Three Essays on Built-in Stability

THREE ESSAYS ON BUILT-IN STABILITY

By

JEAN-PAUL LAM YIK SHING, B.Sc.(HONS.), M.A.

A Thesis

Submitted to the School of Graduate Studies

in Partial Fulfilment of the Requirements

For the Degree of

Doctor of Philosophy

McMaster University

DOCTOR OF PHILOSHOPY (2002)
(Economics)

McMaster University
Hamilton, Ontario

Title: Three Essays on Built-in Stability

Author: Jean-Paul Lam Yik Shing, B.Sc. (Honours)(University of Hull)
M.A. (McMaster University)

Supervisor: Professor William M. Scarth

Number of Pages: 182

Abstract

This dissertation comprises three essays. The first essay examines the implications of alternative fiscal regimes on output volatility using a series of closed economy models. Two fiscal regimes are considered: a flexible fiscal regime ("Keynes") whereby the government uses fiscal policy in a countercyclical fashion, increasing the budget deficit when output falls and a rigid fiscal regime ("Hoover") whereby the government balances the budget at each point in time by changing its expenditure.

In this essay, I explore which fiscal regime is able to limit output volatility in the presence of shocks. The model involves two important features that make it possible for the flexible approach to fiscal policy to be less not *more* stabilizing for output. By issuing more bonds during a downturn (to finance temporary deficits), governments create an obligation to work down the debt-ratio in the future. Thus, while conducting fiscal policy à la "Keynes" can reduce the size of a recession initially, it can delay and weaken any eventual recovery and hence make the recession last longer.

On the other hand, while the impact effect of a negative shock under "Hoover" is bigger, the speed at which the economy recovers is faster as this fiscal regime avoids the destabilizing part of bond-financed deficits. As a result, depending on the magnitude of the impact and the speed at which the economy recovers from a downturn, output volatility can be higher under "Keynes".

The second feature highlighted in this essay which raises the probability that a rigid annual balanced-budget approach can be superior in reducing output volatility, involves the interaction between fiscal and monetary policy. Monetary policy is modelled by deriving the interest-rate setting rule that is appropriate for meeting the central bank's goal (assumed to be an expected future inflation rate of zero), taking the rest of the macro model as the bank's constraint. Since fiscal policy is part of the system, monetary policy adjusts whenever the fiscal regime changes. In particular, since the rigid fiscal regime avoids the destabilizing part of a bond-financed deficit, the central bank finds it appropriate to put less weight on stabilizing long-term expectations and more weight on the deviations of real output from its target. Traditional analyses of fiscal policy have not allowed for such an endogenous reaction of monetary policy.

My results for this essay indicate that the degree of forward-lookingness, the nature of the shock hitting the economy and to some extent the degree of price stickiness are important factors in determining the choice of the best fiscal regime I find that in an number of cases, the "Hoover" approach minimizes output volatility. In particular, in the micro-based specification and forward-looking version of the model, at least for demand shocks and some common ways of specifying prices, output volatility can be reduced by moving away from a flexible fiscal regime toward one that involves rigid annual budget targets. To check for the robustness of my results, a series of sensitivity tests are performed.

The second essay extends the analysis developed in the first essay of this thesis to the small open economy case. The same issues are examined but this time using a richer and more complex framework. Several changes are introduced in this essay. However, despite these changes, I find that the results from this chapter are very similar to those obtained in the closed economy framework. In particular, I find that the "Hoover" approach receives more support when the more forward-looking version of the model is used while the flexible regime dominates the rigid approach when the more backward-looking version of the model is assumed.

In addition to the "Keynes" v/s "Hoover" debate, several other interesting findings emerge from this essay. For example, in the second essay, I find that a more conservative central bank is more desirable when demand and supply shocks are persistent. This verifies the finding of many other studies which have obtained an identical result using the same framework which however excludes government and open economy considerations. As in the previous chapter, I perform a series of sensitivity tests.

The third essay continues this shift in emphasis from fiscal to monetary policy. The third essay is based on two propositions. First the goal of price stability can be achieved with exchange rate targeting, but with also exchange rate flexibility combined with a monetary policy that targets either the price level or an index of wage rates. The three different monetary regimes are assumed to generate the same outcome regarding long-term inflation. As a result, the choice among these alternative monetary regimes can be made on the basis of which fiscal regime delivers the most built-in stability for real output. Second, this essay is based on the belief that changes in aggregate demand are a very important source of disturbance in the economy. Since these shocks are costly to society, they generate the desire for built-in stability.

The three monetary regimes are compared using several models and I assume that the central bank can target any of these regimes in a modest or aggressive fashion in the face of temporary and on-going shocks in demand. All the models in this essay involve consistent exchange rate expectations and through the existence of intermediate imports, supply-side effects of exchange rate changes. Moreover, all models also incorporate the possibility of an imperfect pass-through of exchange rate movements on prices. My results from this essay indicate that in all of these models, either price level or wage-rate targeting can do as well, or better than exchange rate targeting. However, exchange rate targeting is often the second best policy while the other two monetary regimes switch between the first and third best ranking. Hence exchange rate targeting appears to be more robust to model uncertainty compared to the other two targeting regimes and hence emerges as an appealing compromise

Preface

I wish to thank my thesis supervisor, Professor William M. Scarth, for his dedication, invaluable assistance and encouragement during the preparation of this thesis and throughout my doctoral studies. My sincere thanks also goes to Professor Michael R. Veall for his constant support and encouragement during my years of study at McMaster University and to Professor Alok Johri for his aid and direction.

