Rate	169	4.01749	0.0039

Source: Author's Calculation using 3-month Treasury bill data obtained from http://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield and 3-month Data obtained from CBTT database.

The result shows that the US Treasury bill rate Granger cause the pattern of the movement of the Trinidad and Tobago Treasury bill rate, see Table 11. Here the evidence obtained show that in spite of the fact that the TT Treasury bill rate is obtained from bids by the major market players in Trinidad and Tobago, it predicts that the Treasury bill rate in Trinidad and Tobago moves in tandem with that of the US. Accordingly, the US Treasury bill rate influences the Treasury bill rate in Trinidad and Tobago. The results therefore suggest that the Trinidad and Tobago money market is not independent of the US money market rate. The Granger causality test results show that changes in the US Federal rate can help to predict the movement of the Trinidad and Tobago Treasury bill rate in Trinidad and Tobago policy, but the influence is not very strong in the short run, given the estimation result of 0.35 obtained in Table 10.

The results therefore suggest that there is room for independent monetary policy by the CBTT in the short run.

8.0 Conclusion

We showed that Trinidad and Tobago is a very open economy with a heavy dependence on foreign trade. In particular, the country derived most of its export and fiscal revenues from corporation taxes and royalties emanating from the energy companies. As a result, the bulk of foreign exchange inflows were held by the central bank on behalf of the government. This improved the capacity of the central bank to manage the exchange rate by direct trading of foreign currency in the foreign exchange market as opposed to resorting to the use of direct controls or macroeconomic measures. Steady increases in gross international reserves, allowed the CBTT to use sales and purchases of foreign exchange to manage the exchange rate and control liquidity.

With the accumulation of reserves, the government had the option of drawing down on its deposits at the central bank to raise expenditure. The injection of these funds into the economy tended to raise excess liquidity, since the revenues derived from the energy sector acted as outside money. The central bank therefore took measures to aggressively dry up excess liquidity where in the short run such injections did not lead to increased output.

Given persistent excess liquidity, the central bank aggressively sought to dry up excess liquidity in order to give impetus to the interbank market and allow the repo policy rate to effectively signal the control of the monetary stance. In this light the central bank made efforts to develop primary and secondary markets in order to make open market operations effective in drying up excess liquidity. As a result, the repo rate was

accompanied by aggressive absorption of excess liquidity with the idea that use of the repo policy rate by the central bank would be more effective in an environment of tight liquidity, since it is under this condition that commercial banks would be forced to go to the interbank market, thereby providing the impetus for the development of this market.

The CBTT did not practice strict inflation targeting, but it used an inflation anchor with respect to headline inflation. Moreover, the bank set and published its targeted rate rather than acted through an Act of parliament. Core inflation was also monitored, and the difference between these two measures was with respect to food inflation and core inflation excluded this variable. The new style of monetary policy pursued by the central bank led to it seeking to aggressively dry up excess liquidity in order to make the policy rate effective.

A key point raised in the study is that in the absence of an advanced developed financial market, Trinidad and Tobago was able to use the smallness of the market to its advantage. In effect it exercised moral suasion upon the private financial sector to influence them to respond to changes in the policy rate signal. Thus in effect the central bank was able to use the threat of regulatory coercion rather than market forces as is done in the advanced industrialised countries.

Another important point to note is that the set up to achieve the market based monetary policy was not independent of the trends in the US. As a result the money market rates were very much related to that of the US. Perhaps this could have been influenced by the strong trade links with the US and the managed exchange rate adopted by Trinidad and Tobago.

It should be noted that a limitation in the monetary policy design with respect to CBTT is that it did not formally include the external sector in the monetary policy design. The

transmission was simplified compared to the developed economies, as financial markets did not feature prominently in its monetary policy design. Yet given the openness of the economy, the role of the external sector may be pertinent to monetary policy. In subsequent chapters we investigate whether the overseas sector should be included in the assumed transmission mechanism and whether the pass through of the policy repo rate to inflation is affected by international spillovers.

Chapter 4

Is the central bank policy rate useful under a managed float in a resource intensive economy?

1.0 Introduction

This chapter is an empirical investigation into whether the augmentation of the Taylor (1993) rule by the real exchange rate improves the performance of the monetary policy rule when the exchange rate is managed in a small open energy-based economy, such as Trinidad and Tobago, where government is a near monopsonist supplier of foreign currency.[67] The primacy of government in the foreign exchange market stems from its domination of foreign exchange inflows from royalties and taxes from energy production. The study therefore seeks to fill a gap in the literature by presenting empirical evidence on the applicability of Taylor-type monetary policy rules to such an economy and the implications of these rules for macroeconomic stability. We check the robustness of the policy rule across different measures of inflation with respect to traditional and augmented Taylor-type rules. This case study can be instructive as some of these economies, such as Qatar, Nigeria and Trinidad and Tobago, are attempting to adopt a market approach to monetary policy.

Adapting a simple Taylor-type rule for an open economy can imply two types of changes. First, as emphasised by Galí and Monacelli (2005) among others, the open

[67] Managed exchange rates are typical in many economies. For example Saxena (2008) points out that in Asia and Latin America nine out of thirteen economies practice managed floats by intervening in the foreign exchange markets.

economy may lead to same parameters for the New Keynesian open economy Phillips and IS curves. In this vein, Clarida et al (2001) contend that the open economy is 'isomorphic' to the closed economy in that the open economy is described by the same variables as the closed economy, even though the size of the parameters may differ. Second, it may be optimal for policymakers to respond to more variables in an open economy compared to a closed economy, implying a richer form for the optimal monetary policy rule. Indeed, studies by Batini et al (2009) and Shi and Xu (2008) suggested that the traditional Taylor rule ought to be augmented by the exchange rate.

It is not clear in the theoretical literature that has evolved on open economy monetary policy rules, if augmentation by the real exchange rate is optimal compared to the traditional Taylor (1993) rule. Shi and Xu (2008) considered the nominal exchange rate, while Batini et al (2009) and Taylor (2001) considered the real exchange rate to be potentially improving. While these papers explored the broad classification of exchange rate regimes in terms of hard pegs, managed floats and flexible exchange rates, they failed to take account of the fact that managed floats may differ in practice across economies. In particular, to the best of our knowledge, the previous literature has not considered the case where the government is a near-monopsonist supplier of foreign exchange to the domestic market, giving it considerable influence over the exchange rate in the short-term. Consequently, we test whether the real exchange rate is a suitable candidate to augment the traditional Taylor rule when a managed float is adopted with government been the major supplier of foreign exchange to the market.

The open economy also has implications for which measure of inflation should be included in the monetary policy rule. The original Taylor (1993) paper used the GDP deflator as the measurement of the inflation rate. Galí and Monacelli (2005) also suggest that domestic inflation should be the measure used. In practice inflation targeting countries have chosen to target the consumer price index (CPI), which reflects the prices of both domestic and imported goods. As a result, discussions have evolved to an examination of the relative merits of headline and core inflation. Saxton (1997) noted that the use of CPI can be attributed

to its familiarity, ready availability, minor revisions and convenience in communicating with the public. In addition it is a useful measure of the cost of living against which wages are negotiated. Further, Guender (2006) showed in an analytical model that in an open economy, targeting the CPI index is more likely to bring about stability in CPI inflation, the exchange rate and the policy instrument, though it would be less likely to bring about stability in the output gap. Consequently, the preferred measure of inflation adopted by many countries remains the CPI index.

The CPI index is often measured in two forms, the full CPI index which gives headline inflation and one that is trimmed of the most volatile elements to obtain core inflation. Since headline inflation contains components which are subject to volatile swings it can therefore be misleading with respect to the true level of inflation, see for example, Mishkin (2007).[68] Rich and Steindel (2005) argues that a significant degree of noise can be filtered out of inflation by focussing on core rather than headline inflation, since the latter rises more than core inflation in reaction to shocks and may not therefore be easily addressed by the policy interest rate. Moreover, focus on headline inflation may involve unnecessary sacrifice of output through tight monetary policy, given the temporary nature of increases in headline inflation. A possible strategy is for the central bank to be accommodative to headline inflation but aggressive to core inflation, see for example Dhawan and Jeske (2007). In addition, Bronstein et al (2008) show that within a monetary framework, rules which respond to core inflation outperform those which depend on headline inflation since the latter causes unnecessary volatility.

The study is applied to Trinidad and Tobago, an emerging market economy. The economy is foreign exchange constrained given that its currency is not an international reserve currency and the government dominates the earning of foreign exchange in

[68] In the case of Trinidad and Tobago, the volatile component in the index is agriculture prices.

this economy.[69] Moreover, the traditional Taylor (1993) rule is compared to the augmented Taylor-type rule where the traditional rule is augmented by an exchange rate measure.

The remainder of the chapter is structured as follows. A brief review of the literature is presented in Section 2. Here we examine the debate concerning whether the monetary policy rule should be augmented, and if so, whether the real exchange rate is a good candidate. We note Galí and Monacelli (2005) argument that supply and demand disturbances emanating from the external economy go through the parameters of the traditional Taylor rule and therefore the closed economy Taylor (1993) rule is also appropriate to the open economy. We then examine the Taylor (2001) argument that the rule can be augmented by the real exchange rate, where it is shown that the real exchange rate may reduce the variability of inflation and the output gap from their targeted values, but that the improvement is only slight at best.

In section 3 we highlight the modelling framework that the empirical investigation is based on. Assuming that the central bank is forward-looking we first derive a target interest rate based on economic conditions. The chosen policy rate is smoothed in relation to the target rate, to reduce volatility in the policy rate. We then consider the test hypotheses in terms of the candidate Taylor rules. In particular we consider the traditional Taylor (1993) rule and the augmentation of the rule by the real exchange rate.

Section 4 explains the variables and data employed in the study. We also discuss the inflation measures to be used. In Section 5 we outline the estimation method. In particular we estimate traditional Taylor-type rule with respect to domestic and CPI inflation in terms of headline and core inflation measures. We then consider

[69] The dominance of the government in the foreign exchange market is typically the case among oil producers such as OPEC member countries, as these governments are the major recipient of royalties and other corporate taxes from oil production and sales.

augmented Taylor-type rules in Taylor (2001) by including the real exchange rate, deviations of the real exchange rate from the long run steady state exchange rate and the Federal Reserve rate. The estimates are then reported in Section 6 after which the study concludes in Section 7.

2.0 Literature Review

A key issue concerning the incorporation of the open economy into the Taylor (1993) rule is how external disturbances are transmitted to the domestic economy. This has implications for whether or not the Taylor (1993) rule should be augmented. Further, the monetary rule assumed, stems from the assumptions behind the construction of aggregate supply and demand equations.

From the analysis, the impact of a managed float on inflation in the GM model can be deduced. They considered CPI inflation as the weighted average of domestic and imported inflation where the latter was defined in terms of the exchange rate by the price of foreign goods. Here we note in 4.2.22 that movements in the index of imported goods would be directly related to the degree of movements in the nominal exchange rate and the degree of movements in the index of foreign prices. If the volatility of the exchange rate is constrained because the central bank adopt a managed float, then while changes in the foreign price index would be reflected in terms of changes in import prices, the exchange rate would be managed and would therefore have limited effect on import prices. The managed float would therefore limit the likelihood of an appreciation or depreciation of the real exchange rate. Therefore movements in the real exchange rate would more likely arise from movements in the terms of trade with respect to relative prices, rather than from changes in the nominal exchange rate.

2.1 The Galí and Monacelli (2005) model

In this section we use Galí and Monacelli (2005) as the baseline. For Galí and Monacelli (2005), external shocks impact on the structural relationships in the economy and therefore do not necessitate the augmentation of the Taylor (1993) rule. They constructed their model by assuming that the economy consists of optimizing households and firms, with the central bank playing the role of minimizing the variability of inflation and the output gap. The household's problem is to maximize the difference between the utility of consumption and disutility of labour constrained by income and taxes, while the policy maker sets policy using a monetary policy rule.

The utility function is

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t) \qquad 4.2.1$$

β^t is the household's time discount factor as the household seek to maximise the expected present discount value of utility, C_t is the composite consumption index, N_t is labour hours and and subject to the budget constraint

$$P_t C_t + E_t\{Q_{t,+1} D_{t+1}\} = D_t + W_t N_t + T_t \qquad 4.2.2$$

where $Q_{t,+1}$ is the equilibrium price of a riskless bond in foreign currency, D_t is the payoff of the portfolio held in the next period, W_t is the nominal wage rate, N_t and T is lumpsum taxes and transfers. W_t is the wage rate, P_t is the CPI index and D_{t+1} is the nominal payoff in period $t + 1$.

The central bank seeks to minimise a loss function. Woodford (2003) showed that the central bank objective function is a quadratic second order Taylor series approximation to household utility maximisation. In keeping with this, Galí and Monacelli (2005)

expressed the social welfare objective as a fraction of steady state consumption such that

$$\mathbb{W} = -\frac{(1-\alpha)}{2}\sum_{t=0}^{\infty}\beta^t\left[\frac{\epsilon}{\lambda}\pi_{H,t}^2 + (1+\varphi)x_t^2\right] \mathbb{W} = -\frac{(1-\alpha)}{2}\sum_{t=0}^{\infty}\beta^t\left[\frac{\epsilon}{\lambda}\pi_{H,t}^2 + (1+\varphi)x_t^2\right]$$

4.2.3

where $\mathbb{W}$ is social welfare, α is the degree of openness, ϵ is the substitutability between a variety of differentiated goods, λ is the slope of the Phillips curve, $\pi_{H,t}$ is the domestic inflation rate and x_t is the output gap. Also, $\pi_{H,t+1}$ is the forecast of domestic inflation, φ is the disutility of labour and x_t is the current output gap. The policy function suggests that the policymaker cares about stabilising inflation around its target rate and stabilising the output gap. Full stabilisation requires

$$x_t = \pi_t = 0. \qquad 4.2.4$$

The zero targets are assumed in order to avoid inflation bias and to avoid sunspot equilibrium.

At the limit, if $\beta \to 1$ in (4.2.3), this would suggest that the household would tend to value future consumption the same as current consumption. As a result, deviations from full stabilisation in 4.2.4 leads to expected welfare losses where

$$\mathbb{V} = -\frac{(1-\alpha)}{2}\left[\frac{\varepsilon}{\lambda}var(\pi_{H,t}) + (1+\varphi)var(x_t)\right] \qquad 4.2.5$$

Firms are assumed to engage in Calvo pricing: λ depends on the discount rate and the Calvo adjustment probability (θ). As is well known, this implies

$$\lambda \equiv \frac{(1-\beta\theta)(1-\theta)}{\theta}. \qquad 4.2.6$$

It is important to note that domestic inflation and the output gap are included in the loss function, suggesting that the policymaker is seeking to minimise the variance between domestic inflation and the output gap. The model therefore presumes that the monetary authorities are pursuing flexible domestic inflation targeting in that the policy objective is to minimise the variance of inflation and output deviations from their targets.

Following Taylor (1993), the central bank is assumed to be using the rule:

$$i_t = \overline{rr_t} + \phi_\pi \pi_{H,t} + \phi_x x_t \qquad 4.2.7$$

where i_t is the policy short term interest rate and $\overline{rr_t}$ is a constant. The model is based on the domestic inflation rate. CPI inflation is not incorporated in the simple rule. Foreign disturbances are assumed to be reflected in inflation and output and not included directly into the Taylor (1993) rule.

Svennson (2000) observed that all inflation targeting countries target CPI inflation, rather than domestic inflation. He suggested that an attraction to this is that the cost of living and wage setting are more likely to be influenced by the cost of living index which is more readily captured by CPI inflation as it incorporates foreign prices. Further, it allows for the effect of exchange rate changes on relative prices of imports and it also influences wage setting. Accordingly, use of the CPI index goes beyond the traditional Taylor (1993) rule by allowing for the incorporation of foreign disturbances on the cost of living.

The parameters ϕ_π and ϕ_x are fixed exogenously. A critical question which we shall investigate is how the sizes of the coefficients in the traditional rule compare to that of

the augmented rule. In particular we compare the sizes of ϕ_π and ϕ_x for the traditional and augmented rules.

A necessary and sufficient condition for uniqueness of equilibrium is

$$\kappa_\alpha(\phi_\pi - 1) + (1-\beta)\phi_x > 0 \qquad 4.2.8$$

where $\kappa_\alpha \equiv \lambda(\sigma_\alpha + \varphi)$ is the relationship between the output gap and inflation. Taylor (1993) recommends $\phi_\pi > 1$ if the central bank is to be aggressive in fighting inflation and $\phi_\pi < 1$ if the central bank is accommodative in its monetary policy stance. Also, stabilisation of output requires $\phi_x > 0$.

2.1.a Implications of aggregate supply for the monetary rule

Galí and Monacelli (2005) derive a linearised Phillips curve, approximated around zero average inflation steady state equilibrium, is given by

$$\pi_{H,t} = \beta E_t\{\pi_{H,t+1}\} + \lambda\widehat{mc_t} \qquad 4.2.9$$

where $\widehat{mc_t}$ is the proportional deviation from steady-state real marginal cost. Real marginal cost is the difference between the product price and nominal marginal cost, given the mark up by firms in a monopolistic market structure as firms seek to maximise profits by minimising cost. Real marginal cost is affected by the ability of firms to minimise cost given technology, market demand and price stickiness. For simplicity, technology is assumed to be linear and is given by the production function where output is a function of labour and productivity, since labour is assumed in the model to be the only factor of production. That is

$$Y_t(j) = A_t N_t(j) \qquad 4.2.10$$

where Y is output and A is productivity.

Approximating 4.2.10 in log terms we obtain

$$y_t = a_t + n_t \qquad 4.2.11$$

where y_t, a_t and n_t are the logs of Y_t, A_t and N_t in equation 4.2.10.

The closed economy form of the marginal cost stemming from this is

$$mc_t = -V + (w_t - p_{H,t}) - a_t \qquad 4.2.12$$

where V is a government subsidy implemented to counter distortions arising from the monopolistic market structure and $p_{H,t}$ is the price of domestic goods.

The CPI index (p_t) is defined as

$$p_t \equiv (1-\alpha)p_{H,t} + \alpha p_{F,t} \qquad 4.2.13$$

where $P_{H,t}$ is the price index of domestic goods, $P_{F,t}$ is the import price index, α is the index of openness such that $0 < \alpha < 1$.

Adding and subtracting p_t to equation 4.2.12 gives

$$mc_t = -V + (w_t - p_t) + (p_t - p_{H,t}) - a_t. \qquad 4.2.14$$

On the household side, consumption is divided between domestic and foreign goods such that

$$C_t = \left[(1-\alpha)^{\frac{1}{\eta}}\left(C_{H,t}\right)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}}\left(C_{F,t}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \quad 4.2.15$$

where C_t is the composite consumption index, $C_{H,t}$ is domestic consumption, $C_{F,t}$ is consumption of an index of imported goods, η is the substitutability between domestic and foreign goods with $\eta > 0$. Further,

$$C_{i,t} \equiv \left(\int_0^1 C_{i,t}(j)^{\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}} \quad 4.2.16$$

and

$$C_{F,t} \equiv \left(\int_0^1 \left(C_{i,t}\right)^{\frac{\gamma-1}{\gamma}} dj\right)^{\frac{\gamma}{\gamma-1}} \quad 4.2.17$$

Here ε is the elasticity of substitution between varieties of goods within any country and γ is the elasticity of substitution between different country imports.

Consumption demand for foreign goods are inversely related to the price of imported goods relative to domestic goods, the openness of the economy and the elasticity of substitution between imported goods and domestic goods so that

$$C_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t\,. \quad 4.2.18$$

We use I to denote imports of good (j) and i to denote countries. The optimal allocations on the variety of domestic and imported goods are

$$C_{H,t}(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\varepsilon} C_{H,t} \quad 4.2.19$$

and

$$C_{I,t}(j) = \left(\frac{P_{I,t}(j)}{P_{i,t}}\right)^{-\varepsilon} C_{i,t} \qquad 4.2.20$$

so that total expenditure for the domestic and foreign goods is

$$P_{H,t}C_{H,t} + P_{F,t}C_{F,t} = P_t C_t \qquad 4.2.21$$

thus suggesting that the household must decide on how much to spend on imported goods in relation to domestic goods. As a result, external and domestic demand is shaped by the preference of consumers foreign over domestic goods, the choice of which is influenced by relative prices. Further, the real exchange rate can influence this decision through its impact on relative prices.

The bilateral exchange rate of country i at time t is given by $\varepsilon_{i,t}$. The price of variety j exports is given by $P_{i,t}^{i}(j)$. Assuming that variety j is sold at producer currency pricing then the imported price is $\varepsilon_{i,t}P_{i,t}^{i}(j)$. In log terms, the price index of imported goods $P_{F,t}$ is

$$P_{F,t} = \int_0^1 (e_{i,t} + p_{i,t}^{i})di = e_t + p_t^* \qquad 4.2.22$$

Thus as shown in 4.13, the CPI incorporates the effects of the exchange rate. Substituting in 4.2.22 gives

$$s_t = e_f + p_t^* - p_{H,t} \qquad 4.2.23$$

where e_f is the nominal exchange rate and p_t^* is the index of foreign prices. The right hand side of the expression gives the real exchange rate, q_t. s_t is the terms of trade, which is

$$s_t \equiv p_{F,t} - p_{H,t} \qquad 4.2.24$$

The relationship between the real exchange rate (q_t) and the terms of trade can therefore be derived so that

$$q_t = s_t + P_{H,t} - P_t$$

$$= (1-\alpha)s_t \qquad 4.2.25$$

Assuming purchasing power parity holds, then s_t can be substituted into the CPI equation in 4.2.13 to become

$$p_t \equiv p_{H,t} + \alpha s_t \qquad 4.2.26$$

Per-period utility is assumed to be

$$U(C,N) \equiv \frac{C^{1-\sigma}}{1-\sigma} - \frac{N^{1+\varphi}}{1+\varphi} \qquad 4.2.27$$

The elasticity of the marginal disutility of labour from the utility function is given by φ, while σ is the coefficient of risk aversion.

The per unit utility function can be substituted into the overall utility function in equation 4.2.1 and maximised subject to the budget constraint in equation 4.2.2.

One result that can be obtained is

$$C_t^{\sigma} N_t^{\varphi} = \frac{W_t}{P_t} \qquad 4.2.28$$

In log terms 4.2.28 can be expressed as

$$w_t - p_t = \sigma c_t + \varphi n_t \qquad 4.2.29$$

Substituting 4.2.29 and 4.26 into equation 4.2.14 gives

$$mc_t = -v + \sigma c_t + \varphi n_t + \alpha s_t - a_t \qquad 4.2.30$$

This shows that there is a terms of trade effect, so prices in the world economy affects domestic inflation through the marginal cost and the effect is stronger the more open the economy (as indicated through the positive impact of a change in α on the marginal cost). Thus, considering the growth in prices, equation 4.2.26 becomes

$$\pi_t = \pi_{H,t} + \Delta s_t \qquad 4.2.31$$

where π_t is CPI inflation. Therefore a change in the terms of trade directly impacts on CPI inflation and the terms of trade effect comes through the marginal cost in equation 4.2.30. Thus a major difference between CPI inflation and domestic inflation is that the former is impacted by changes in the terms of trade whereas domestic inflation is only affected by changes in marginal cost.

Substituting 4.2.11 and 4.2.27 into 4.2.29 gives the open economy marginal cost as

$$mc_t = -v + \sigma y_t^* + \varphi y_t + s_t - (1+\varphi)a_t \qquad 4.2.32$$

This shows that there are two effects of external disturbances on the marginal cost curve and therefore on the Phillips curve: the terms of trade effect and output effect.

2.1.b Aggregate Demand

The focus so far has been on the aggregate supply, but now we consider aggregate demand. The IS curve for the open economy can be represented as

$$x_t = E_t\{x_{t+1}\} - \frac{1}{\sigma_\alpha}\left(r_t - E_t\{\pi_{H,t+1}\} - \overline{rr}_t\right) \qquad 4.2.33$$

where x_t is the output gap defined as

$$x_t \equiv y_t - \bar{y}_t \qquad 4.2.34$$

with y_t and $\bar{y}_t$ been the current output and the natural rate of output respectively.

$$y_t = c_t + \frac{\alpha\omega}{\sigma} s_t \qquad 4.2.35$$

which is obtained from a first order approximation around a steady state as shown by Galí and Monacelli (2005).

This shows that output is directly linked with world output where

$$y_t = y_t^* + \frac{1}{\sigma_\alpha} s_t \qquad 4.2.36$$

Galí and Monacelli (2005) define the natural level of output as the "equilibrium output in the absence of nominal rigidities" (pp 718).[70] This is given by

$$\bar{y}_t=\Omega+\Gamma a_t+\alpha\Psi y_t^* \qquad 4.2.37$$

With $\Gamma\equiv\frac{1+\varphi}{\sigma_\alpha+\varphi}>0$ and $\Psi\equiv-\frac{\theta\sigma_\alpha}{\sigma_\alpha+\varphi}$

where Ω is a constant, Γ and Ψ are the productivity and world output parameters respectively, both of which depend on the degree of openness (α), the elasticities of substitution between domestic and imported goods (η) and between variety of goods produced within each country (γ) and the inter temporal demand for goods. It also depends on marginal disutility of labour.

There is a critical point here as 4.36 and 4.2.37 shows that both equilibrium domestic output and the natural level of output increase when world output increases. However, world output has a greater effect on actual domestic output compared to the natural level of output which increases by a fraction of world output given that $\alpha\Psi<1$. This is a key way in which the open economy affects the model as an expansion of world output leads to an increase in the output gap as domestic output increases in greater proportion than the natural rate.

σ_α is the coefficient of relative risk aversion in the open economy. When $\sigma_\alpha<\sigma$ the IS curve given in 4.3.33 becomes flatter causing changes in interest to have a larger effect on the output gap since

$$\sigma_\alpha\equiv\frac{\sigma}{(1-\alpha)+\alpha w}>0 \qquad 4.2.38$$

[70] Justiano and Primiceri (2010) also points out that the natural level of output is obtained under imperfect market structure but with flexible prices and wages.

with

$$\omega \equiv \sigma\gamma + (1-\alpha)(\sigma\eta - 1) \qquad 4.2.39$$

Constant elasticity of substitution and perfect capital mobility are assumed so that $\omega = 1$ given $\sigma = \eta = \gamma = 1$. This allows the open economy monetary rule to be isomorphic to the closed economy monetary rule in that welfare is maximised by a common specification of the monetary rule regardless of the degree of openness. This therefore suggests that the specification of the monetary rule can be the same in spite of the level of openness.

In addition the output gap is positively related to changes in the natural rate of interest.[71] The natural rate of interest $(\overline{rr})$ is given by

$$\overline{rr}_t \equiv \rho - \sigma_\alpha\Gamma(1-\rho_a)a_t + \alpha\sigma_\alpha(\Theta + \Psi)E_t\{\Delta y^*_{t+1}\} \qquad 4.2.40$$

where $\Theta = \omega - 1$.

2.1.c Summary of external supply and demand disturbances

Based on GM analysis, for an open economy supply disturbances come through the terms of trade effect. These disturbances impact on the marginal cost of domestic curves as can be obtained in equation 4.2.30. Also, external demand disturbances act on the slope of the IS curve by altering the relationship between output and interest rate as it makes the IS curve flatter, as can be gleaned from inserting 4.2.38 in 4.2.33 when openness increases. As a result, the effect of increased openness on the economy is to make the Phillips and IS curves flatter, therefore altering the relationship between

[71] Woodford (2003) defines the natural rate of interest as: "the real rate of interest required to keep aggregate demand equal at all times to the natural rate of output". pp 248.

interest rate with either output and or inflation. Therefore, in setting the monetary policy reaction function in terms of output and inflation, there is no need to augment the monetary rule for the open economy compared to the closed economy.

2.2 Taylor (2001) discussion of the inclusion of the real exchange rate in the Monetary Policy Rule

Taylor (2001), borrowing from Obstfeld and Rogoff (1995) examines the situation where there may not be perfect capital mobility, so the central bank may use the policy rate to react to deviations of the real exchange rate from economic fundamentals. The inclusion of the real exchange rate is consistent with much of the literature for the open economy, see for example, Batini et al (2007), Molodtsova and Papell (2008) and Mohanty and Klau (2004). These papers assume that the central bank would be motivated to stabilise the exchange rate because external disturbances are expected to act on the exchange rate, rather than only through the terms of trade, given the low degree of substitutability between foreign and domestic goods. Moreover, the central bank may wish to stabilise the exchange rate since changes in the exchange rate can have profound implications for the size of the debt stock and the debt repayment required.

An interpretation of exchange rate movements is that the spot exchange rate moves in relation to long-run purchasing power parity (PPP).[72] In such a case, PPP is treated as the key economic fundamental against which spot exchange rate movements are benchmarked. The idea here is that the real exchange rate may not converge at each point in time thus permitting short term deviations from PPP. As a result, the monetary authorities react to deviations of the exchange rate from its long term target in order to bring the rate back in line with PPP.

[72] According to Taylor and Taylor (2004), purchasing power parity holds if "the nominal exchange rate between two currencies should be equal to the ratio of aggregate price levels between the two countries, so that a unit of currency of one country will have the same purchasing power in a foreign country"p125.

This is different to Galí and Monacelli (2005) where prices are assumed to follow the law of one price at each point in time, given perfect capital mobility. Consequently, the real exchange rate was not included in their policy rule as macroeconomic adjustments took place immediately as a result of real exchange rate changes. Perfect capital mobility allowed the law of one price to obtain and it did not therefore allow for exchange rate deviations from its fundamentals owing to speculation. However, Taylor (2001) considers whether the inclusion of the real exchange rate in the monetary policy rule would lead to smaller fluctuations of inflation and the output gap around their targeted values.

The monetary rule considered is

$$i_t = \phi_\pi \pi_t + \phi_y y_t + h_0 q_t + h_1 q_{t-1} \qquad 4.2.41$$

where q_t is the real exchange rate.

Taylor (2001) constructed the equation without an intercept term since he assumes that the inflation target rate is zero and interest and exchange rates are measured by policy makers relative to their long run steady-state values. He does not explicitly state whether he uses domestic or CPI inflation in the definition of the real exchange rate. However, Moldova and Paper (2008) employed CPI inflation using a model similar to equation 4.2.41. We therefore follow and use domestic CPI index (P_d) and foreign CPI for the foreign price index (P_f).

The real exchange rate is defined in foreign currency terms so that

$$RER = \frac{e_f P_d}{P_f} \qquad 4.2.42$$

where e_f is the units of foreign currency per unit of domestic currency. Accordingly $q_t \equiv logRER_{i,t}$, that is, the real exchange rate in log terms.

To the extent that the real exchange rate is important, there are two possibilities: the central bank reacts to the current real exchange rate, or the reaction follows an autoregressive process. An advantage of the latter is that the lagged response allows the bank to partially offset the effects of initial changes in the policy rate.

From equation 4.2.41, various possibilities can be considered.

$$h_0 = h_1 = 0 \qquad 4.2.43$$

in which case, the model reverts to the traditional Taylor-type (1993) rule outlined in 4.2.7.

Also,

$$h_o + h_1 = 0 \qquad 4.2.44$$

where $h_0 \neq 0$ and $h_1 \neq 0$.

An interpretation of 4.2.44 is that the central bank reacts to the current exchange rate and reverses its action in the second period. For example, the real exchange rate can initially rise above equilibrium PPP as a result of an increase in e_t. In such a case the central bank can be expected to loosen monetary policy by lowering the policy rate in the second period to offset this. Accordingly, the central bank raise its policy rate in the first period and then reduces it in the second period.

Another possibility is that

$$h_o + h_1 > 0 \qquad 4.2.45$$

or

$$h_o + h_1 < 0 \qquad 4.2.46$$

with $h_0 < 0$ while $h_1 > 0$ or $h_0 > 0$ while $h_1 < 0$.

Both 4.2.45 and 4.2.46 allows for partial offsetting of initial policy responses by the central bank. An intuitive explanation of the offsetting by the central bank offered by Taylor (2001) with respect to 4.2.45 is that if the real exchange rate appreciates above the PPP value then the central bank would seek to stimulate domestic demand by lowering the policy rate to relax monetary policy. However, assuming that the appreciation has a lagged impact on inflation the central bank would try to partially offset the initial effect in the second period. The temporary effect on inflation could arise since an appreciation in the real exchange rate would cause foreign goods to be cheaper. As a result, domestic demand would weaken and there is a temporary slowdown in inflation. In the second period the central bank would avoid additional easing and instead would raise the policy rate to offset the initial effect of lowering it in the first period. By raising the policy rate the central bank is able to curb the excessive demand that arose from the first period reaction. The reverse would hold for 4.2.46.

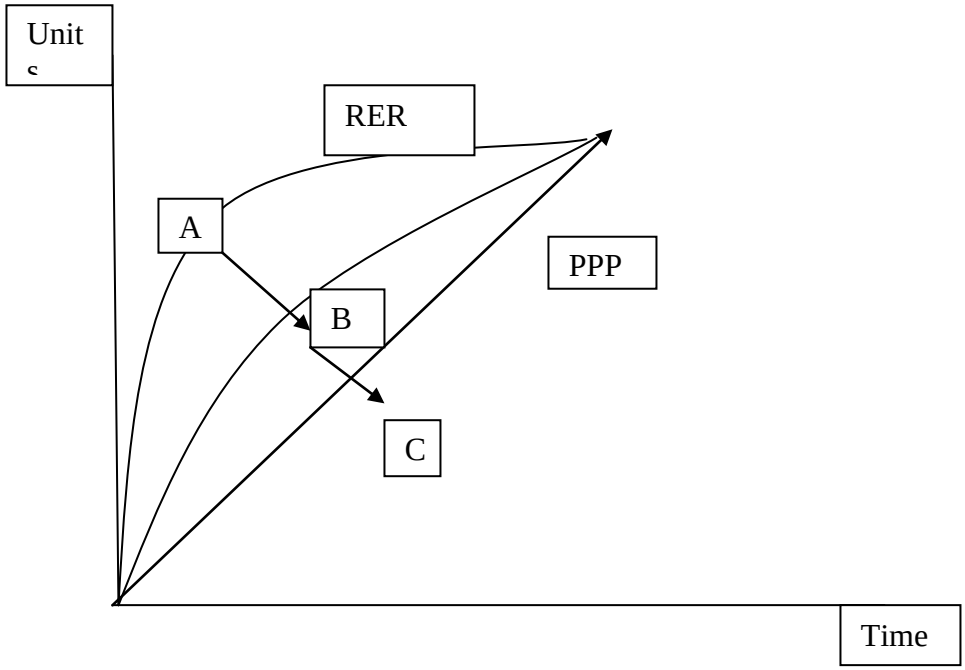
To illustrate, Taylor (2001) used the study by Ball (1999a) where the latter found the parameters $h_0 = -0.37$ and $h_1 = 0.17$ to be optimal. According to Taylor (2001) an interpretation of this result is that if the exchange rate appreciated by 10 per cent, then a 3.7 percentage cut in interest rate in the first period combined with a 1.7 per cent increase in the second period would lead to a long run reduction in the interest rate of 2 percentage points. Thus the central bank initially loosens monetary policy in

an attempt to stimulate domestic demand to counter the fall in demand for domestic goods. The central bank partially offsets this by raising the policy rate in the second period in order to counter resulting excess demand from the first period. Ball (1999a) found that this rule leads to a slightly better performance of inflation and output gap in terms of narrowing fluctuations around the respective targets.