I owe many thanks to my family, for their love, constant support and encouragement throughout the course of my studies. My gratitude especially goes to my parents who have provided me with a lifetime of love, encouragement and moral support. Thank you also to my sister and brother and especially to my five nephews and my niece whom I adore and who rightfully think that playing video games is much more entertaining than writing a thesis. Finally I wish to thank Emmanuelle for her support and understanding and my friends for their encouragement.

The second and fourth chapters of this thesis were prepared with the intention of joint publication with my supervisor, Professor William Scarth. I had primary responsibility for solving the models and played a role in the writing of the papers.

Table of Contents

List of Tables

Chapter II

Chapter III

Chapter IV

Chapter 1

Introduction

The conduct of fiscal and monetary policy has undergone important changes in the last decade. Many governments have adopted strict annual budget targets, while more and more central banks have become increasingly independent of political and governmental control and have established explicit inflation targets.[1] Although the move towards central bank independence and conservatism in the 1980s and 1990s was greatly influenced by the intellectual impetus provided by the work of Barro and Gordon (1983), Rogoff (1985), Walsh (1995) and Svensson (1997), recent changes in fiscal policy making were primarily motivated by practical and political factors.[2] After witnessing an explosion in their debt-to GDP ratio in the 1980s, many countries were faced with a debt crisis. As a result, there was an urgent need to bring the debt-to-GDP ratio back under control.[3] In many countries, this was achieved by establishing rigid annual budget targets (mostly by cutting government expenditure) and these targets were to be met "come hell or high water".[4] Fiscal restraint was not only necessary to restore the credibility of the government but also to

[1] In Julius et al (2000), 55 of the 91 countries surveyed have an explicit inflation target

[2] A conservative central bank is regarded as having a strong dislike for inflation and will usually put more weight on inflation and less weight on output stabilization compared to society.

[3] For example Canada's debt-to-GDP ratio increased from around 30% at the end of the 1970s to over 70% in 1995

[4] Paul Martin, 1997 Budget Speech

ensure the sustainability of fiscal policy in the long run, especially in the light of an ageing population and also to promote macroeconomic stability. Choosing the best or appropriate monetary and fiscal regime remains one of the most central decisions governments and central banks have to make. Consequently, it is imperative to understand the implications and consequences of these different monetary and fiscal regimes on the economy.

This dissertation comprises three essays. The first essay examines the implications of alternative fiscal regimes on output volatility using a series of closed economy models. Two fiscal regimes are considered: a flexible fiscal regime whereby fiscal policy is conducted in a countercyclical fashion and a rigid fiscal regime where the government balances the budget at each point in time.[5] I explore which fiscal regime is able to limit output volatility in the presence of shocks and assess if conventional wisdom (which views a flexible fiscal regime as more stabilizing for output) is supported. The second essay extends the analysis of the first essay to a series of small open economy models. The same issues as in the first essay are examined but the second essay contains richer and more complex models. The robustness of my results are thoroughly checked in each essay by performing a series of sensitivity tests. Finally, the third essay compares the performance of different monetary regimes using a series of small open economy macro models. Three different monetary regimes are examined - price level, exchange-rate and wage targeting - and their ability to minimize output volatility is assessed by introducing temporary and on-going shocks to the models.

---

[5] In this thesis, the flexible approach to fiscal policy is sometimes described as the Keynesian or "Keynes" approach whereas the rigid approach to fiscal policy is described as the "Hoover" approach.

In spite of important changes in both fiscal and monetary policy making, researchers in recent years have focused almost exclusively on issues related to monetary policy, particularly on finding the best monetary policy rule or regime. As a result, research on finding and comparing different monetary rules has exploded in recent years and seems to have converged on a model framework which Goodfriend and King (1997) have labelled the "New Neoclassical Synthesis" and which Clarida, Galì and Gertler (1999) have dubbed the "new science of monetary policy".[6] This framework emphasizes forward looking behaviour on the part of agents, incorporates nominal price rigidities and is derived from micro foundations. As a result, it is less vulnerable to the Lucas critique. This is an important consideration as these models are often used for policy simulations. Moreover, most of these models typically exclude fiscal policy.[7]

Despite the strong consensus on the framework used to analyze monetary policy issues, there are disagreements regarding the choice of the best monetary policy regime. The literature involves many competing conclusions regarding which monetary regime is more conducive for minimizing output and price volatility. Moreover, since most studies evaluate different monetary regimes in a single model, they cannot test the robustness of their results to model uncertainty. This issue is probably as important as finding the best monetary regime but the literature seems to have emphasized the latter.[8]

---

[6] Examples of such models include Batini and Haldane (1999), Clarida, Gali and Gertler (1999), Kerr and King (1996), McCallum and Nelson (1999a, 1999b) and Walsh (1999a, 1999b, 2001). The list of papers using such framework is extensive