Another study which used equation 4.2.41 is Taylor (1999). Taylor (1999) suggested $h_o = -0.25$ and $h_1 = 0.15$ for the European Central Bank. He found that while better performances with respect to inflation and the output gap were found for some European countries, performance deteriorated for Germany. As a result, he concluded that it is not clear whether the inclusion of the exchange rate in the monetary policy rule leads to improved performances in the inflation targeting and the output gap.

Taylor (2001) did not consider the possibility that $h_0 > 0$ and $h_1 > 0$ in 4.2.25; or $h_0 < 0$ and $h_1 < 0$ in 4.2.46. An interpretation of this is that the central bank reacts through incremental steps in one direction to restore exchange rate equilibrium. The idea here is that exchange rate stability assists in stabilising inflation and output. As a result where the exchange rate deviates from it parity relationship, the central bank may find it useful to use the policy rate to address this disequilibrium, but it does so in small steps. Diagram 4 gives a hypothetical example of where the RER curve deviates from PPP. If for example RER is at point A on the diagram then the central bank would engage in monetary policy to bring RER to point C. However, it does so in a series of steps, since its initial policy action only leads the RER to come down to B in the diagram.

Diagram 4: Relationship between Real Exchange Rate and Purchasing Power Parity



3.0 Model Framework

The empirical investigation is influenced by Clarida et al (2000). Their strategy is to first specify a target short-term interest rate as a function of the state of the economy in the form of a Taylor-like policy rule for the target interest rate. They then consider how the policy rate is set by the central bank, taking the target rate into account and include the effect of interest rate smoothing, whereby the actual policy rate is a weighted average of the target rate and the previous policy rate.

The smoothing assumption is used to mimic the tendency by the central bank to undertake small adjustments in the policy rate, and to make these adjustments in the same direction. Woodford (2003) noted that this might reduce macroeconomic volatility since it helps the private sector anticipate interest rate changes.

3.1 Target Rate

We take Taylor (1993) monetary policy rule to be the target rate. In addition, the rule is casted in the form of Clarida (2002) to take account of the information set of policy makers at the time of prescribing monetary policy. Further, we distinguish between headline and core inflation measures, to see whether they have implications for our overall hypothesis that the monetary rule should be augmented by the real exchange rate when there is a managed float, with the central bank been the major supplier of foreign exchange in the market. We therefore specify the target rate as

$$i_t^*=\bar{\imath} + \beta_\pi\left(E\left[\pi_{t,k}^{\top}|\Omega_t\right] - \pi^*\right) + \beta_x\left(E[x_t|\Omega_t|]\right) + h_0 e_t + h_1 e_{t-1} \qquad 4.3.1$$

where i_t^* is the target short term interest rate, $\bar{\imath}$ is a constant, β_π is the inflation coefficient; $\pi_{t,k}^{\top}$ is expected inflation in period $t+k$; $\top$ represent either headline inflation (H) or core inflation (C), π^* is the inflation target, Ω_t is the information set of the central bank in the current period, β_x is the coefficient of the output gap. The specification for inflation is forward looking over one period so the expected inflation is operationalised by using π_{t+1}. From henceforward we assume that , $k = 1$.

For ease of estimation of the target interest rate, the inflation rate can be combined with a constant inflation target such that $\alpha \equiv \bar{\imath} - \beta_\pi \pi^*$. As a result equation 4.3.2 can be rewritten as

$$i_t^*=\alpha+\beta_\pi\left(E\left[\pi_{t,k}^T|\Omega_t\right]\right)+\beta_x(E[x_t|\Omega_t|])+h_0e_t+h_1e_{t-1} \quad 4.3.2$$

where T is domestic inflation, or CPI inflation in terms of headline (H) or core (C) inflation. In so doing, the target rate is dependent on the relative weights the central bank places on inflation, output gap and possibly the real exchange rate. We examine real exchange rate in absolute terms and in terms of deviations from steady state level.

To demonstrate the degree of aggressiveness with which the central bank reacts to inflation Clarida et al (2000) showed that by expressing the real rate as $r_t=i_t-E[\pi_{t+n}|\Omega_t|]$, this can be substituted into equation 4.3.2 and rearranged to become

$$r_t^*=\bar{r}+(\beta_\pi-1)\left(E\left|\pi_{t,k}^T\right|\Omega_t-\pi^*\right)+\beta_x(E[x_t,q|\Omega_t|])+h_0e_t+h_1e_{t-1} \quad 4.3.3$$

where r_t^* is the desired real interest rate and $\bar{r}$ is the long run equilibrium real interest rate. The real desired rate would increase beyond the inflation rate once $\beta_\pi > 1$, thus allowing the central bank to pursue an aggressive stance to stabilize inflation. In contrast, the central bank would instead be engaging in accommodative monetary policy if $\beta_\pi < 1$, in that the bank would allow the policy rate to accommodate changes in inflation while accommodating economic growth. The real interest rate can also be affected by the measure of inflation rate, as was shown by Kozicki (1999).[73]

3.2 Policy Rate

The Central Bank is assumed to make gradual adjustments in its policy rate. As a result the bank engages in interest rate smoothing as the policy rate set by the central bank

[73]For Kozicki (1999), the type of inflation measured affects the policy rule. Alternative inflation measures they considered included CPI, core CPI, GDP price and expected inflation.

reflects gradual adjustment to changes in the target rate. Substituting the target rate in equation 4.3.3 into the policy rate framework in equation 4.3.4 the model becomes

$$i_t = \rho i_{t-1} + (1-\rho) i_t^* + \varepsilon_t \qquad 4.3.4$$

The lagged interest rate term is included to suggest that the policy rate is gradually adjusted towards the target rate. ρ represents a smoothing parameter where the higher the value of ρ, the greater is the degree of smoothing used by the central bank in changing its policy rate. When ρ is significant it suggests that the central bank gradually adjusts its policy rate in reaction to prevailing economic conditions as captured by the target rate. Further, we assume the error term (ε_t) to be identical and independently distributed (i.i.d).[74]

3.3 Empirical Model

We investigate GM model to see whether it is optimum for domestic inflation to be incorporated into the Taylor rule as opposed to the incorporation of a CPI inflation measure whether it be in terms of core or headline. In essence, we investigate under the scenario where the exchange rate is managed, which measure of inflation is best. Moreover, we test whether it matters as to how the real exchange rate is measured, whether it be in absolute terms or deviation of the spot rate from steady state target. Further, given that the Trinidad and Tobago exchange rate is managed in relation to the US exchange rate, we investigate whether the incorporation of the US policy rate into the Trinidad and Tobago reaction function may be appropriate.

[74] This assumes that the policy rate is not serially correlated, otherwise the error term would be autoregressive such that $\eth_t = \eth_{t-1} + \varepsilon_t \; v_t = v_{t-1} = \varepsilon_t$. In such a case there would be 'serially correlated omitted variables' as suggested by Rudebusch (2002), rather than partial adjustment of the policy rate. However, English et. al. (2003) showed that even if Redebusch (2002) observation is correct, there still remains smoothing of the policy rate by the monetary authorities.

The central hypothesis of this chapter is whether the augmentation of the Monetary Policy Rule improves the performance of the rule. Following Taylor (2001) we select the most efficient reaction function with respect to the variance of inflation and the output gap, with the lower standard deviation indicating stronger stabilisation as a result of lower variability. Consequently, we examine whether the variances of inflation and the output gap are lower when the monetary policy rule is augmented by the real exchange rate. This would indicate whether it is appropriate to augment the rule or whether the traditional Taylor (1993) rule is adequate to base the policy rate on. We then compare the coefficients in equations 4.3.4 for headline and core inflation.

Here we examine different reaction functions owing to disturbances with respect to domestic inflation, CPI inflation, different shocks in real exchange rate and the Federal reserve rate. Furthermore, we check the sizes of the parameters to see how they compare to the normative prescription outline by Taylor (1993), Taylor (2001), Clarida (2000) and Galí and Monacelli (2005). We also examine the aggressiveness of monetary policy conducted by the central bank of Trinidad and Tobago, based on the size of β_π. The aggressiveness is based on Taylor (1993) and Galí and Monacelli (2005) assertion that the central bank is aggressive if $\beta_\pi > 1$.

3.3.a Summary of alternative reaction functions

The generalised reaction function is given by

$$i_t = \rho_k i_{t-k} + (1-\rho_k)\left(\alpha + \beta_\pi \pi^{\xi}_{t+1} + \beta_x x_t + h_0 q^{\kappa}_t + h_1 q^{\kappa}_{t-1}\right) + \varepsilon_t \qquad 4.3.5$$

where ρ is the degree of smoothing of the policy rate by the central bank, ξ can either be inflation measured in domestic terms (D) or in terms of headline (H) or core inflation

(C). The alternative ways in which the real exchange rate is measured is in terms of the ratio of domestic to foreign prices by either the spot exchange rate RER_0 (see 4.2.42), the deviation of the exchange rate from the median exchange rate RER_1 (see 4.3.6) or the log deviation of the nominal exchange rate from the trend rate RER_2 (see 4.3.7) such that

$$RER_1 = \frac{P_d}{P_f} \times \left(e_f - e_f^{median}\right); \quad ` \qquad 4.3.6$$

or

$$RER_2 = \frac{P_d}{P_f} \times \left(loge_t^f - loge_t^{trend}\right) \qquad 4.3.7$$

The size of β_π suggests the aggressiveness with which the central bank responds to inflation. If $\beta_\pi > 1$, then the central bank responds aggressively by raising the policy rate to stabilise inflation. If on the other hand $\beta_\pi < 1$, then the central bank maintains an accommodative stance in support of the expansion in aggregate demand to support growth and employment. Further, the stabilisation of the output gap requires its coefficient to be positive such that $\beta_x > 0$.

Given that Gal*i* and Monacelli (2005) assert that the open economy model is isomorphic to the closed economy, in their model inflation and the output gap are assumed to be sufficient to determine the policy rate in an open economy. Following the pattern discussed by Taylor (2001), the external influences are assumed to act in a dynamic manner. In the models we use the forecast of domestic inflation which is given by π^D_{t+1} and the forecast of headline CPI Inflation (π^H_{t+1}) and Core CPI inflation (π^C_{t+1}).

For the first model we obtain the Taylor Type monetary rule by imposing the restriction on 4.3.6 that $h_0 = h_1 = 0$. Hence the traditional Taylor (1993) rule is obtained by

$$i_t = \rho_k i_{t-k} + (1-\rho_k)\left(\alpha + \beta_\pi \pi^d_{t+1} + \beta_x x_t\right) + \varepsilon_t \qquad 4.3.8a$$

We then insert CPI inflation in terms of headline and core inflation measures. Accordingly we measure

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\alpha + \beta_\pi \pi^H_{t+1} + \beta_x x_t) + \varepsilon_t \qquad 4.3.8b$$

and

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\alpha + \beta_\pi \pi^C_{t+1} + \beta_x x_t) + \varepsilon_t \qquad 4.3.8c$$

3.3.b Testing the Taylor (2001) format for augmenting the Taylor Rule

We maintain the same format as in Taylor (2001) to test the augmented rule in combination with different measures of inflation. Accordingly, we allow for the substitution of the augmented variables both in current and lagged terms. The three measures of inflation employed are domestic inflation, CPI core inflation and CPI headline Inflation. The combination of variables and tests are given by the following equations below.

The group of augmented rules is given in terms of domestic inflation, headline inflation and core inflation respectively. In the first instance we examine the augmentation of the Taylor type rule by the real exchange rate as defined by Taylor (2001) and represented by equation 4.2.42. Thus the equations were represented as

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\gamma_0 + \gamma^D_\pi \pi^D_{t+1} + h_0 q_t + h_1 q_{t-1}) + \varepsilon_t \qquad 4.3.9a$$

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\gamma_0 + \gamma_\pi^H \pi_{t+1}^H + h_0 q_t + h_1 q_{t-1}) + \varepsilon_t \quad 4.3.9b$$

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\gamma_0 + \gamma_\pi^C \pi_{t+1}^C + h_0 q_t + h_1 q_{t-1}) + \varepsilon_t \quad 4.3.9c$$

We then consider the idea that the central bank may try to manage the real exchange rate so as to minimise deviations of the real exchange rate from a long run steady state which we assumed to be based on the median real exchange rate (q_t^a) calculated as 4.3.6 above. The Taylor (2001) framework is retained to consider the deviation of the dynamics of the real exchange rate deviation from the steady state equilibrium respect to domestic, headline and core inflation in the following

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\gamma_0 + \gamma_\pi^D \pi_{t+1}^D + \beta_x x_t + h_0 q_t^a + h_1 q_{t-1}^a) + \varepsilon_t \quad 4.3.10a$$

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\gamma_0 + \gamma_\pi^H \pi_{t+1}^H + \beta_x x_t + h_0 q_t^a + h_1 q_{t-1}^a) + \varepsilon_t \quad 4.3.10b$$

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\gamma_0 + \gamma_\pi^C \pi_{t+1}^C + \beta_x x_t + h_0 q_t^a + h_1 q_{t-1}^a) + \varepsilon_t \quad 4.3.10c$$

The deviations of the real exchange rate was also considered in terms of the spot rate to the long-term trend in the long term rate (q_t^b). Here we assume that policy makers manage the nominal exchange rate in such a way so as to force it to converge to a long run trend. The policy interest rate is therefore assumed to react to changes in the real exchange rate accordingly. We therefore incorporate it into the equations to obtain

$$i_t = \rho_k i_{t-k} + (1-\rho_k)\left(\gamma_0 + \gamma_\pi^D \pi_{t+1}^D + \beta_x x_t + h_0 q_t^b + h_1 q_{t-1}^b\right) + \varepsilon_t \qquad 4.3.11a$$

$$i_t = \rho_k i_{t-k} + (1-\rho_k)\left(\gamma_0 + \gamma_\pi^H \pi_{t+1}^H + \beta_x x_t + h_0 q_t^b + h_1 q_{t-1}^b\right) + \varepsilon_t \qquad 4.3.11b$$

$$i_t = \rho_k i_{t-k} + (1-\rho_k)\left(\gamma_0 + \gamma_\pi^C \pi_{t+1}^C + \beta_x x_t + h_0 q_t^b + h_1 q_{t-1}^b\right) + \varepsilon_t \qquad 4.3.11c$$

We test the idea that the US Federal policy rate (fr_t) is significant to the monetary policy reaction function in Trinidad and Tobago, given the trilemma argument in the literature. The trilemma argument is that an economy cannot simultaneously maintain a fixed exchange rate, capital mobility and monetary independence. This argument implies that monetary independence for Trinidad and Tobago would depend on openness of the capital market and the exchange rate regime. Given the managed exchange rate and capital mobility of the economy, the US Federal Rate may be significant to the setting of the policy rate by the central Bank of Trinidad and Tobago. As a result it would suggest that there is an absence of monetary autonomy of the central bank of Trinidad and Tobago. We test the dynamic reaction of the policy rate to changes in the Federal Reserve rate, with the idea that the small open economy is a follower and reacts to the policy rate of the large economy.

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\gamma_0 + \gamma_\pi^D \pi_{t+1}^D + \beta_x x_t + h_0 fr_t + h_1 fr_{t-1}) + \varepsilon_t \qquad 4.3.12a$$

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\gamma_0 + \gamma_\pi^H \pi_{t+1}^H + \beta_x x_t + h_0 fr_t + h_1 fr_t) + \varepsilon_t \qquad 4.3.12b$$

$$i_t = \rho_k i_{t-k} + (1-\rho_k)(\gamma_0 + \gamma_\pi^c \pi_{t+1}^c + \beta_x x_t + h_0 fr_t + h_1 fr_t) + \varepsilon_t \qquad 4.3.12c$$

This argument hinges on the idea that there may be loss of monetary independence, by the monetary authorities in Trinidad and Tobago, owing to capital mobility and the managed exchange rate where policy makers try to intervene in the market to reduce the volatility of the floating exchange rate.[75] As a result the US Federal Reserve rate can be the major external rate which may influence the monetary policy reaction by the central bank of Trinidad and Tobago.

4.0 Variables and Data

The study covers the first quarter of 1997 to the first quarter of 2008 using end of quarter data to obtain 44 data points. Data for domestic variables are obtained from the CBTT database. Inflation is defined as the quarter on quarter changes in CPI index obtained from the central bank data base. Quarter on quarter changes are used as it is assumed that the central bank use a quarterly forecast horizon given that this is the highest frequency for which quarterly changes in GDP can be obtained to assess demand conditions. Further reasons for making quarterly forecasts is that the central bank would like to fine-tune monetary policy to deal with higher frequency intervals. In addition, the longer the forecast horizon the greater would be the margin of error.