[7] In most cases, fiscal policy is either absent or is modelled in some rudimentary fashion

[8] One notable exception is Levin, Wieland and Williams (1999) who compare the performance of alternative monetary policy rules in four macro models of the U.S economy

While the study of alternative monetary policy regimes has been a fruitful area of research in recent years, there has been practically no theoretical work (and few empirical studies) on the implications of alternative fiscal regimes on output and inflation stabilization, let alone the consequences of alternative fiscal regimes on the conduct of monetary policy.[9] The first and second essay of this thesis fills this gap partially and contributes to this debate in several ways. In these essays, I compare two fiscal regimes and evaluate them according to their ability to minimize the variability of key economic variable, notably output and inflation. The two types of fiscal regimes I consider are a flexible ("Keynes") regime whereby the government uses fiscal policy in a countercyclical fashion, increasing the budget deficit when output falls and a rigid ("Hoover") regime whereby the government balances the budget at each point in time by changing its expenditure. In the first essay, the two types of fiscal regimes are evaluated according to their ability to minimize the unconditional variance of output while in the second essay, the two regimes are evaluated using a loss function comprising of the unconditional variances of output and inflation

If one of the main concerns of policymakers is to minimize output volatility, conventional wisdom supports a flexible approach to fiscal policy since balanced budget rules can make fiscal policy procyclical and hence hamper the operation of the automatic stabilizers. This argument is best illustrated with this simple example. Suppose the economy is hit by an adverse demand shock which reduces output. If the government is running a flex-

---

[9] Empirical work on the effects of alternative fiscal regimes on output and inflation variability is rare and the findings from these very few studies are in general inconclusive. The second chapter of this thesis summarizes some of these findings

ible fiscal regime, it can help restore output back to its initial level by running a budget deficit. On the other hand, if the government has a rigid fiscal policy regime, to balance the budget, the government has to cut its expenditure since revenue from taxes has fallen. As a result, under this regime. output falls even more as the effects of a negative demand shock is exacerbated.

However, while a flexible fiscal regime can mitigate the impact of adverse shocks on the economy, it also implies that the government must accumulate debt since the government has to finance its deficits by issuing more bonds which has to be repaid at some point in time. This, as witnessed in recent years, can have important effects on the volatility of output and inflation and hence on the stability of the economy. These issues are examined in two of the three essays presented in this thesis.

In the first essay, the analytical underpinnings of built-in stability are explored in a closed-economy setting. The model involves two features that make it possible for the flexible approach to fiscal policy to *increase* output volatility. By issuing more bonds during downturns (to finance temporary deficits), governments create an obligation to work down the debt-ratio in the future. Thus while a flexible fiscal policy can reduce the size of a recession initially, it can delay and weaken any eventual recovery. In particular, shocks can involve increased persistence when the Keynesian approach is followed.

On the other hand, while the impact effect of a negative shock under a rigid fiscal regime is bigger, the speed at which the economy recovers is faster as this regime avoids the destabilizing part of bond-financed deficits As a result, depending on the magnitude of the impact effect and the speed at which the economy recovers from a downturn, output volatility can be higher under a flexible fiscal policy. With forward-looking behaviour in the determination of both private demand and price-setting behaviour, the negative dimension of this dynamic trade-off becomes is accentuated.

The second feature highlighted in this essay which raises the probability that a rigid annual budget-balance approach can be superior in reducing output variability involves the interaction between fiscal and monetary policy. Monetary policy is modelled by deriving the interest-rate setting rule that is appropriate for meeting the central bank's goal - assumed to be an expected future inflation rate or expected price level target of zero - taking the rest of the macro model as the central bank's constraint. Since fiscal policy is part of the system, monetary policy adjusts whenever the fiscal regime changes. In particular, since a more rigid fiscal policy avoids the destabilizing feature of bond financed deficit, the central bank finds it appropriate to put less weight on stabilizing long-term expectations and more weight on the deviations of real output from its target. Traditional analyses of fiscal policy have not allowed for such an endogenous reaction of monetary policy and have also largely ignored the destabilizing feature of a flexible fiscal policy regime [10]

This essay addresses these issues in two settings - a standard descriptive rational expectations analysis and a related model which has more explicit micro foundations and which is similar in spirit to the "New Neoclassical Synthesis" model of Goodfriend and King (1997) [11] In both cases, the model is solved by assuming trial solutions for the

---

[10] There is no coordination problem (no game of chicken) between the monetary and fiscal authority. The objective of the monetary authority is *independent* of the type of fiscal regime in place while its period-by-period decision rule is *dependent* on the type of fiscal regime

endogenous variables of the model. The variance of output is then calculated analytically and numerically and the two fiscal regimes are ranked according to their ability to minimize output volatility. Three shocks are considered, a demand, cost-push and a supply shock.[12] Finally, to assess how robust my results are, a series of sensitivity tests are performed.