Compared to the US Federal Funds Rate which was created in July 1954, Trinidad and Tobago only introduced a policy repo rate in the second quarter of 2002. Moreover, other markets outside the US have only recently implemented the use of policy rates relative to the US. Given the short time span within which many markets have implemented the policy rate, so far the relevant literature on emerging markets have

[75] According to Saxena (2006) only a few countries in the world are likely to have independent monetary policy.

used either of two proxies for the policy rate: the interbank rate and the Treasury Bill Rate.[76]

For Trinidad and Tobago, both the Treasury bill and the interbank rates are highly correlated with the repo policy rate – correlation is 0.96 and 0.98 respectively. The correlation of the Treasury bill rate with the repo rate stems from the fact that Treasury bills can be used by banks as collateral on the interbank market. When liquidity is tight, banks can borrow on the interbank market, using Treasury bills as collateral.[77] Consequently the price of collateral moves closely with the interbank rate as banks are unable to borrow from the interbank market, they may need to borrow from the central bank at the repo rate. The interbank rate would be highly correlated with the repo rate as the central bank deliberately sets the repo rate at a margin of 200 basis points above the interbank rate.

Despite the high correlation of both rates with the repo rate, it is only the Treasury bill rate that is available for the entire period of the study, that is, the first quarter of 1997 to the first quarter of 2008. The interbank rate data spans the last quarter of 1999 when it was introduced, to the first quarter of 2008.

Further, the inflation rate is measured in terms of headline (H) and core (C). The difference between both measures in the Trinidad and Tobago case is that core inflation excludes food prices, while headline inflation includes the food price index. To be consistent with the quarterly availability of GDP changes, we measure both forms of inflation on a quarterly Inflation.

The Central Bank of Trinidad and Tobago does not formally publish forecasts of the inflation rate. Nevertheless, from interviews with some members of the monetary

[76] For example Clarida et al. (1997) used the interbank rate as a proxy for the policy rate for Germany, while Söderlind et al (2003) used the 3-month Treasury bill rate as a proxy for the short-term interest rate in Sweden.
[77] Liquidity may be tight as banks in the system may be heavily loaned up.

policy committee of the central bank, it was gleaned that the bank informally forecast quarterly changes in the inflation rate by using its limited data to make judgements of changes in indicators, such as quarterly GDP, the change in government expenditure in the economy, movement of liquidity arising from external capital inflows and short-term factors influencing food prices. We therefore adopt a one period ahead forecast of the inflation rate.

5.0 Methodology

Following Clarida (2000), we use Generalised Method of Moments (GMM) for the estimation. We put forward the contention that the rational for using GMM is with respect to the endogeneity problem owing to possible correlation between explanatory variables and lagged interest rate with the error term. In addition, use of the GMM does not require prior assumptions about the distribution. Baum et al (2002) posit that GMM is useful for getting around heteroskedastic problem of unknown form, by making use of orthogonal conditions to achieve efficient estimation.

Expressing our model as

$$\mathrm{Y} = X_t\Phi + E \qquad 4.5.1$$

where Y and E are $(T \times 1)$ vectors, X_t is a $T \times K$ matrix of explanatory variables and Φ is a $K \times 1$ matrix of parameters. If $X_t$and E are correlated, then consistent estimators would not be obtained through a regression. But suppose we also have instruments that are correlated with X_t but orthogonal to E (the IV method). Let Z be the $T \times L$ vector of instrumental variables, with $K \geq L$. Then by pre-multiplying X by Z

$$Z'\mathrm{Y} = Z'X\Phi + Z'E \qquad 4.5.2$$

or

$$\bar{Y} = \bar{X}\Phi + U \qquad 4.5.3$$

where $\bar{Y}$ is $Z'\mathrm{Y}$, $\bar{X}$ is $Z'X$ and U is $Z'E$.

The OLS estimator is chosen to minimise the criterion function

$$U'U = (\mathrm{Y} - X\Phi)'(\mathrm{Y} - X\Phi) \qquad 4.5.4$$

To minimise the criterion function, the variance matrix must be proportional to the identity matrix for the OLS estimator to be efficient. As a result a weighting matrix (W) is used to minimise the criterion function such that

$$U'WU = (Y - X\Phi)'W(\mathrm{Y} - X\Phi). \qquad 4.5.6$$

Here we use a HAC Newey West weighting matrix to find a heteroskedastic and autocorrelation consistent estimator for the long-run covariance matrix.

The instruments consist of the intercept term, lags of the endogenous variables and two exogenous variables. These two exogenous variables are oil prices and excess reserves. The number of instruments totalled 22 when the rule is not augmented and 26 when it is augmented.

6.0 Estimation Results

Diagnostic tests showed that the models were over identified and the independent variables were orthogonal to the error term. The results exhibited in all the Tables, suggested that there is a high degree of interest rate smoothing by the central bank in relation to the volatile target rate. The coefficients of the lagged dependent variables (ρ) ranged between 0.86 and 0.99 thus suggesting that the central bank was highly engaged in smoothing the policy rate. As such the results showed that the policy rate reacts by 0.14 to 0.01 per cent respectively, to a 1 per cent change in the target rate. This shows that the central bank changes the policy rate by small increments relative to the target rate.

The inflation coefficient was significantly above one in all regressions, which showed that the central bank was aggressive in fighting inflation in all periods regardless of inflation measures, see Tables 12-15. Similarly, the results showed that the output gap was significant and above zero for all Taylor-type rule in all regressions. Thus the results fit the traditional Taylor –type rule with respect to inflation and output gap.

We test how the size of the coefficients obtained empirically in Tables 12-15 compare to the size of 1.5 recommended by Taylor (1993). Here it is found that the CPI measure of inflation was significantly different to Taylor (1993). We then compare the standard errors for inflation and output gap for each reaction function of Taylor-type rules. We found that in terms of the Traditional Taylor-type rules, core inflation turned out to exhibit the lowest variance compared to domestic and headline inflation. At the same time, the variances for domestic and headline inflation were 0.99 and 1.01 respectively. Similarly, in terms of the output gap, we found that the variance was lowest for the output gap when the core inflation measure was used. The standard

error was 0.11 for core inflation compared to 0.43 and 0.48 when domestic and headline inflation were used in the monetary rule respectively. The result therefore suggest that where the Taylor rule is not augmented, the policy makers would do better fashioning the policy rule after core inflation targeting since this yielded the lowest variances with respect to inflation and the output gap.

Table 12 Alternative reaction functions for Traditional Taylor-type rule

Equations in 4.3.8	Domestic Inflation (a)	CPI Inflation	
		Headline Inflation (b)	Core Inflation (c)
ρ	**0.96 (0.01)*** **	**0.97 (0.01)*** **	**0.93 (0.01)*** **
α	**2.17 (1.67)***	**-14.38 (6.35)** **	**-1.96 (0.90)*** **
π_t^D	**3.30 (0.99)*** **		
$\beta_{\pi,t+1}^h$		**3.31 (1.01)*** **	
$\beta_{\pi,t+1}^c$			**2.50 (0.23)*** **
$\beta_{y,t}$	**1.12 (0.41)*** **	**1.82 (0.48)*** **	**0.90 (0.11)*** **
$\bar{R}^2$	0.96	0.96	0.96
σ	2.68	2.71	2.72
SE	0.56	0.54	0.54
SSR	11.63	11.11	11.23
J-Statistic	10.11	9.87	9.16
Included observations	41	42	42

Notes: Standard errors are in brackets and are based on Newey West heteroscedasticity and serial correlation robust estimator. * indicate significance at a 10% level, ** indicate significance at a 5% level and *** indicate significance at a 1% level.

In terms of the dynamics, we found that the reaction of the policy rate to changes in the real exchange rate was negative in consecutive periods. This therefore suggested that there was no offsetting as noted in Taylor (2001). Thus a view of this could be that policy makers tend to lower the policy rate in reaction to an appreciation of the real exchange rate, in a bid to ease monetary conditions and stimulate domestic demand. The policymaker does this in incremental steps, hence two consecutive periods of negative coefficients on the coefficients of the real exchange rate. The idea here is that

the policy makers expand demand in order to put pressure on nominal interest rate to fall and for the real exchange rate to depreciate towards the purchasing power parity fundamentals as in Diagram 4. As a result, there is no offsetting of the policy rate here as in Taylor (2001).

We then check the variances for the augmented Taylor rules. We first check the variances when the rule is augmented in terms of the real exchange rate using the spot exchange rate as in Taylor (2001), see Table 13. Again, the variances when the core inflation measure was used turned out to be the lowest for inflation and the output gap. In particular, the variance for core inflation was 0.15 while for headline inflation and domestic inflation it was 0.30 and 0.88 respectively. Thus, the result suggests that the best measure was obtained when core inflation was used in the monetary policy rule.

Table 13 Alternative Reaction Functions for Taylor (2001) real exchange rate

Equations in 4.3.9	Domestic Inflation (a)	CPI Inflation	
		(b)	(c)
ρ	**0.95 (0.01)*** **	**0.92 (0.01)*** **	**0.85 (0.01)*** **
α	**9.53 (11.58)**	**46.48 (5.87)*** **	**25.86 (1.71)*** **
π_t^D	**3.21 (0.88)*** **		
$\beta_{\pi,t+1}^h$		**2.18 (0.30)*** **	
$\beta_{\pi,t+1}^c$			**1.98 (0.15)*** **
$\beta_{y,t}$	**0.92 (0.28)*** **	**0.69 (0.15)*** **	**0.48 (0.04)*** **
h_0	**-0.07 (0.04)***	**-0.17 (0.04)*** **	**-0.13 (0.04)*** **
h_1	**0.05 (0.03)***	**-0.07 (0.03)***	**-0.10 (0.04)*** **
$\bar{R}^2$	0.96	0.97	0.97
σ	2.68	2.72	2.72
SE	0.58	0.53	0.53
SSR	11.59	9.98	10.20
J-Statistic	0.97	10.10	10.20
Included observations	41	42	42

Notes: Standard errors are in brackets and are based on Newey West heteroscedasticity and serial correlation robust estimator. * indicate significance at a 10% level, ** indicate significance at a 5% level and *** indicate significance at a 1% level.

The result was similar when the rule is augmented by the real exchange rate when it is assumed to converge to the median exchange rate, see Table 14. The core inflation and the output gap exhibited the lowest variance of 0.16 and 0.06 respectively. This was followed by headline inflation measure which exhibited a variance of 0.39 for headline inflation and 0.15 for the output gap. Thus the core inflation measure of inflation turned out to be best for the traditional rule and the real exchange rate in terms of its absolute value and its convergence to the median exchange rate.

Table 14 Alternative Reaction Functions for Deviation of RER from targeted median

Equations in 4.3.10	Domestic Inflation (a)	CPI Inflation (b)	(c)
ρ	**0.97 (0.01)*** **	**0.93 (0.01)*** **	**0.86 (0.02)*** **
α	**-7.20 (9.59)**	**44.45 (6.53)*** **	**23.92 (1.65)*** **
π_t^D	**3.27 (1.12)*** **		
$\beta_{\pi,t+1}^h$		**2.39 (0.39)*** **	
$\beta_{\pi,t+1}^c$			**2.11 (0.16)*** **
$\beta_{y,t}$	**1.30 (0.55)** **	**0.77 (0.15)*** **	**0.53 (0.06)*** **
$RERMED_0$	**0.01 (0.02)**	**-0.03 (0.01)** **	**-0.01 (0.02)**
$RERMED_1$	**-0.01 (0.02)**	**-0.01 (0.01)**	**-0.02 (0.02)**
$\bar{R}^2$	0.95	0.96	0.97
σ	2.68	2.72	2.72
SE	0.58	0.53	0.54
SSR	11.62	10.22	10.46
J-Statistic	10.03	10.19	10.56
Included observations	41	42	42

Notes: Standard errors are in brackets and are based on Newey West heteroscedasticity and serial correlation robust estimator. * indicate significance at a 10% level, ** indicate significance at a 5% level and *** indicate significance at a 1% level.

Core inflation and the output gap also turned out to be the best measure of inflation in the monetary rule, when the rule was augmented by the deviation of the real exchange rate from the trend in the rate, see Table 15. The variance of the core inflation rate was 0.52 and the variance of the output gap was 0.14. Headline inflation turned out to

be the second best given a variance of 3.45 while the output gap turned out to be the second best when domestic inflation was used as the inflation measure.

Table 15 Alternative Reaction Functions for Deviation of RER from Trend

Equation 4.3.11	Domestic Inflation (a)	CPI Inflation	
		(b)	(c)
ρ	**0.98 (0.01)*** **	**0.99 (0.01)*** **	**0.95 (0.01)*** **
α	**-4.80 (6.38)**	**-31.64 (22.80)**	**-4.01 (0.07) ***
π_t^D	**8.30 (4.49)***		
$\beta_{\pi,t+1}^h$		**5.90 (3.45)****	
$\beta_{\pi,t+1}^c$			**3.04 (0.52)*** **
$\beta_{y,t}$	**2.01 (1.11)***	**3.40 (1.71)***	**1.17 (0.14)*** **
$RERtrend_0$	**-0.42 (0.08)*** **	**-0.26 (0.06)*** **	**-0.28 (0.07)*** **
$RERtrend_1$	**-0.23 (0.05)*** **	**-0.21 (0.07)*** **	**-0.27 (0.09)*** **
$\bar{R}^2$	0.96	0.96	0.96
σ	2.69	2.72	2.72
SE	0.54	0.54	0.54
SSR	10.39	10.55	10.31
J-Statistic	9.93	10.10	10.22
Included observations	41	42	42

Notes: Standard errors are in brackets and are based on Newey West heteroscedasticity and serial correlation robust estimator. * indicate significance at a 10% level, ** indicate significance at a 5% level and *** indicate significance at a 1% level.

The results tended to be quite different when the monetary rule was augmented by the Federal Reserve rate, see Table 16. Domestic inflation turned out to exhibit the lowest variance of 0.14. However, the inflation coefficient turned out to be less than one, been 0.36. This suggest that the domestic inflation measure was accommodating, rather than been aggressive. Thus, the result suggested that domestic inflation was accommodating to US monetary policy. The output gap was the same for the output gap when domestic and core inflation measures were used.

Table 16 Alternative Reaction Functions when Rule is Augmented by US Federal Rate

Equation 4.3.12	Domestic Inflation (a)	CPI Inflation	
		(b)	(c)
ρ	**0.85 (0.01)*** **	**0.90 (0.03)*** **	**0.88 (0.01)*** **
α	**0.89 (0.50)***	**-1.23 (2.04)**	**-0.59 (1.29)**
π_t^D	**0.36 (0.14)** **		
$\beta_{\pi,t+1}^h$		**0.45 (0.26)***	
$\beta_{\pi,t+1}^c$			**1.06 (0.29)*** **
$\beta_{y,t}$	**0.27 (0.05)*** **	**0.40 (0.10)*** **	**0.41 (0.05)*** **
FR_0	**0.20 (0.04)*** **	**0.21 (0.08)** **	**0.27*** **
FR_1	**0.02 (0.04**	**-0.06 (0.09)**	**-0.14 (0.06)** **
$\bar{R}^2$	0.96	0.96	0.97
σ	2.68	2.72	2.72
SE	0.50	0.51	0.50
SSR	8.88	9.37	9.11
J-Statistic	10.28	10.26	10.23
Included observations	41	42	42

Notes: Standard errors are in brackets and are based on Newey West heteroscedasticity and serial correlation robust estimator. * indicate significance at a 10% level, ** indicate significance at a 5% level and *** indicate significance at a 1% level.

In general the core inflation measure tended to lead to the best performance of inflation and the output gap for most of the regressions. This would have suggested that for the traditional Taylor rule and the augmentation by the real exchange rates, the policy rate is better at stabilizing core inflation regardless of the inflation measure used. However, the Federal reserve rate put a different spin as inflation turned out to be accommodating, with domestic inflation been the best measure among inflation measures. At the same time the estimated responses to the output gap differed between measures of the inflation rate.

Use of the Wald test showed that in most cases, except for where the rule was augmented by the Federal reserve rate, the estimated coefficients for inflation was larger than the Taylor prescribed 1.5. Generally, the output gap was lowest when core inflation was the measure used, but it was not the lowest when the rule was augmented by the Federal reserve rate.

The dynamics differ somewhat when the rule is augmented by the Federal reserve rate. The responses when domestic inflation is used is consistently positive thus suggesting that the central bank raises the short term interest rate in response to increases in the Federal Reserve rate. However, the coefficients are offsetting in the presence of CPI inflation in the sense that it is positive in the first quarter but negative in the second quarter. As a result, the dynamics to changes in the Federal Reserve rate is sensitive to whether we consider domestic or CPI inflation.

Overall comparing the variances of the regressions, our results showed that core CPI inflation not domestic inflation as posited by Galí and Monacelli (2005), that exhibited the lowest variability. Moreover, inflation exhibited the lowest variability when the rule is augmented by the real exchange rate. In fact the best results were obtained with respect to Table 13 when the core inflation measure was used and the rule was augmented by the actual real exchange rate. In addition, we found that domestic and headline CPI inflation were accommodative when the rule is augmented by the US Federal Reserve rate.

7.0 Conclusion

Certain key findings can suggest empirically supported imperatives for designing a monetary policy rule for a resource intensive economy where the central bank is a monopsonist supplier of foreign currency to the market and the economy practice a managed float as Trinidad and Tobago. We find that the augmented Taylor rule leads to lower variability of inflation and output gap compared to the traditional Taylor rule. As such, our results do not support Galí and Monacelli (2005) contention that domestic inflation rate is optimal for the Taylor rule. Instead we find that it is superior to augment the Taylor-type rule by the real exchange rate in the form as suggested by Taylor (2001), if core inflation is targeted.