My results for this essay indicate that the two models yield different verdicts concerning alternative fiscal policies. In the more micro-based specification and forward looking version of the model, at least for demand shocks and some common ways of specifying sticky prices, output volatility can be reduced by moving away from the traditional flexible (Keynesian) approach toward one that involves rigid annual budget-balance targets. On the other hand, a flexible fiscal regime performs better than the rigid approach when the more descriptive version of the model is used (traditional IS function) In the case of cost-push and supply shocks, as the monetary authority reacts aggressively to offset future inflation, the choice of the fiscal regime becomes less important and in some cases does not even matter. Hence, my results indicate that the degree of forward lookingness, the nature of the shock hitting the economy and to some extent the degree of price stickiness are important factors in determining the choice of the best fiscal regime

While the result that a rigid fiscal policy can be more stabilizing for output as compared to a flexible approach is in itself a very interesting finding and to the best of my

[11] Like many other macro models, my models are highly aggregative and are assumed to be stable

[12] In the model, since the output gap captures movements in marginal costs associated with variations in excess demand, the cost-push shock reflects any other factors that might affect expected marginal costs. The supply shock is defined as a shock to the natural-rate of output

knowledge among the very few studies to have theoretically demonstrated so, the robustness of this result needs to be checked in the context of small open economy models. This question is addressed in the next chapter of this thesis.

The second essay extends the analysis developed in the first essay of this thesis to the small open economy case. It addresses the same issues raised in chapter 2 but this time using a richer and more complex framework. In this essay, I also analyze whether my findings from the previous essay survive these important extensions. Because of the added complexity and for practical reasons, I make several changes to the framework. However, despite these changes, I show that my main results from this essay are similar to the previous one. Some of these changes are discussed below and in more detail in the third chapter.

First, because of the added complexity, I do not attempt to solve the model analytically as in Chapter 2. Instead, the model is solved numerically using solution methods as described in Backus and Driffil (1986), Currie and Levine (1993) and Soderlind (1999). Moreover, in this chapter, I take a more general approach and do not evaluate the two fiscal regimes exclusively based on their ability to minimize output volatility but rather on their ability to minimize a weighted sum of the unconditional variance of the output gap and the unconditional variance of the deviations of inflation from its target, assumed to be zero for convenience.[13]

---

[13] The numerical solution methods allow me to experiment with different weights on the output gap and the deviations of inflation from its target

Second, because of what is assumed in the solution algorithm, chapter 3 involves a very different timing regarding when the central bank sets the interest rate. In the second chapter, the interest rate setting rule is optimally derived and it is also assumed that the central bank has to set the interest rate before observing any given shock. On the other hand, in the third chapter, the central bank is assumed to set the interest rate at the same time a shock hits the economy.

Third, in this chapter, the central bank is assumed to target in a flexible manner either inflation or the exchange rate instead of strictly targeting the future price level or future inflation as in chapter 2.[14] Hence, the central bank assigns a non-zero weight to output volatility in its loss function when it is targeting inflation or the exchange rate. However, as argued by Batini and Haldane (1999), although strict future inflation targeting explicitly assumes that the central bank does not put any weight on real output, this does not necessarily mean it does not care about the real side of the economy. They argue that strict future inflation targeting is nevertheless "real output encompassing," since it involves the central bank caring indirectly about real output in the short run.

Fourth, price level targeting is replaced by exchange rate targeting. My findings from chapter 2 indicate that the outcome under price and inflation targeting are almost identical. Since I am already considering inflation targeting, there is no need to consider price level targeting also. Moreover, since exchange rate targeting has gained more attention than price level targeting in the literature in recent years, it is worthwhile examining

---

[14] Results of my simulations indicate that strict targeting is dominated by flexible targeting in most cases or is unstable. This is why I consider only flexible targeting.

how my results (regarding which fiscal regime is preferable) would change if this type of targeting regime is adopted by a central bank.

Fifth, a new aggregate supply specification is introduced in this chapter. In the second chapter, two types of aggregate supply are assumed: one based on the popular model of Calvo (1983) and the other is the so-called P-Bar aggregate supply. However, in this essay, the P-Bar aggregate supply is replaced by the Fuhrer-Moore (1995) aggregate supply. The reasons for this change are simple. In the first essay, I was particularly interested in obtaining analytical results while at the same time having a supply function which has more price stickiness than Calvo's. As a result, the P-Bar supply function was a good choice. However, in this essay, I present numerical results only and do not attempt to derive any analytical results. Consequently, the P-Bar supply function loses some of its appeal. Moreover, since the model is set up on the assumption that the Fuhrer-Moore aggregate supply function is a good way of introducing more price and inflation stickiness into Calvo's (1983) model, there is a lesser need to have both P-Bar and Fuhrer-Moore aggregate supply specifications.

The results from this chapter are very similar to those obtained in the closed economy framework and hence are "isomorphic" to chapter 2. In the open economy framework, at least in the case of a demand shock, I also find that the flexible fiscal regime dominates the rigid fiscal regime when the more backward-looking version of the model is assumed. A similar result is obtained when cost-push and supply shocks are involved. however under these two shocks, the support for the flexible regime is not as overwhelming as in the case involving demand shocks. Several sensitivity tests performed on the parameters of the model indicate that these findings are robust.

Furthermore, as in the second chapter, I find that the results for cases involving the more forward-looking version of the model (replacing the 'textbook' IS by the 'intertemporal' IS function) are quite different. The flexible approach or "Keynes" receives less support in general while the support for the "Hoover" or rigid approach increases.[15] However, my findings for this chapter indicate that the choice of the fiscal regime when the 'intertemporal' IS is involved is less dependent on the aggregate supply.

While my analysis in the closed-economy model supports the rigid fiscal regime especially when a demand shock and the aggregate supply involving more price stickiness are considered (P-Bar), on the other hand, in the open economy framework, my findings are different. I find that even when the supply function involving less price stickiness is involved (Calvo), the rigid fiscal regime receives some support. This fiscal regime does as well as the flexible regime irrespective of the type of aggregate supply involved. As in chapter 2, my results survive many of the sensitivity tests performed on the model.

Several other interesting findings emerge from this essay. Like Clarida, Gali and Gertler (1999), I find that a more conservative central bank is recommended if cost-push shocks are more persistent.[16] My findings also indicate that a conservative central bank is appropriate if demand and supply shocks are very persistent. Hence my findings also sup-

---

[15] In many cases, I find that the rigid approach does as well as the flexible approach for all three shocks. The loss function value is almost the same under both regimes

[16] In my model, this implies that the central bank assigns more weight to inflation in its loss function compared to society.

port those of Walsh (1999b) who obtains a similar result using a "New Neoclassical Synthesis" framework which excludes government and open economy considerations

The intuition behind these findings is simple. The optimal and appropriate response to an adverse and persistent cost-push and/or supply shock in models which embrace the "New Neoclassical Synthesis" is to impart a lot of inertia to interest rates or to leave them high for a long period of time. This is because this type of policy influences agent's future inflation expectations in a favourable way. In these models, since current inflation depends on expected future inflation, if the latter is influenced in a favourable manner, current inflation will also. Since a conservative central bank is more credible than a "liberal" central bank in creating a threat that it will keep interest rates high for a long period of time if a shock occurs, this type of central bank behaviour is recommended if very persistent shocks hit the economy

The third essay continues this shift in emphasis from fiscal to monetary policy This essay is based on these two propositions. First, the goal of price stability can be achieved with exchange-rate targeting, but also with exchange-rate flexibility combined with a monetary policy that targets either the domestic price level or an index of wage rates Hence, the three different monetary regimes do not generate different outcomes concerning long-term inflation. As a result, the choice among these alternative monetary regimes can be made on the basis of which regime delivers the most built-in stability for real output. Second, this essay is based on the belief that changes in aggregate demand are a very important source of disturbance in the economy. Since these shocks can be costly to society, they generate the desire for built-in stability.

Three monetary regimes are compared: price-level targeting, wage-rate targeting and exchange-rate targeting. I also assume that the monetary authority can target any one of these variables in an aggressive fashion or in a more moderate way While price level and exchange-rate targeting have often been considered in the literature, on the other hand, wage-rate targeting is seldom studied.[17] Recent developments in Europe and greater concern about globalization and financial crises have rekindled interest in exchange-rate targeting while support for wage-rate targeting is provided by a generic issue raised by Goodfriend and King (1997). They argue that the appropriate response of the monetary authority in the presence of distortions in the economy (in the third essay, nominal rigidities) is simply to eliminate these frictions. This can be achieved by targeting the current value of the most sticky nominal variable. When the value one must accept for that price is made equal to the value that is desirable for that variable, the fact that it is sticky ceases to be a problem. According to this approach, then, the central bank should target neither the exchange-rate nor the overall price level. Instead, it should target only the component of prices that is most sticky. For the models in chapter 5, this approach requires targeting an index of wage rates. One of my interesting findings is that, contrary to what Goodfriend and King (1997) predict, this is not the best policy in all cases by any means.

Because of the uncertainty surrounding model specifications, I pay particular attention to the question of robustness by performing a variety of sensitivity tests on the model. Hence, I explore how my results survive several important changes in model spec-

[17] Wage-rate targeting would be difficult to implement in practice and this is why it is often ignored

ifications, changes which concern the degree to which agents are forward looking and the degree to which each model is based on explicit optimization.

The issue of robustness is frequently ignored in the literature as most studies focus on finding the best regime using a highly stylized model. However, as indicated by my results and other studies such as Levin, Wieland and Williams (1999), Taylor (1999) and Côté, Kuszczak, Lam, Liu and St-Amant (2002), finding a robust monetary regime which can survive changes in model specifications is probably as important as finding the best monetary regime in a specific model.

All the models in this essay involve model-consistent exchange rate expectations, supply-side effects of exchange rate changes through the existence of intermediate imports, and the possibility of an imperfect pass-through of exchange rate movements on prices. In each model, I examine the implications of alternative monetary policies for both the effect on output of a one-time (unexpected) change in demand and the effect on the amplitude of the business cycle that accompanies an ongoing cycle (anticipated) in demand.