Accordingly, our results show that the Taylor-type rules when applied to Trinidad and Tobago economy is better for stabilising domestic and headline CPI inflation when it is augmented by actual real exchange rate.

Further, we found that inflation to be accommodative to the US Federal Reserve Policy Rate when traditional and headline inflation are used in the Taylor rule and the rule is augmented by the real exchange rate. This is therefore suggestive of a lack of monetary independence with respect to US monetary policy when the central bank tries to stabilise these forms of inflation. Rather, the results suggest that policy makers realise greater independence in stabilising core inflation rather than domestic and headline inflation measures given that the coefficient was close to unity.

Further, we do not find evidence that the central bank offsets its initial adjustment of the policy rate when the real exchange moves. Instead we find that the monetary authority react to an appreciation of the real exchange rate over two quarters by lowering the policy rate. As a result there is no offsetting of the policy rate by the authorities to reverse the previous quarter, as in Taylor (2001).

Overall, the evidence suggests that while the Taylor-type rule can still be applied to an economy with a managed float that is driven by government acting as a monpsonist supplier of foreign currency to the market, it would be more efficient if the rule is augmented by the actual real exchange rate.[78] Consequently, the evidence obtained disputes the conclusions of Clarida et al (2001) and Galí and Monacelli (2005) contention that the closed economy form of the monetary rule is isomorphic for the open economy, since both speculation on the exchange rate and the loss of monetary independence, can impact on the policy rate thereby impacting the macroeconomic stability.

[78] Ball (1999b) define efficient rule for monetary policy rule as "one that minimizes a weighted sum of output variance and inflation variance." pp 63.

Chapter 5

Pass through of the policy repo rate in the presence of persistent excess liquidity and international spillovers in an emerging market

1.0 Introduction

In this chapter we examine the pass through of the policy repo rate on the credit market rate and therefore on aggregate demand, in the presence of both chronic excess liquidity and spillovers of disturbances emanating from advanced industrialised economies.[79] These factors can potentially cause the policy rate to have a less than predictable effect on the credit market rate. Both factors can therefore disrupt the effect of changes in the repo rate upon the credit market rate. To the best of our knowledge, this is the first study that is testing to see whether spillovers from the advanced industrialised countries impact on the pass through from the policy rate to commercial bank intermediation lending rate.

Excess reserves and spillover of external disturbances are critical considerations for energy producing countries, such as Trinidad and Tobago, that are trying to make the transition to market-based instruments. They can blunt the effectiveness of the policy

[79] We use excess liquidity and excess reserves interchangeably. Moreover we consider excess liquidity of the banking system to be representative of excess market liquidity for two reasons. Firstly commercial banks dominate the financial sector and secondly, the central bank during the period of the study only regulated the banking sector and therefore its monetary measures were directed at commercial banks.

rate of the central bank.[80] For example, when excess liquidity is persistent, banks may not be forced to return to the central bank to borrow funds and therefore respond to the policy lending rate. In addition, issues regarding the capacity of the country to stage independent monetary policy arise, since the pass through of the policy rate can be thwarted by spillovers of external disturbances onto the market. Under such circumstances, the market rate could become de-coupled from the repo rate, so that the latter would at best act as a signalling rate.

It should be noted that excess reserves are typical of oil commodity producing countries such as those in the Middle East, North Africa, and Venezuela. These countries tended to record oil related excess liquidity, particularly when oil prices rise. Poghasyan and Hesse (2009) contend that for these countries oil prices positively impact on exports, government revenues, fiscal balances and GDP growth. In spite of this, energy prices tend to be positively correlated with oil related excess liquidity in spite of credit growth. Excess liquidity can occur as the increased inflow of oil revenues may be greater than the ability of the real side of the economy to absorb these revenue inflows.[81]

In discussing spillovers of disturbances emanating from advanced industrialised countries we focus mainly on external spillovers of monetary policy, trade, prices and interest rates.[82] This yield insights on the integration and interaction of the Trinidad and Tobago financial market with the US and UK markets. As a result, we allow for trade linkages and the international determination of prices of resources. Other forms

[80] Other energy producing countries seeking to make the transition to market based monetary policy include, Qatar and Nigeria.

[81] Sanusi (2010) pointed out that in Nigeria, extraordinary oil windfalls between 2004-8 led by heightened oil prices, led to high levels of excess liquidity way beyond the capacity of the real sector in the economy to absorb. Also Saxegaard (2006) observed that rapidly growing excess liquidity presented a challenge to monetary policy in Sub Sahara Africa, where the largest oil producers there are Nigeria and Angola.

[82] In defining spillovers, we benefited from Weyerstrass et al. (2006). They gave a typology of different definitions of spillovers, which included external and internal spillovers, shock vs. Policy induced slipover, direct vs indirect spillover and positive vs. Negative spllover.

of spillovers such as those arising from government debt channel and structural reform as were outlined by Weyerstrass et al. (2006) are outside the scope of our analysis.

We point out that the transmission of monetary policy is facilitated by deeper integration of financial markets. To this end, we examine whether monetary policy disturbances in the UK and the US can spillover onto financial markets in Trinidad and Tobago and whether this can impact on the pass through of the policy repo rate. The level of financial integration between markets can lead to spillovers of external disturbances, and according to Canova (2005), it can be indicative of the level of financial integration between countries. Financial integration between developed and less developed countries may stem from the progressive financial liberalisation policies that the developing economies have pursued since the 1980s.[83] Canova (2005) also contended that the more fixed the exchange rate regime of the home country is, the greater the spillover of macroeconomic disturbances onto the macro economy. We therefore argue that the significance of the spillover variables would be dependent on the degree of financial integration between Trinidad and Tobago and the UK and US economies and it would also be dependent on the level of stability of the exchange rate.

Spillovers of external disturbances on the retail lending rate may decouple the market rate from the policy rate. The spillovers can occur as a result of increasing financial integration of markets so that disturbances in one economy can have a contagion effect on interest rates in another economy. This could be manifested through disruption of trade and capital flows given the ties that may exist between economies. We contend that as markets become more integrated, the spillover effects may become stronger and more significant to the transmission mechanism with respect to the policy rate to the market lending rate.

[83] Gibson and Tsakolotos (1994) identified three ways in which financial liberalisation occurred – the freeing of national markets thus reducing government intervention in financial market, globalisation of markets conditioned on growing liberalisation of national economies and the deregulation in the financial sector.

In a wider sense we look at the impact of disturbances on the pass through of the policy rate, from large to small economies. The transmission is assumed to be asymmetric, in that we do not consider common shocks. We contend that the transmission is more likely to take place as economies become more liberalised and financial integration increases. According to Canova (2005), the transmission can be manifested in terms of co-movement of interest rates or a shock in the advanced industrialised country such as the US can contribute to movements in the domestic interest rate.

The repo rate was introduced in March 2002, as the lowest rate at which the central bank would lend to commercial banks.[84] Working through the transmission mechanism it is expected to impact on market lending rates and, through this, on aggregate demand. However, the transmission mechanism is expected to work best where there are no spillovers of external disturbances or accumulation of excess commercial bank cash reserves deposited at the central bank.[85]

We begin by examining the stylised facts associated with excess liquidity and spillovers of foreign disturbances. This is examined by looking at the nexus between excess liquidity and the prime lending rate in Trinidad and Tobago. Given possible excess reserves and spillover effects we assume that the central bank must take into account the magnitude by which commercial banks would adjust their lending rates in reaction to changes in the policy rate.

[84] Buzeneca (2007) reported that the repo rate is widely used by developing countries as many of them seek to transition to direct monetary policy.

[85] The transmission mechanism was captured in "The Implementation of Monetary Policy in Trinidad and Tobago" Public Education Pamphlet Series, no. 1 of the Central Bank of Trinidad and Tobago, September 2005.

The theoretical framework outlined by Martin and Milas (2010) is then discussed in Section 3. They allow for the base rate to work sequentially through the system of the IS and Phillips curve equations, to stabilise the output gap and inflation around its targeted rate. In doing so, they incorporate risk and liquidity measures in order to impact on the interbank rate. By applying their model to the UK, they find these parameters to be significant to the monetary policy rule. In their framework, the policy rate is transmitted through the money market to the Libor rate. Accordingly, they use the 3 month LIBOR rate as the benchmark money market rate, which in itself could be treated as the floor for lending to the privates sector.[86]

A limitation of their study is that by confining the transmission mechanism from the policy rate to the money market rate, they did not directly capture the cost of borrowing by commercial bank customers in the retail credit market. Moreover their model did not allow for the effect of spillovers of external disturbances onto the domestic market, given that they used the money market rate as the floor rate in the credit market.

We add to the literature by considering the pass through of the policy rate in the presence of excess bank reserves with spillovers of external disturbances and by extending the transmission mechanism to the retail lending market. By extending the transmission we are able to introduce spillover effects and consider different lag lengths in the investigation of the pass through effects of changes in the policy rate on the prime lending rate. The international spillovers are externalities stemming from financial disturbances in the advanced industrialised countries. These externalities may take place through cross-border loans to banks, non banks and to government. Foreign banks may lend to different segments in the economy so that this would feed into the

[86] The 3 month Libor rate is obtained daily from surveys reported by the British Bankers Association based on banks in the interbank market declaring how much they are prepared to pay to borrow from each other on the interbank market.

banking sector at different speeds. With these there can be different points of contact with the domestic financial sector.

In Section 4 we outline the framework and methodology we use to test the hypothesis that the pass through of the policy rate to the commercial bank lending rate is sensitive to changes in excess reserves and international spillovers. Here we point out that Generalised Method of Moments (GMM) is the estimation technique used. We use the prime lending rate as the representative commercial bank lending rate. This rate is defined as the rate at which commercial banks are prepared to lend to their best customers that present the lowest credit risk. It is therefore treated as the floor interest rate upon which term interests margins are built on. An important difference between the LIBOR rate as used by Martin and Millas (2010) and the prime lending rate we used in this study, is that while the former is representative of the cost of credit to banks in the interbank market, the latter is the base interest rate cost of borrowing by households, firms and government in the economy.

An advantage of the prime lending rate is that its impact on demand is more immediate as, theoretically, lending rates impact upon credit demand in the economy, so that the eventual effect of changes in the policy rate upon demand is through the lending rates. It is critical therefore for the central to be able to gauge the extent to which the market rate changes are tied to its changes in the policy rate, in a bid to forecast reactionary demand changes.[87]

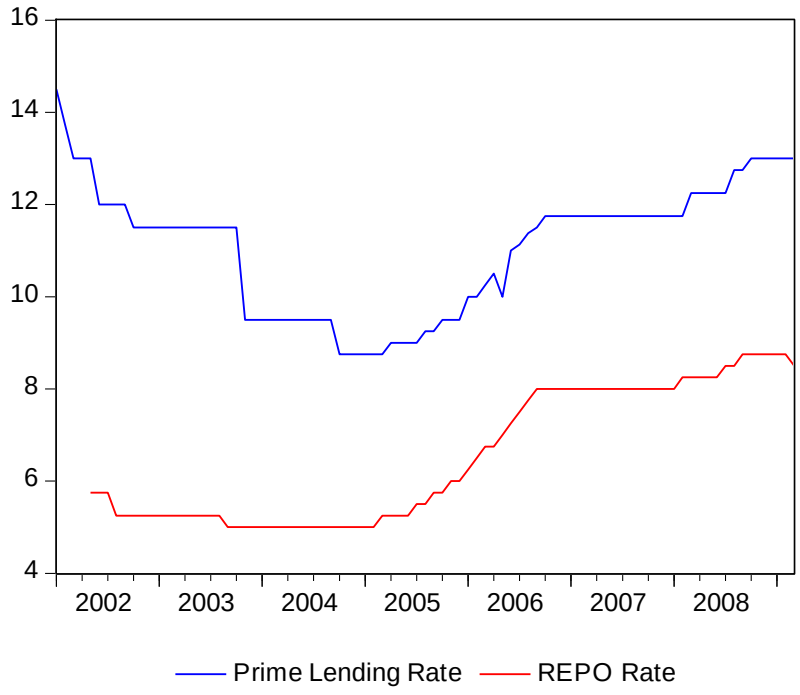
We test in section 5 to see if the pass through of the policy rate to the credit market lending rate in Trinidad and Tobago is sensitive to external and domestic disturbances. The estimation results are reported in that section. The study is then concluded.

[87] Kobayashi (2008) explores the idea that the central bank aims to stabilise the credit market rate in the presence of productivity and preference shocks. This stems from the idea that the lending rate follows a cost channel. We assume however that the central bank is engaged in policy rate smoothing where it has more control, rather than through loan rate smoothing.

2.0 Stylized Facts

An examination of plots of the repo and prime lending rates can be useful in understanding the transmission from the former to the latter. Figure 16 shows that the prime lending converged towards the repo rates during the pre2005 period but increased in the post 2006 period. This is evident as the spread between the prime lending rate and the repo rate narrowed at the point of inception of the repo rate in 2002 as the banking sector gained more experience with the repo as a policy instrument. The gap contracted to under 5 per cent by November 2003 and under 4 per cent by October 2004.

Figure 16 Trend in Lending and Repo rates in Trinidad and Tobago

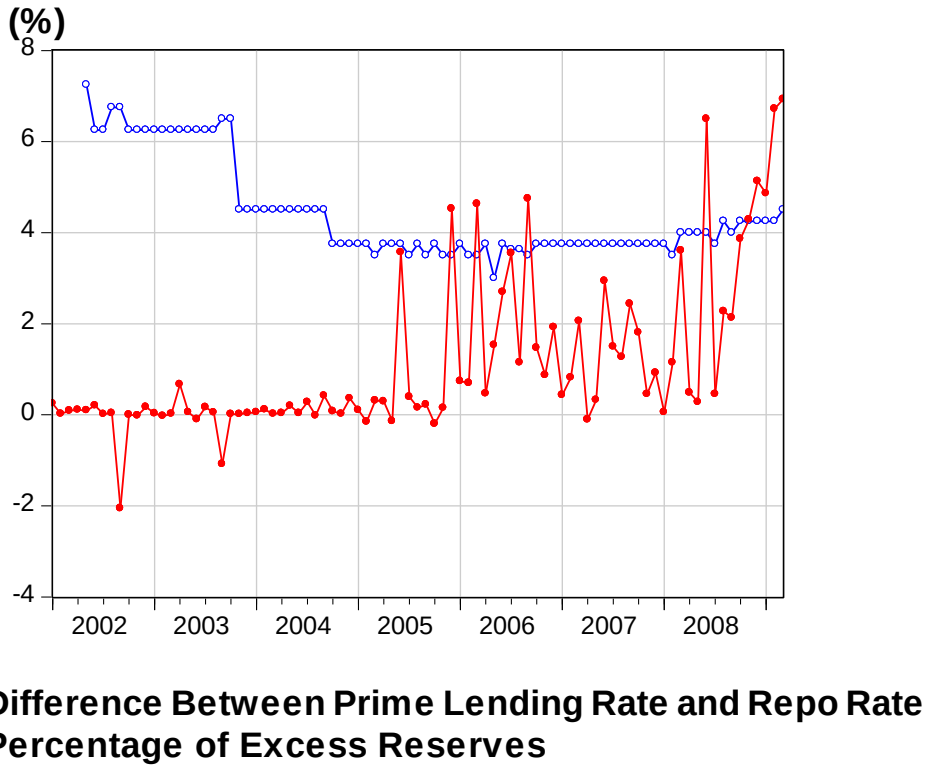


Source: Plotted from data extracted from CBTT database.

We argue that the gap at the inception could have been due to recency of its introduction, but the subsequent convergence could have occurred as the central bank was better able to exercise moral suasion as the banks understood the repo much better. This therefore could have been attributable to the learning curve that the market went though in this respect.

To deepen our analysis we divided the periods into periods to study the characteristics of the gap between the prime lending and repo rates (PIMPREP). The periods are formulated from inspection of the plot of PIMREP. In the first instance the plot was compared to excess reserves, see Figure 17.

Figure 17 Excess reserves and Difference between Market rates and Repo Rate



Source: Calculated and Plotted from data obtained from CBTT data base.

From Figure 16 we observe that the prime lending rate declined from 2002 to 2004 to converge to a declining but relatively flat repo rate. As a result the difference between these rates declined, see Figure 17. We therefore use this as the first period. The second period is formulated as the interval between 2005 and 2007. Here the interval is relatively flat remaining under 4 per cent. Then we notice for the brief period in 2008 the difference between the prime lending rate and the repo rate rises above 4 per cent, so we use this as the third threshold. A fourth threshold is formulated for post 2008 period as the gap between the repo rate and the prime lending rate increased in this period.

2.1 Association between PIMREP and Excess Reserves

Descriptive statistics are reported in Table 17 and PIMREP is plotted in Figure 17. It can be noticed that for the second threshold, PIMREP tended to show short bouts of instablity as the amplitude of excess liquidity increased. From 2005 onwards PRIMREP is more volatile when excess reserves rises to over 3 per cent in amplitude. Moreover the gap became wider in the first quarter of 2009 when excess liquidity increased. As excess reserves increased from a median of 0.84 in the 2005-7 period to 6.72 in the first quarter of 2009, PIMREP increased from a mean of 3.67 to 4.33 in the corresponding periods. This shows that increases in the amplitude of excess reserves were associated with widening of the gap between the prime lending rate and the repo rates. Other factors such as spillovers of external disturbances can be at play here so we tests in Section 5 to see the significance of these factors.