My results from this essay indicate that in all these models, either a price-level or wage-rate targeting can do as well as, or better than exchange rate targeting. However, exchange-rate targeting is often the second best policy while the other two monetary regimes switch between the first and third best ranking. Furthermore, in almost all cases, aggressive targeting should be avoided and the degree of exchange-rate pass through does not qualitatively alter my results. Contrary to what Goodfriend and King (1997) predict, my findings also indicate that targeting the wage-rate is not always the best policy despite the fact that my approach respects their general view concerning the "New Neoclassical Synthesis" and despite the intuitive appeal of their suggestion. Moreover, the results from this essay also indicate that it may be important to distinguish between temporary and ongoing shocks as they can yield qualitatively different results and hence suggest different implications for the conduct of monetary policy.

The conclusion that I draw from this part of my thesis is that it is not only important to find the best monetary regime in any given model but it is also important to check if this regime would perform well in other model specifications. In this essay, although exchange-rate targeting is never the best regime in any of the three models I consider, it is often second best whereas price-level and wage-rate targeting switch between the first and third best ranking. Hence exchange-rate targeting appears to be more robust to model uncertainty compared to the other two targeting regimes and emerges as an appealing compromise.

This thesis is organized as follows. Chapter 2 compares alternative fiscal regimes using a series of closed economy models. Chapter 3 extends the analysis developed in the previous chapter to a small open economy framework. Chapter 4 compares alternative monetary regimes using different open economy models. Finally, Chapter 5 concludes.

Chapter 2

Alternative Public Spending Rules and Output Volatility

1. Introduction

For many years following World War II, macroeconomists have taught students the advice of John Maynard Keynes – that we should use fiscal policy as a mechanism to help balance the economy, not the budget, each year. The idea is to run budget deficits during years when actual output is less than the natural rate and budget surpluses when output exceeds the natural rate. It is thought that this countercyclical policy can be pursued – without causing an explosion in the debt-to-GDP ratio – as long as the natural rate of output is measured in such a way that we witness "overheated" periods about as often as we do periods of "excess capacity."

This strategy has been hailed as one of the truly central and important lessons that we have learned from the Great Depression. At that time, unbalanced annual budgets were assumed to be evidence of irresponsible policy. But since then we have come to think that it is the fixation with annual balanced-budget targets that represents the irresponsible approach. After all, if private demand falls – lowering overall output and therefore tax revenue -- cutting government spending further reduces demand and therefore magnifies the size of the initial recession. The Keynesian message is that the budget should be balanced over the duration of a full business cycle -- not in each and every year.

In the 1970s and 80s, many countries ignored Keynes' advice and started to run budget deficits even in periods of boom. As a result, they witnessed an explosion in their debt-to-GDP ratio during that period and support for anything resembling the Keynesian approach waned. Faced with increasing political pressures, many countries introduced rigid annual budget targets and even balanced-budget laws to restore fiscal discipline and credibility. Moreover, greater concern about the impact of the ageing baby boomers on government finances also pushed many governments to adopt rigid annual budget targets.[1] In many countries the budget had to be balanced "come hell or high water".

Despite increasing tolerance of the public for fiscal austerity and discipline, there is also at the same time, a growing concern that a policy of rigid annual budget targets or balanced budgets can hamper the operation of fiscal automatic stabilizers and hence be destabilizing for the economy, at least in the short-run. However, while this is true in general in the short-run, running a flexible fiscal policy can nevertheless prolong the effects of an adverse shock and hence delay and weaken any eventual recovery. This is because under a flexible fiscal regime, by issuing more bonds during a downturn (to finance temporary deficits), the government creates an obligation to work down the debt-to-GDP ratio in the future. Hence while a flexible fiscal policy can initially reduce the size of a recession, it can make it last longer. In particular, shocks can involve increased persistence when the Keynesian approach is followed. On the other hand, although the impact effect of a negative shock can be bigger under a rigid fiscal regime (since it impedes on the built-

[1] The borrowing pattern of many governments was also seen as unsustainable by financial markets There is evidence that government borrowing costs rise at an increasing rate once the debt-to-GDP ratio is above a certain threshold and that capital markets begin to ration credit to governments at high level of debt-to-GDP ratio. See Goldstein and Woglom (1992)

in stabilizers), this policy avoids the destabilizing part of a bond-financed deficit. As a result of this trade-off between the impact and the "long-run" effect, a rigid fiscal policy can be *more stabilizing* for output.

These issues are examined in this essay by using a series of small macro models which are similar in spirit to other models which are extensively used to analyse issues related to monetary policy and which have been described by Goodfriend and King (1997) as representing the "New Neoclassical Synthesis" and by Clarida, Gali and Gertler (1999) as the "new science of monetary policy". To make the comparison between these two fiscal policy regimes stark, I investigate two polar cases. Under the flexible fiscal regime or the Keynesian approach, both taxes and program spending are held constant forever (as proportions of GDP) at levels that would balance the budget if it were not for the stochastic shocks and the model's short-run dynamic features. This fiscal set up ensures that there is no long-run trend in the debt-to-GDP ratio and that the temporary budget deficits are financed entirely by short-run variations in the quantity of government bonds outstanding. Macroeconomic instability in this model is avoided since it is assumed that the underlying (exogenously determined) trend growth rate in real output exceeds the after-tax real interest rate paid on government bonds.

The other polar case I analyse is the rigid fiscal regime or the "Hoover" approach. In this case, the budget is balanced at every instant, so the bond stock never changes – even in the short run. The government allows the level of program spending to vary by whatever it takes to meet this rigid balanced-budget rule. One might argue that my comparison involves a "straw man," since this second case involves more rigidity than what is typically contemplated in actual economies. For example, the fiscal rule passed by legislatures is often limited to a stipulation that the government never incur a deficit. Such a rule can be obeyed, with fiscal policy still playing what is intended to be a stabilizing role, if the government runs a surplus on average (with a higher surplus during booms and a lower surplus in recessions). Such a strategy is not likely to be observed however, since an ongoing budget surplus implies a negative government debt in the steady state. In any event, by relying on the strong polar case (thereby "stacking the cards" against the non-Keynesian option), I have made it all the more interesting that lower output volatility emerges in the "Hoover" case. (This result means that when "Hoover" is supported, any intermediate approach is also recommended over the Keynesian alternative.)

I have already offered some intuition in my introductory chapter to explain why a rigid approach to fiscal policy can be more stabilizing for output. However, since this counter-conventional result is key to understanding the intuition behind my findings, I remind the reader of these issues here. The models studied in this and the subsequent chapter involve two features that are often ignored. First, the accumulation identity for government debt is involved, but only when the Keynesian regime is in operation – that is, when the budget is *not* balanced at every point in time. The addition of this dynamic relationship makes the speed of adjustment in the overall economy slower. This is because, by issuing more bonds during downturns (to finance temporary deficits), a government with a fixed long-run debt-ratio target creates an obligation to work the debt ratio back down later on. This propagation mechanism is missing with continuously balanced budgets. As a result, shocks can involve more persistence when the Keynesian approach is followed.

Thus, while a flexible fiscal regime can reduce the size of a recession initially, it can make it last longer. With forward-looking behaviour in the determination of both private demand and price-setting behaviour, the negative dimension of this dynamic trade-off is accentuated. This is why counter-conventional results are more likely in a micro-based setting.

The second feature in my models that raises the probability that a rigid annual balanced-budget approach can be superior involves the interaction between fiscal and monetary policy. Monetary policy is modeled by deriving the interest-rate setting rule that is appropriate for meeting the central bank's goal -- taking the rest of the macro model as the bank's constraint. Since the operation of fiscal policy is part of the system, monetary policy adjusts when the fiscal regime changes.[2] The central bank's *objective* -- assumed here to be either an expected future inflation rate or an expected price level target of zero -- is *independent* of changes in the fiscal regime. But given this, the central bank's period-by-period decision rule *is dependent* on the fiscal regime. In particular, since a more rigid fiscal policy avoids the longer-term slower-adjustment-speed feature of bond-financed deficits, the central bank finds it appropriate to react less aggressively to short-term developments in the economy. As a result, output can be less volatile under a rigid fiscal regime.[3] Traditional analyses of government spending rules have not allowed for such an endogenous reaction of monetary policy. Again, forward-looking agents with model-consistent expectations can magnify the importance of this adjustment in monetary policy.

---

[2] This addresses to some extent the Lucas critique since the reaction function of the central bank changes when the fiscal regime changes

[3] See section 4.3 of this chapter.

This chapter is organized as follows. Section 2 provides a review of the literature on the effects of alternative fiscal regimes on output volatility. Section 3 presents the different models. My results are discussed in Section 4. Section 5 finally concludes.

2. Literature Review

In recent years, many countries have used monetary policy as their main stabilization tool. Consequently, fiscal policy has been relegated to a less important role This may explain why research on issues related to monetary policy (especially research on monetary policy rules) using models consisting of optimizing agents and slow adjusting prices has exploded in recent years (see for example Kerr and King (1996), Batini and Haldane (1999), Clarida, Gali and Gertler (1999, 2001), McCallum and Nelson (1999b, 2000), Rudebusch and Svensson (1999), King (2000), Svensson (1999a, 1999b, 2000), Walsh (2000, 2001) and Jensen (2002)). Surprisingly, within this growing literature, there is a consensus among researchers about the type of model used to analyse various issues related to monetary policy. The common framework, which is derived from microfoundations, emphasizes forward looking behaviour on the part of agents and incorporates nominal rigidities. This framework represents the new paradigm in macro/monetary economics and has been labeled the "New Neoclassical Synthesis" by Goodfriend and King (1997).

This new paradigm retains much of the empirical applicability appeal of the traditional expectations-augmented IS-curve/Phillips-curve structure, yet it has the added advantage of being more thoroughly grounded in dynamic general equilibrium theory. However, King (2000), who has been among the pioneers of this new approach, has warned that given the compact nature of this new generation of IS-curve/Phillips-curve models, it may still be prudent to restrict their use to illustrating already-known results, rather than using them to derive new results. Nevertheless, many researchers (such as Clarida, Galì and Gertler (1999, 2001), McCallum and Nelson (1999b), Woodford (1999), Svensson (2000), Walsh (1999b, 2001) and Jensen (2002)) disagree, arguing that the new generation of compact macro models involves structural, not reduced-form, relationships For this reason, I feel comfortable investigating the "Hoover"-vs-"Keynes" question within this framework.