Table 17 Prime and repo difference to excess reserves

	2002 – 2004	2005-2007	2008:1 – 2008-12	2009:1 – 2009:3
Pimrep – excess reserves correlation	-0.30*	-0.21	0.57*	0.58
Primrep mean	5.25	3.67	4.00	4.33
Primrep std	1.07	0.16	0.24	4.50
Excess Reserves Median	0.04	0.84	2.20	6.72
Excess Reserves Max	0.67	4.75	6.50	6.93

Note: Primrep is the Prime Lending Rate minus the REPO Rate

2.2 Possible influence of Spillovers of disturbances

In studying the gap between the prime lending and repo rates, we may be able to detect the possible influence of spillovers of financial disturbances in the US and UK financial markets. Following the onset of the financial crises, a widening of the gap can be noticed. The spread rose to over 4 per cent by March 2008. This was therefore a lagged response, considering that the inception of the crises could be traced to begin in the US economy in mid 2007 in the US economy before spreading worldwide. Accordingly, spillover of foreign disturbances may occur with lags on the spreads between the prime lending and repo rates. A contributing factor to the lagged impact is that disturbances could have spilled over to different segments of the economy.

The likelihood that spillovers of foreign disturbances could have impacted on Trinidad and Tobago economy as FDI becomes more important to the economy. Table 18 shows how FDI grew from an average of 1.4 per cent in the decade of the 1970s to an average of 4.9 per cent in 2000-8. The data show that FDI as a ratio of GDP was more significant to the Trinidad and Tobago economy, compared to the US and UK economies. In addition it was above the average for Latin America and the Caribbean region, given its larger FDI to GDP ratio in each decade. As such, there was deepening of financial integration of TT over the decades and across regional terms.

Table 18 Percentage of FDI to GDP

Country	1970-9	1980-9	1990-9	2000-8
Trinidad and Tobago	1.4	1.7	2.7	4.9
Upper Middle Income Countries	0.0	0.1	0.5	1.2
High Income OECD	0.5	0.6	1.3	2.7
High Income non-OECD	0.5	0.7	1.3	2.9
Latin America and Caribbean	0.7	0.5	1.5	3.2
UK	0.2	0.8	1.1	1.5
USA	0.7	0.7	1.8	3.0

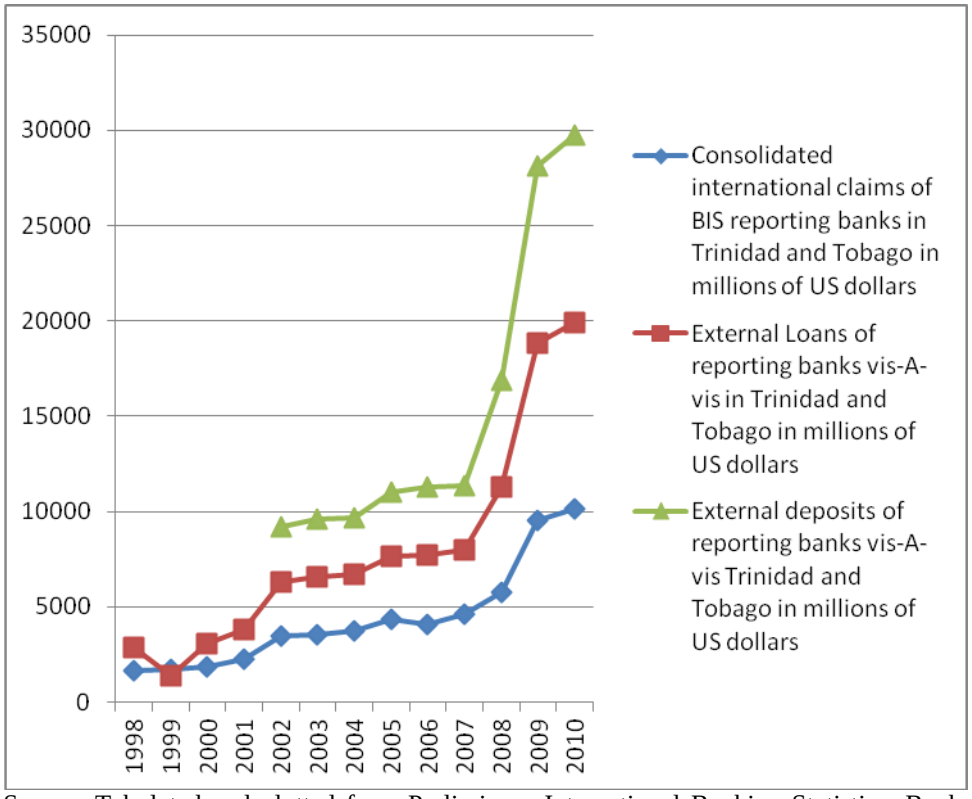
Source: Tabulated from World Development Indicators. Cited in Birchwood and Brackin (2010)

The significance of FDI to the TT economy spurred exposure of banks in the UK and US to support the FDIs in the region, thus leading to even more financial integration between Trinidad and Tobago and the global community. Figure 18 shows that the degree of exposure of the BIS sample of reporting banks to Trinidad and Tobago. The evidence showed that claims and loans of BIS reporting banks exhibited an upward trend over 1998 to 2010. From the BIS data, the onset of the global crises did not slowdown the demand for loans but rather it intensified the demand for loans from the

sample of banks from the advance developed countries, perhaps as economic agents became more dependent on bank financing.

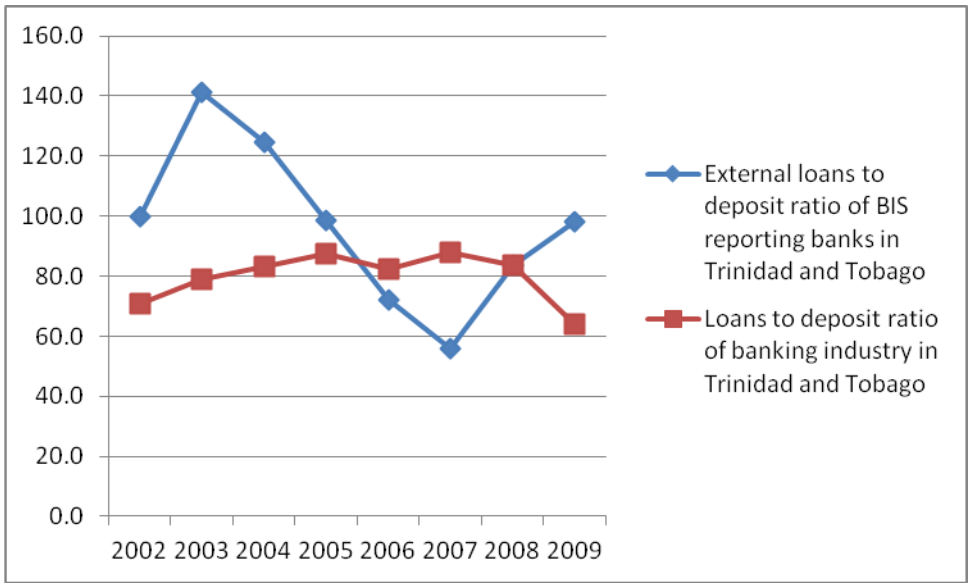
Except for the period 2006-7, the evidence obtained in Figure 19 shows that the banks emanating from the advanced industrialised countries were typically more loaned up, in terms of loans to deposit ratio, compared to the industry in Trinidad and Tobago. This may suggest that there are differences in pressures on the lending rates between domestic banks in Trinidad and Tobago compared to banks emanating from the industrialised countries. For example, foreign banks could have lent to the higher end of the market to finance foreign direct investment for energy based investments, where the market is exposed to international competitive pressures. Consequently, there could have been a loosening of the relationship between the repo and the lending rates of the banks emanating from the advanced industrialised countries.

Figure 18 Trend in Claims on Trinidad and Tobago by BIS Reporting Banks



Source: Tabulated and plotted from Preliminary International Banking Statistics, Bank of International Settlements, many issues and Central Bank of Trinidad and Tobago database.

Figure 19 Comparison of loans to deposit ratio of international banks to domestic bank in Trinidad and Tobago



Source: Tabulated and plotted from Preliminary International Banking Statistics, Bank of International Settlements, many issues and Central Bank of Trinidad and Tobago database.

The spillover can also take place through different points of impact giving rise to different channels in the economy. Table 19 shows how banks in the advanced industrialised countries had exposures to different sectors in the domestic economy. The non bank private sector accounted for the highest percentage of claims as over two thirds of the claims arose from this sector. This was generally followed by claims on the public sector and then by claims on banks. If we assume that monies going to the non-bank and public sectors ultimately find their way to the banking sector but at different speeds, this would imply that economic shocks may impact on the pass through at differential speeds.

Table 19 Percentage Claim on Consolidated Cross-Border and Local Claims in all Currencies

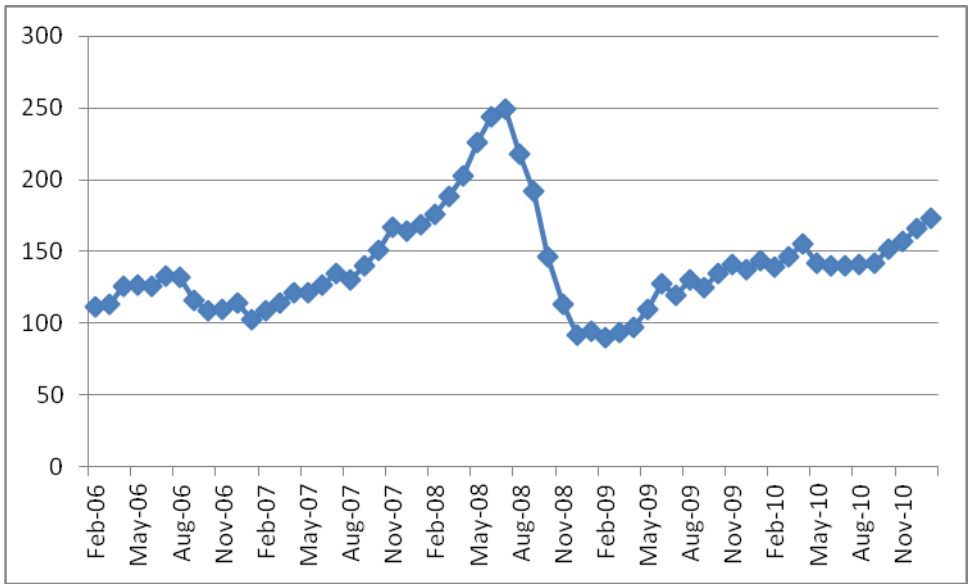
	1998	2005	2007	2010
Claims on banks	6.8	9.9	9.7	5.0
Claims on non bank private sector	83.0	87.7	70.2	66.7
Claims on public sector	10.2	2.3	20.1	28.3

Source: Tabulated from Bank of International Settlements

2.3 Trade Effects

Another mode of transmission could have been through the price of key export commodities. We consider the energy price index, given that Trinidad and Tobago key exports are in oil and natural gas. It is evident that these prices collapsed by mid 2008 following the onset of the crises, see Figure 20. This could have led to a reduction in foreign exchange earnings and therefore slowdown the buoyancy of the economy, slowdown real estate prices and therefore negatively spilled over to the financial sector. As a result, loan demand could have been adversely affected thus leading to changes in bank lending rates relative to the repo rate.

Figure 20 Energy Price Index



Source: Index Mundi online: http://www.indexmundi.com/commodities/?commodity=energy-price-index&months=60.

This is in keeping with Poghosyan and Hesse (2009) who suggested that direct and indirect channels of transmissions could arise owing to changes in oil prices. For example they suggested that it could have impacted directly on the banking system through oil related lending or through excess liquidity. In addition, it could have been indirectly acted through fiscal investments which in turn affect the productive capacity in the economy and impact on demand conditions in the economy. We argue, therefore, that this can affect the domestic term structure of interest rates in relation to the repo rate.

3.0 Theoretical Framework by Martin and Milas (2010)

The theoretical model by Martin and Milas (2010) incorporates spreads between interbank credit and money market rates. The benchmark interest rate is the Libor 3month rate. Their model is specified as

$$\pi_{t+1}=\pi_t + \alpha_y y_t + v_{t+1} \quad 5.3.1$$

$$y_{t+1} = \beta_y y_t - \alpha_r\left(E_t i_t^{borrow} - E_t\pi_{t+1} - \bar{r}\right) + \eta_{t+1} \quad 5.3.2$$

$$i_t^{borrow} = \omega_{0t} + \omega_{1t} i_t^{base} + \varepsilon_t \quad 5.3.3$$

where π is the inflation rate, y_t is the output gap, v is a supply shock, i_t^{borrow} is the interest rate at which the private sector can borrow, i_t^{base} is the base rate, and η is a demand shock. They assume that v_{t+1} and η_{t+1} are unknown, while ε_t is known. They describe ω_{0t} and ω_{1t} as yield curve factors.[88]

They further assumed that the base rate is chosen at time t based on information available at time t-1, to minimise the loss function with respect to inflation. Martin and Milas (2010) assume that the spread is a function of risk and liquidity measures and that the responsiveness of the credit interest rate to the money market rate was a function of market liquidity. Consequently they specify:

[88] Block and Hirt (1994) defined a yield curve as "A curve that shows interest rates at a specific point in time for all securities having equal risk but different maturity dates" p670.

$$i_t^{lib,3} = \omega_{00} + \omega_{01}\left(i_t^{lib,1} - i_t^{repo,1}\right) + \omega_{02}\left(i_t^{repo,3} - i_t^{repo,1}\right) + \omega_{03} liq_t^{FSR} + (\omega_{11} + \omega_{12} liq_t^{FSR}) i_t^{base} + \epsilon_t \quad (5.3.4)$$

where $i_t^{lib,3}$ is the average 3 month libor rate; $i_t^{lib,1} - i_t^{repo,1}$ is the spread between the unsecured 1 month Libor and secured Gilt Repo rates; $i_t^{lib,3} - i_t^{repo,1}$ is the spread between the unsecured 3-month libor and secured Gilt-Repo rates; liq_t^{FSR} is the UK liquidity index. Accordingly, equation (5.3.4) was obtained by substituting the parameters in (5.3.3) with $\omega_{0t} = \omega_0 + \omega_{01}\left(i_t^{lib,1} - i_t^{repo,1}\right) + \omega_{02}\left(i_t^{repo,3} - i_t^{repo,1}\right) + \omega_{03} liq_t^{FSR}$ and $\omega_{1t} = \omega_{11} + \omega_{12} liq_t^{FSR}.i_t^{lib,3}$. We note that the spreads between unsecured and secured lending was used to capture lending risk. Effectively then, Martin and Milas (2010) capture risk in the constant term in equation (5.3.3), while the pass through of the base rate is captured through its interaction with the liquidity index.

3.1 Lagged effects of International Spillovers on the Pass Through of the Short-Term Interest Rate in Trinidad and Tobago

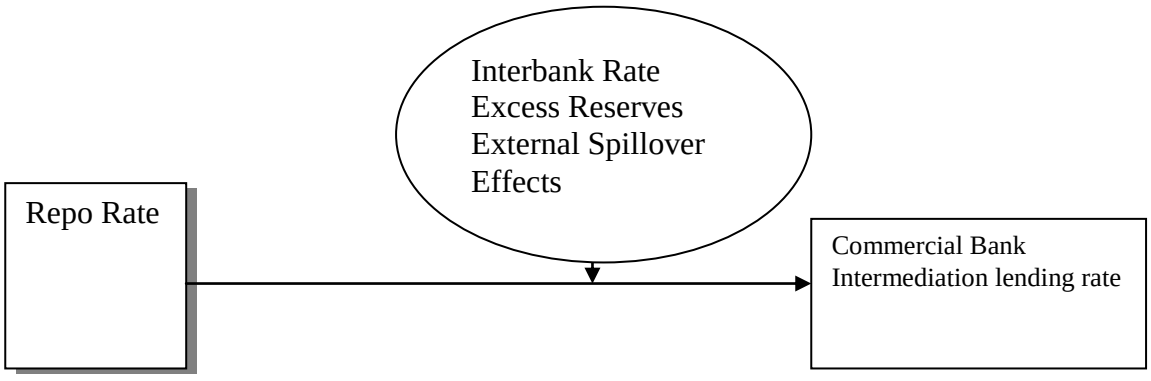
Given the embryonic stage of development of the money market in Trinidad and Tobago, the model is applied to the market with some modifications. This is done since the market did not possess the variety of instruments or maturities of the UK or US markets. We contend that use of the prime lending rate can allow the transmission mechanism in the model to utilise a larger information set. This is owing to the fact that the prime lending rate can be the ex post representative interest rate to the credit market, determined after spillovers of external disturbances and liquidity conditions are taken into consideration. Using the prime lending rate therefore, allows us to extend the model to accommodate these influences with respect to the transmission

of the repo rate to the bank lending rate, to see if these factors can cause the market rate to be decoupled from the policy rate.

The transmission mechanism as depicted by the central bank of Trinidad and Tobago was outlined in Diagram 1 of chapter 3. For this chapter we are primarily interested in the transmission between the policy rate and the interest rate term structure. Given the dominance of commercial banks in the financial structure in Trinidad and Tobago, we use the prime lending rate as the representative private sector market rate. The idea here is that lending rates of commercial banks affects the demand for credit which in turn impact on consumption demand.

By considering the prime lending rate, this allows us to examine the effects of excess reserves and external spillovers on the transmission mechanism. We therefore use Diagram 5 to visualise the hypothesis that the pass through of the policy rate to bank lending rates is sensitive to changes in these variables.

Diagram 5 Transmission mechanism of repo rate to commercial bank lending rate in Trinidad and Tobago



Further to Martin and Milas (2010), we investigated whether disturbances that occurred in the respective financial sectors of the Uk and US between 2007 and 2009, may have been transmitted contemporaneously or with a lag. We contend that the temporal nature of the transmission depends on the type of transmission mechanism that takes place. For the study, it is assumed that multiple transmission mechanisms may have been at play in transmitting the disturbances in US and UK financial markets to the financial sector in Trinidad and Tobago. Moreover, we assume that the transmission is done through different points in the economy and therefore work their way through to the banking system at different speeds. In so doing, we modify equation (5.3.3) to allow for the pass through of the policy rate through excess reserves, spillover of foreign disturbances.

The assumption of contemporaneous transmission rests on the presumption that there is cross border trading of liquidity between banks headquartered in the UK and US in the financing of counterparties in Trinidad and Tobago. Our description of these direct links is influenced by the IMF (2009) and Frank et al. (2008). Here it is suggested that financial disturbances are transmitted through the international interbank market as well as through changes in financial asset prices. [89] This is generated by the dependence of the multinational banks on the wholesale market to source external funds rather than just deposits. [90]

To apply this model to Trinidad and Tobago financial sector the transmission is assumed to take place either through portfolio decisions of international banks

[89] According to the Bank of International Settlement (1983), the international interbank market is an informal market where "banks lend funds to each other [and] (t)he amounts are typically large ... maturities are short, normally between overnight and six months, although placements up to a year and sometimes longer can be arranged." P7.

[90] McGuire et al (2008) showed that international interbank claims expanded by 22 per cent over 2002-7, driven mainly by interoffice activity between multinational banks. They showed that net flows were strongest from the US to the UK banks, but they were also significant between the UK to the classification "others" which included Canada, Australia, Denmark and Norway. Further, they noted strong net outflows from the UK to the Caribbean countries with offshore banks located in Aruba, the Bahamas, Bermuda, Cayman islands, Netherland Antilles and Panama.

headquartered in the advanced industrialised countries, particularly the US and UK, or through direct borrowing from international commercial banks headquartered in the UK and US. With respect to portfolio decisions, these international banks are assumed to be either using foreign deposits to finance lending activities in Trinidad and Tobago or the portfolio management decisions are assumed to be centrally made so that externally based branches are treated as part of a global portfolio.

Wherever these arguments hold true, it would suggest that the lending rates of foreign banks can take a different growth path to lending rates of domestic banks. This could occur as foreign banks are not restricted to the internal liquidity conditions to generate funds. As a result, interest rates applied by foreign banks can be subject to external influences, rather than domestic liquidity and the repo rate. Also, the market lending rate (i^{borrow}) should be seen as a combination of lending rate of domestic banks (i^{DL}) and the interest rate of foreign banks operating in the domestic market (i^{FL}) such that

$$i^{borrrow} = f\left(i_t^{DL} + i_{t+\lambda}^{FL}\right) \tag{5.3.5}$$

If this functional relationship obtains in the domestic market, it can suggest that the transmission of the repo rate can be less than full as the market rate may react with a lag since the reaction of the interest rate of overseas banks may be influenced also by external influences so that $i^{FL} = f(\varsigma)$ where ς denote foreign disturbances and λ reflect the time lag of 0,1,2... .

We suggest that another mode of transmission can be assumed to take place indirectly with a lag. Here, shocks are assumed to take place through trade links between Trinidad and Tobago with the US and UK markets. As such, disturbances in the financial sector in the US and UK are assumed to impact through the real side. In particular, the financial sector disturbances in the developed economies are assumed to impact on the real side of these economies by causing an economic slowdown which is presumed

to impact on their import demand and prices of leading exports of Trinidad and Tobago. Given that Trinidad and Tobago is an energy exporter, its fortunes would be influenced by the floundering export prices for energy commodities. As a result of depressed commodity prices, this is assumed to cause feedback to the buoyancy of the Trinidad and Tobago economy and subsequently the financial sector is impacted. We therefore argue that trade effects can cause spillovers so that the trade channel may be likely to be an important transmission channel.

Adopting the variables from Martin and Milas (2010), we further specify the variables for the spillover of external disturbances as

$$i_{t-\lambda}^{FL} = f\left(X_{t-\lambda}^{US}, S_{t-\lambda}^{UK}, L_{t-\lambda}^{UK}\right) \tag{5.3.6}$$

where X_t^{US} is the US yield curve, calculated as the difference between the 5 year bond rate and the 3 months Treasury bill rate; S_t^{UK} is the risk at time t in the UK credit market captured by the spread between the unsecured UK interbank rate and the secured Gilt Repo rate and L_t^{UK} is the UK liquidity index.[91] These arguments suggest that lags are likely to arise when the transmission is extended beyond the interbank market to the bank retail lending market.

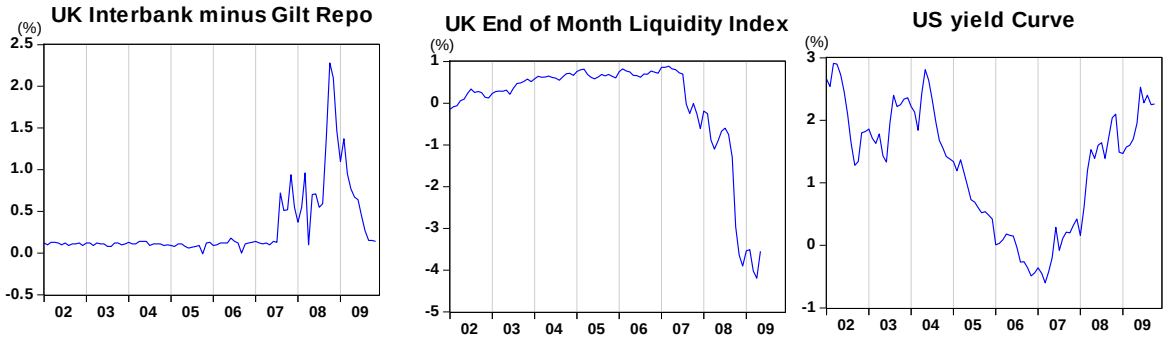
3.2 Timing of Spillover of External Disturbances

We assume that the spillover of international disturbances is signalled through the US yield curve and the UK risk and liquidity measures, see Figure 21. These variables may be critical to the pricing of funds resulting from the transmission noted above. For

[91] Stock and Watson (2003) cited literature that showed a significant relationship between the positive yield curve and an increase in real economic activity, while an inverted yield curve tended to be indicative of a recession. For example, Estrella and Hardouelis (1991) found that a positive slope of the yield curve proved useful for forecast of inflation and real economic activity.

example, banks may price their loans to compensate for risk and liquidity since risk present a cost to financial intermediation. At the same time, the slope of the yield curve can influence how banks factor in pricing according to the maturity of funds. [92] It can be seen that during the course of 2007 there was a radical departure from the underlying trend in the various markets with respect to the three indicator variables. Risk increased as captured by the spread between the UK interbank rate minus the Gilt Repo rate, the UK end of month liquidity index fell and the US yield curve began rising.[93]

Figure 21 International Indicators



Within the period of the crises, there were massive jumps in the risk indicator in the UK. This can be captured by the spread between unsecured and secured lending. In Table 20, we compare these jumps with that of Trinidad and Tobago intermediation spread. Thus we form our notion of the transmission of disturbances from the UK to the Trinidad and Tobago market through observation.

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[92] Notwithstanding this, there has been limited debate on the usefulness of the yield curve with respect to emerging economies. Debates have raged in the advanced industrialised countries on the usefulness of the yield curve as a means of forecasting inflation or economic buoyancy in the US and the UK, see for example the literature review of Stock and Watson (2003)

[93] Some central banks , inclusive of the Bank of England, use the yield curve to do inflation rate forecasting. See for example Joyce and Medrum (2008) and Gurbaynak et al. (2007) and Stock and Watson (2003) for a discussion on this.

A limitation of the Trinidad and Tobago market is that it does not report unsecured and secured lending as the UK market does. As a result we could not substitute spreads between secured and unsecured lending in the constant term as did Martin and Milas (2010). Instead we use intermediation spreads which we define as the difference between the prime lending rate and the risk free prime lending rate.

Table 20 Risk Indicators in the UK and Trinidad and Tobago (TT) Financial Markets

Obs	Month	UK Lending risk	TT Intermediation Risk	Monthly change in UK lending risk spread (basis points)	Monthly change in TT intermediation Risk (basis points)
1	2007M05	0.1	4.7	-2	-24
2	2007M06	0.14	4.85	4	15
3	2007M07	0.13	4.84	-1	-1
4	2007M08	0.72	4.89	59	5
5	2007M09	0.51	4.78	-21	-11
6	2007M10	0.52	4.75	1	-3
7	2007M11	0.94	4.64	42	-11
8	2007M12	0.55	4.75	-39	11
9	2008M01	0.37	4.75	-18	0
10	2008M02	0.55	4.76	18	1
11	2008M03	0.96	5.25	41	49
12	2008M04	0.1	5.25	-86	0
13	2008M05	0.7	5.21	60	-4
14	2008M06	0.71	5.2	1	-1
15	2008M07	0.55	5.21	-16	1
16	2008M08	0.59	5.73	4	52
17	2008M09	1.39	5.7	80	-3
18	2008M10	2.28	6.03	89	33
19	2008M11	2.1	5.96	-18	-7
20	2008M12	1.47	6.06	-63	10
21	2009M01	1.1	6.78	-37	72
22	2009M02	1.37	8.63	27	185
23	2009M03	0.95	9.74	-42	111

7 M
9 M
5 M
7 M
8 M
5 M

Source: UK data are extracted from Bank of England data set and Trinidad and Tobago data extracted from the Central Bank of Trinidad and Tobago.
Notes: UK lending risk is taken as the spread between the unsecured interbank 3-month lending rate minus the secured Gilt Repo lending rate. M denotes months.

We search for the length for transmission by first mapping the change in the monthly UK risk that is above 30 basis points, with the change in Trinidad and Tobago

intermediation risk above 30 basis points. Varying transmission lengths are obtained ranging between 5 and 9 months. We treat the transmission of 9 months as an outlier, and so exclude this from the calculation of the mean lags. Consequently we obtain the mean length of transmission as 6.4 months.

In the same way we also compare the temporal ordering of the large changes in the US yield curve with a change in the prime lending rate for Trinidad and Tobago for the speriod of the global crises. We considered a large change in the US yield curve to take place when the change is over +/-0.45 basis points in magnitude. We compare that change with the next change in the prime lending rate, by observing the interval between changes. For the period in the sample that the global crises occurred, we show three such points, see Table 21. It can be seen that the interval between large changes for the yield curve and the next change in Trinidad and Tobago repo rate are 9, 6 and 7 months. The median of these was 6 months and a mean is 6.67. However, since there are only three data points we go with median since the mean number of data points would be acutely sensitive to the extreme size of any one of the interval points. The evidence therefore shows that for the UK lending risk and the yield curve, a lag length of 6 months may be plausible.

Table 21 US Yield Curve indicators and Trinidad and Tobago (TT) Financial Markets

Obs	Monthly change in US yield curve	Monthly change in Prime lending rate
2007M05	0.22	0
2007M06	**0.49**	0
2007M07	-0.37	0
2007M08	0.19	0
2007M09	0.1	0
2007M10	-0.01	0
2007M11	0.12	0
2007M12	0.1	0
2008M01	-0.26	0
2008M02	0.**45**	0
2008M03	0.**59**	**0.5**
2008M04	0.33	0
2008M05	-0.14	0
2008M06	0.21	0
2008M07	0.04	0
2008M08	-0.25	**0.5**
2008M09	0.34	0
2008M10	0.31	0.**25**
2008M11	0.06	0
2008M12	-0.61	0
2009M01	-0.02	0
2009M02	0.1	0
2009M03	0.03	0

9 M

6 M

7M

Source: http://www.irs.gov/retirement/article/0,,id=177408,00.html
Notes: M denotes months.

An examination of the evidence for the yield curve measure therefore corroborates the results obtained from the risk measure since it suggests that an average lag of 6 months for both may be plausible. The result is similar to Canova (2005) who finds that the lag with which monetary disturbances emanating from disturbances in USA spillover may spillover to Latin America is somewhere within two quarters. He obtains

this through the use of impulse response functions using quarterly data for the first quarter of 1980 to the last quarter of 2002. Thus our visual inspection corroborates his results. Hence for the regression we assume that the turbulence in the UK market is transmitted to the Trinidad and Tobago market over an average of 6 months after rounding off.

4.0 Model specifications

To find the pass through in the presence of excess reserves and spillovers we formulate the general regression as

$$i_t^{borrow} = \beta_0 + (\beta_1 + \beta_2 exres_t + \beta_3 X_{t-\lambda}^{US} + \beta_4 S_{t-\lambda}^{UK} + \beta_5 L_{t-\lambda}^{UK}) i_t^{base} + \varepsilon_t \qquad 5.4.1$$

The equation is formulated to capture the interaction of the base rate with excess reserves and spillovers of foreign disturbances, to see how they impacted on the pass through of the repo rate. This reverts to the standard pass through model as in Lowe (1995) if we impose
$\beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$. In Lowe (1995) equation they examined the degree of pass through of the policy rate to the credit market rate where they let β_1 be the degree of pass through. Further, it is also implied by Martin and Milas (2010) if we export their model outlined in equation (5.3.4) to Trinidad and Tobago, given the non existence of, the libor, repo yield curve and UK liquidity index in that country. In effect the restriction is set in equation (5.3.4) that $\omega_{01} = \omega_{02} = \omega_{03} = \omega_{12} = 0$.

We use the standard constant spread model as our simple model from which we can compare the spillover results. Consequently we relate the repo rate to the prime lending rate which is used as the floor rate, the best rate private sector customers can borrow at. As such, in the simple model it is assumed that excess reserves and spillovers have no effect on the pass through of the repo rate.

We relax the assumption that excess reserves and spillovers have no effect on the pass through of the base rate at which the private sector can borrow from commercial bank. In allowing for spillover effects, we impose two different restriction on the dynamic effects. First we test the regression where $\lambda = 0$ and then we test a separate regression where $\lambda = 6$. Thus the former assumes that the central bank react contemporaneously to external disturbance, whereas, in the latter it is assumed that the transmission of foreign disturbances takes 6 months so that policy makers react by a lag of 6 months.

The degree of the pass through of the short-term interest rate can be assumed to be dependent on the stability and slope of the yield curve, see for example Baláz et al (2006). As such, the steeper the yield curve, the greater the degree of pass through that can be expected. Like Mehl (2006), we construct the US yield curve by using the difference between the 5 year maturity and the 3 month Treasury bill rate.

Martin and Milas (2010) contended that risk can impact on aggregate demand independent of the policy rule. They found that higher risk led to a widening of the spread between the lending and the base rates which they attributed to be the result of a rise in unsecured lending risk. We therefore examine whether the risk has the same effect that Martin and Milas (2010) found with respect to the UK, in that the spillover of risk lead to a widening of the spread between the policy and lending rates.

The size of the spread between the policy and prime lending rates in Trinidad and Tobago is assumed to be influenced by the spillover of liquidity emanating from financial markets in the UK. Liquidity in the UK market is indicative of the ease with which UK financial institutions can generate income from assets. This includes the ability of financial institutions to raise funds through the money market, which largely depend on the liquidity positions of financial institutions. We contend that cross-

border liquidity is more readily transmitted between markets the more closely integrated financial markets are between countries.[94] In our case we suggest that such integration can take place through cross-border demand for financial assets and cross-border funding of investments.[95] Further, we argue that the demand for investment assets by financial institutions in Trinidad and Tobago can be affected by the state of liquidity of financial assets in the UK market and this in turn can have an indirect effect on excess reserves in the banking sector.

From equation (5.4.1), if $\beta_2 \neq 0$ then excess reserves impact on the pass through of the repo rate onto the lending rate. Excess reserves represent a cost to commercial banks since they receive no interest on it. Commercial banks may react in two alternative ways. Where there are limited avenues for placing these reserves to gain interest revenues, banks may lower lending rates in a bid to increase loan demand. On the other hand, they may opt to raise lending rates in order to compensate for the loss of income owing to non remunerated excess reserves. Both scenarios may depend on the capacity of the economy to absorb increasing liquidity stemming from increased inflows of energy receipts.

Table 22 shows how correlation signs were inconsistent between the prime lending rate and excess reserves as the correlation sign changes between sub-periods from negative between 2002-2004 to positive between 2005 to 2009:3. The other variables were consistent with respect to their signs for all periods. For the relation between prime lending rate and excess reserves, the direction of the relation is an empirical matter, since it depends heavily on prevailing demand conditions, competitiveness of the environment and individual bank strategy. Similarly, if $\beta_3 \neq 0$, $\beta_4 \neq 0$ and $\beta_5 \neq 0$ then international spillovers stemming from the US yield curve, UK credit risk and the

[94] See for example Datar et al (2008) for a discussion on cross border liquidiy in relation to the spillover in the US and Japanese markets.

[95] Cross-border demand can be facilitated by the trading of financial instruments. For example, Tang and Yan (2007) suggested that Credit Default Swaps (CDS) can facilitate cross border demand.

UK liquidity index respectively, impact on the pass through of the repo rate. We contend that the signage of these spillover coefficients are largely an empirical matter.

Table 22 Correlation with Prime Lending Rate

	Excess Reserves	US yield Curve	UK Credit Risk	UK Liquidity Index
2002-2009:3	0.31	0.08	0.47	-0.57
2002-2004	-0.14	0.26	0.02	-0.94
2005-2009:3	0.48	0.17	0.65	-0.66

4.1.3 Strength of excess reserves and international spillovers when Full Pass Through is Imposed

To separate the different effects within the interaction terms, full pass through is imposed on regressions 5.4.2. Accordingly we impose full pass through of the repo rate by modelling the spread between the prime lending rate (i^l) and the policy repo rate (i^r) as the dependent variable. This would therefore mean that $\frac{di_t^l}{di_t^r} = 1$. As such, from equation (5.4.1) we let $\beta_1 = 1$ and the difference between the lending and the policy rates is modelled as the dependent variable. We therefore formulate the variable $\gamma_t = i_t^l - i_t^r$ as the dependent variable to obtain

$$\gamma_t = \beta_0 + \beta_2 exres_t + \beta_3 X_{t-\lambda}^{US} + \beta_4 S_{t-\lambda}^{UK} + \beta_5 L_{t-\lambda}^{UK}. \qquad 5.4.2$$

The importance of this specification is that the interaction term is dispensed with and the relative importance of excess reserves and international spillovers are examined,

given a one to one change between the repo and the commercial bank lending rate.

5.0 Methodology and Data

Whereas Martin and Milas (2010) would have only considered the pass through of the base rate to the borrowing rate, we also add excess reserves and the potential spillovers emanating from other international financial markets in the interaction term. Both the repo rate and excess reserves are considered to be the domestic variables while, following from Martin and Milas (2010), the international variables are taken as the US yield curve, UK risk and liquidity indexes. The pass through of the repo rate with respect to excess reserves is assumed to be manifested contemporaneously since they originate in the domestic financial sector. On the other hand, allowances are made for the pass through of the international variables to either be contemporaneous or to take place with a 6 month lag since the disturbance began overseas.

A few departures from Martin and Milas (2010) should be noted. We use the repo rate as the base rate and the prime lending rate as the rate at which the private sector can borrow from commercial banks outside of the interbank market. Further we interpret ω_{1t} in equation (5.3.3) as the degree of pass through of the repo rate, whereas Martin and Milas (2010) interpreted it together with ω_{0t} as determinants of the yield curve. Instead we use ω_{0t} as the proxy for the systematic risk. Moreover, unlike Martin and Milas (2010) where the value of the error term in equation 5.3.3 is known, we assume that ε_t is a random error term that is identical and independently distributed.

Following Martin and Milas (2008), Generalised Method of Moments (GMM) is used as the estimation technique used to find estimates of the parameters. Further, we estimate the model over the full sample period and over a subsample from 2005:1 to 2009:3. We therefore examine

$$i_t^{borrow} = \omega_{0t} + \omega_{1t} i_t^{base} + \varepsilon_t. \quad 5.5.1$$

In adopting the model for Trinidad and Tobago, we represent i_t^{borrow} as the prime lending rate reported for the commercial banking industry and i_t^{base} to denote the repo rate charged by the central bank.

The general model to capture the pass through is given in regressions 5.5.2 and 5.5.3. Systematic risk is captured by β_0. The pass through of the repo rate is captured by β_1 along with its interaction with excess reserves. The interaction of the repo rate with the spillover of variables is captured by β_2. A positive β_2 would suggest the extent to which increased financial risk in the UK market would magnify the impact of the pass through of the repo rate on the prime lending rate. The spillover of the US yield curve, risk and liquidity in the UK market are captured by β_3, β_4 and β_5 respectively. If β_3 is positive, then it would suggest that the yield curve is positively sloped and that environment would facilitate upward movement in bank lending rate. Similarly, if β_4 and β_5 are positive, then it would imply that increased risk and liquidity in the UK market would have magnify the pass through of the repo rate on the prime lending rate. The foreign variables are therefore included to obtain

$$i_t^{borrow} = \beta_0 + (\beta_1 + \beta_2 exres_t + \beta_3 X_t^{US} + \beta_4 S_t^{UK} + \beta_5 L_t^{UK}) i_t^{base} + \varepsilon_t \quad 5.5.2$$

$$i_t^{borrow} = \beta_0 + (\beta_1 + \beta_2 exres_t + \beta_3 X_{t-6}^{US} + \beta_4 S_{t-6}^{UK} + \beta_5 L_{t-6}^{UK}) i_t^{base} + \varepsilon_t \quad 5.5.3$$

Using equation 5.4.2 we set $\lambda = 0$ in 5.5.2 and then $\lambda = 6$ in 5.5.3.

We then construct the regression model by assuming full pass through, in order to gauge the relative importance of excess reserves to spillover of foreign disturbances in impacting on the pass through of the repo rate. Formulating without lags, we express the equation

$$\gamma_t = \beta_1 + \beta_2 exres_t + \beta_3 X_t^{US} + \beta_4 S_t^{UK} + \beta_5 L_t^{UK} + \varepsilon_t \qquad 5.5.4$$

As in equation (5.4.1), we then allowed for delayed spillovers by assuming that international spillovers to γ_t act through 6 lags. As such,

$$\gamma_t = \beta_0 + \beta_2 exres_t + \beta_3 X_{t-6}^{US} + \beta_4 S_{t-6}^{UK} + \beta_5 L_{t-6}^{UK} + \varepsilon_t \qquad 5.5.5$$

Monthly data are used for the period May 2002 following the introduction of the repo rate, to March 2009. As a result, the overall sample contains 77 data points. Within this period, a subsample is extracted to run from January 2005 to March 2009 and it therefore contains 51 data points. The equations are therefore tested for the overall period and the sub sample periods.

5.1 Instruments and Lags

Martin and Milas (2010) only used lags of endogenous variables as instruments. However, we include both endogenous and exogenous instruments. The exogenous instrument we include is the growth of loans. Growth of loans is deemed as exogenous since it is not included in the regression of interest. Furthermore, its correlation with the prime lending rate turned out not to be significant for the period 2002:2 to 2009:3.

However, we assume that the buoyancy of the credit market and therefore interest rate would depend on the demand for loans which is indicated by the growth of loans.

Similar to Martin and Milas (2010), the first 6 lags are employed for the overall period with respect to the endogenous variables. We also employ the same number of lags for the exogenous variable — the growth of loans. For the subsample, two lags are used for the domestic endogenous variables but six lags are maintained for the international spillovers. The smaller number of number of lags are used for domestic variables, given the need to conserve degrees of freedom owing to the shorter data set of the subsample of 51 data points and the idea that the effects of domestic variables were believed to be more immediate as they were transmitted internally.

6.0 Results

The regression for the full period is dileanated as (a) and for the subsample we annotate as (b). In all cases, better regressions were obtained for the subsample period rather than for the full period, given smaller standard errors.

6.1 Simple Model of Pass through effects

The evidence reported in Table 23 show that there is full pass through of the policy rate to the credit market rate. The result is robust to the time period selected so that the pass through was 1.05 and 1.02 for the overall and subsample periods, respectively. Use of the Wald test reveals that β_{01} is not significantly different from 1 in both samples. Consequently the results show that there is a one to one pass through from the policy rate to the credit rate.

Table 23 Degree of Pass through to the credit market for Equation 5

	Overall Sample (2002:11 to 2009:03)	Subsample (2005:1 to 2009:03)
	Equation 5.5.1a	Equation 5.5.1b
β_{00}	3.41 (0.315)***	3.71 (0.033)***
β_{01} (repo)	1.05 (0.043)***	1.01 (0.004)***
$\overline{R^2}$	0.31	0.96
S.E of regressions	1.12	0.27

Notes: Dependent variable is the Prime Lending rate for the credit market. Standard error of parameter estimates are placed in brackets.

6.2 Impact of excess Reserves and international spillovers on the pass through of the policy repo rate to the lending rate

The results obtained for equations 5.4.3 are 5.4.4 are shown in Table 24, where all the estimated coefficients turned out to be significant. In the Table we use (a) to signify the total sample and (b) to signify the subsample. The evidence reveals that the domestic variables have a greater impact on the lending rate compared to the international spillovers. Particularly, the pass through of the repo rate exhibited by β_{01} is found to have the strongest effect on the lending rate, despite the inclusion of excess reserves and international spillovers.

The evidence also suggests that the interaction of the repo rate and excess reserves constitute the second highest coefficient as shown for β_{03} for both sample sizes and lag lengths. However, the results are mixed for the overall sample as the coefficient is negative 1 for the contemporaneous spillovers contained in regression 5.4.1, while it is positive for the other variables. Compared to the other regressions, for 5.4.1 there is a larger margin of error of (0.075). Moreover the standard error of the regression is higher at 0.82 relative to the subsample where the standard error is 0.18. Thus, we deem the negative coefficient for the overall sample to be less reliable.

In contrast, excess reserves had positive effects for the remaining regressions and it is 0.5 for both the contemporaneous and lagged versions of the subsample. The positive coefficient is in keeping with what was obtained by Martin and Milas (2010). The positive results may have suggested either of two things. Firstly, given that the effect of excess reserves is positive in most cases, it may suggest that increases in the repo rate amplify the positive effect of excess reserves on the pass through. Thus in this case, both the repo rate and excess reserves could have had positive effects on the lending rate. On the other hand, the result does not exclude excess reserves having a negative effect on the pass through. In this case increases in the policy rate may outweigh the dampening effect of excess reserves. As a result, even if increases in excess reserves acted as a drag on the pass through of the policy rate, the pass through effects of changes in the policy rate would have outweighed the dampening effects of excess liquidity.

The effects of the international spillover variables on the pass through of the repo rate are marginal. Owing to the marginal effects of spillovers variables, the results show that it would have taken more extreme changes in international spillovers of foreign disturbances for changes to have noticeable effects on the pass through of the repo rate. Consistent signs are obtained for the liquidity spillover, but contrary to the positive sign obtained for Martin and Milas (2010) for the domestic UK economy, the spillover turned out to be negative thus suggesting that UK liquidity spillover had a tendency to make the market lending rate move closer towards the repo rate.

An empirical investigation of the factors that may be at work in influencing the transmission of UK liquidity to Trinidad and Tobago financial market may be beyond the scope of this study. Rüffer (2006) pointed out that the impact of liquidity spillover on pass through is less straight forward to explain compared to internal liquidity impact. Intuitively we offer a tentative transmission here, that as liquidity increased in

the UK, funds in Trinidad and Tobago would have been attracted to the UK market and therefore was less likely to be retained at home. Conversely, tight liquidity conditions in the UK would make the UK less attractive for financial investments demand by Trinidad and Tobago, so that the retention of these funds could lead to an increase in liquidity at home. Thus increased liquidity in the UK could have had opposite effects on the pass through in the Trinidad and Tobago market to what Martin and Milas observed for the UK market. However, as Canova (2005) suggested, a fuller treat would need to take into account relative capital flows, relative price changes, relative real exchange rates and improvements in trade balance.

Table 24 Interaction of excess reserves and spillovers with repo rate

	Overall Sample (2002:11-2009:3)		Subsample (2005:1-2009:3)	
	Contemporaneous Spillovers of external shocks Equation 5.5.2(a)	***6 month lag in Spillovers of external shocks*** Equation 5.5.3(a)	***Contemporaneous Spillovers of external shocks*** Equation 5.5.2(a)	***6 month lag in Spillovers of external shocks*** Equation 5.5.3(b)
β_{00}	4.01 (0.139)***	5.29 (0.062)***	3.64 (0.010)***	3.46 (0.040)***
β_{01} (repo)	1.02 (0.020)***	0.83 (0.009)***	1.02 (0.001)***	1.05 (0.004)***
β_{03} (Excess Reserves interaction with repo rate)	-1.00 (0.075)***	0.13 (0.069)*	0.05 (0.006)**	0.05 (0.023)**
β_{6} (UK liquidity index interaction with repo rate)	-0.03 (0.002)***	-0.02 (0.002)***	-0.01 (0.000)***	-0.02 (0.002)***
β_{7} (UK Risk Spread interaction with repo rate)	-0.07 (0.007)***	0.01 (0.002)***	-0.003 (0.000)**	0.005 (0.001)***
β_{8} (US yield Curve interaction with yield curve)	0.04 (0.004)***	0.02 (0.002)***	0.01 (0.000)***	0.01 (0.001)***
$\overline{R^2}$	0.62	0.62	0.98	0.98
S.E of regressions	0.82	0.84	0.18	0.18

Notes: Dependent variable is the Prime Lending rate for the credit market. Standard error of parameter estimates are placed in brackets.

The spillover of the risk spread was different for differing lag lengths. As such, the sign was negative where the effect of the spillover emanating from risk in the UK market was assumed to be instantaneous. This suggested that increased risk emanating from the US financial market had a dampening effect on the pass through of the policy repo rate to the lending rate in the Trinidad and Tobago market. On the other hand, where the spillover of risk in the UK financial market was assumed to take place with a lagged effect, the impact turned out to have a positive effect on the pass through of the policy repo rate onto the lending rate. At the same time, the spillover of the US yield curve remained consistently positive.

6.3 Implications of full pass through

Full pass through was imposed in order to decompose the interaction terms in equations 5.5.4 and 5.5.5 and the results were reported in Table 25. Excess reserves turned out to be negative and significant regardless of sample size. This may suggest that the positive effect of the repo rate and excess reserves that was obtained could have occurred as the pass through of the repo rate outweighed the dampening effect of excess reserves as banks seek to lower lending rates in a bid to raise loan demand.

Table 25 Imposition of Full Pass Through

	Overall Sample (2002:11-2009:3)		Subsample (2005:1-2009:3)	
	Contemporaneous Spillovers of external shocks Equation 5.5.4(a)	6 month lag in Spillovers of external shocks Equation 5.5.5(a)	Contemporaneous Spillovers of external shocks Equation 5.5.4(b)	6 month lag in Spillovers of external shocks Equation 5.5.5(b)
β_{00}	4.09 (0.032)***	4.10 (0.06)***	3.88 (0.005)***	4.01 (0.007)***
β_{01} (exres)	-5.91 (0.647)***	-5.00 (0.75)***	-1.07 (0.161)***	-3.37 (0.261)***
β_6 (UK liquidity index)	-0.21 (0.016)***	-0.43 (0.06)***	-0.15 (0.004)***	-0.36 (0.006)***
β_7 (UK Risk Spread)	-0.42 (0.031)***	-0.25 (0.08)***	-0.05 (0.005)***	0.13 (0.01)***
β_8 (US yield Curve)	0.26 (0.007)***	0.29 (0.023)***	-0.01 (0.003)***	-0.03 (0.004)***
$\overline{R^2}$	0.26	0.25	0.52	0.48
S.E of regressions	0.80	0.80	0.18	0.19

The spillover from the UK liquidity index remained negative, suggesting that changes in the UK liquidity index tended to have a negative effect on the lending rate relative to

the repo rate in Trinidad and Tobago. However, the other spillover variables did not consistently reflect the same sign when they were incorporated. Risk in the UK financial sector spilled over to reduce the lending rate in Trinidad and Tobago in regressions 5.5.4 (a), 5.5.5(a) and 5.5.4(b), but it was found to have a positive effect in regression 5.5.5(b).

The effect of the yield curve was positive for the overall sample period, which suggested that in the long term the Trinidad and Tobago market were likely to raise their lending rate as the yield curve become steeper. The US yield curve turned out to be negative for the subsample when full pass through of the repo rate was assumed, which was opposite to the sign it exhibited for the subsample when it was interacted with the repo rate. The slope of the yield curve was -0.01 and -0.03 for the instantaneous and lagged responses respectively. This ran counter to the sub-period where the coefficients were positive. Given the lower magnitude in the yield curve coefficients, the results suggest that the spillover of the yield curve diminished in importance to the pass through effects in Trinidad and Tobago.

7.0 Conclusion

The results suggest that full pass through of the policy rate to the credit market lending rate is robust to excess liquidity and international developments, particularly where the prime lending rate reflected an upward trend. We suggest that this may have been as a result of effective moral suasion employed by the central bank. It would have also been possible that the central bank may have tried to sterilise excess liquidity from the commercial banking sector before making changes to the repo rate.

From among the other domestic variables, the results show that the predictability of the lending rate also depends heavily on the level of excess reserves, given the significance of this variable. This variable was revealed as having the potential to

dampen the pass through of the policy rate and thereby have a bias towards higher levels of demand, once demand increases in reaction to lower interest rates. As such, excess reserves undermined pass through effects. Based on the findings, the Central Bank may find it prudent to take excess reserves into account in setting the repo rate.

We suggest that multiple transmission of external disturbances may be at work in impacting on the pass through. The results show that shocks could have been transmitted via domestic variables, contemporaneously through international banks and through lagged effects. Moreover, the international variables could have some effects on the pass through of the policy rate. Nevertheless, given that domestic variables had stronger effects and the marginal significance of the international spillovers, the results suggest that the pass through may not be severely undermined or strengthened by international spillovers. Moreover, there is support for the financial integration of the Trinidad and Tobago economy with the UK and US economies given the significance of the spillover variables, but the integration is not strong enough to overshadow the importance of the domestic variables. As such, the transmission of external disturbances through important was still overpowered by excess reserves and the repo policy rate in the Trinidad and Tobago market.

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