To analyse the various issues raised in the previous section, I use several models which retain much of the "New Neoclassical Synthesis" paradigm but where fiscal policy plays a major role. This new paradigm has in most parts ignored fiscal policy or has remained largely silent on the role and importance of fiscal policy or public spending rules. As a result, within this new framework, there has been practically no theoretical work on the implications of balanced-budgets or alternative fiscal regimes on output volatility.[4] However, there have been several empirical studies which have analysed the

[4] With the advent of the EMU, there has been a renewed interest on the interplay between monetary and fiscal policy, particularly issues related to the Stability Growth Pact. These studies (for example Chari and Kehoe (1998), Beetsma and Uhlig (1999),Cooper and Kempf (2000)) however do not look at the impact of alternative fiscal regimes on output stability but rather at the interaction between monetary and fiscal policy, in particular the rationale for having fiscal constraints in a monetary union. The strategic interaction between monetary and fiscal policy has also been analysed within the context of the fiscal theory of the price level (FTPL). According to the FTPL, "good" monetary policy has to go in hand with "good" fiscal policy to avoid nominal instability. My analysis departs from many of these issues since I assume that there is no "game of chicken" between fiscal and monetary policy The main focus of this paper is on output stabilization and hence it avoids many of the issues related to the strategic interaction between fiscal and monetary policy

impact of alternative fiscal regimes on output volatility and these studies are related to the work presented in this and subsequent chapter.

Recent empirical research on alternative fiscal regimes has focused on three main issues: whether rigid fiscal rules can effectively deliver better budget outcomes and hence enforce greater fiscal discipline, whether fiscal restraints can reduce government borrowing rates because financial markets view government borrowing as less risky and whether a rigid fiscal policy increases output volatility since it hampers the operations of built-in stabilizers. My review of the literature focuses essentially on the latter and discusses some of the studies which have analysed the impact of alternative fiscal regimes on output volatility.

There is ample evidence in the literature that more strict budget rules deliver better budget outcomes or improve fiscal behaviour. For example, Poterba (1997) presents evidence on how limits on annual discretionary spending contained in the 1990 Budget Enforcement Act have led to a fall of discretionary spending in the United States and have thus produced better fiscal outcomes. Similar findings are obtained by Bohn and Inman (1996) who also argue that more stringent fiscal rules improve fiscal behaviour. They find that policies which prevent governments from "carrying over" their deficits are the most effective ones and that U.S states which are not allowed to carry over their deficits have in general bigger long-run surpluses. Evidence on how rigid budget rules improve fiscal behaviour is also provided by Alesina and Perroti (1996).

Many studies have also shown that more fiscal discipline reduces government borrowing rates. For example, Goldstein and Woglom (1992) and Bayoumi, Goldstein and

Woglom (1995) find that U.S states with more stringent fiscal regimes experience a lower cost of borrowing. Similar findings are also obtained by Bayoumi and Eichengreen (1994) who argue that for average level of debt-to-GDP ratio, the introduction of spending limits can reduce borrowing costs by as much as 50 basis points. Evidence for Canada (only three provinces are considered) is provided by Mattina and Delorme (1996) who show that higher debt-to-GDP ratio leads to a bigger yield spread.[5]

The efficacy of built-in stabilizers in small and structural models has been examined by numerous studies. For example, Gorbet and Helliwell (1971), Blinder and Solow (1973, 1976), Smyth (1974), McCallum and Whitaker (1979), Christiano (1984), DeLong and Summers (1986), Scarth (1988), Hairault, Henin, Portier (1997), Cohen and Folette (1999), van der Noord (2000) and Fatas and Mihov (2002) have looked at the importance and role of built-in stabilizers in smoothing business cycles fluctuations. Most of these studies conclude that automatic stabilizers are important for smoothing output especially in the short-run. The work of Cohen and Folette (1999) in this regard is particularly interesting. Using the FRB/US model of the Federal Reserve Board, they not only show that automatic stabilizers affect output but they also raise numerous other issues. For example, they argue that automatic stabilizers have different effects on output depending on the type of shock hitting the economy. According to Cohen and Folette (1999), automatic stabilizers tend to stabilize the economy when demand shocks occurs but can hinder the adjustment process when supply shocks occurs.[6]

---

[5] They assume that the yield spread is an indicator of the default risk. The bigger the spread the bigger the risk of default.

There have been also few studies (especially theoretical) in the literature which have examined the effects of alternative fiscal regimes on output volatility. Most studies which have looked at this issue are empirical and have been limited to the study of the effects of alternative fiscal spending regimes on output volatility in U.S states. In general, evidence in favour of the conventional view - that a flexible fiscal regime reduces output volatility - has been mixed, although one might argue that present evidence favours a flexible fiscal regime. Some of these empirical work is discussed below.

Bayoumi and Eichengreen (1995), using data from selected OECD member countries and from various U.S. states, analyse whether the existence of more stringent fiscal constraints (which limits the responsiveness of fiscal stabilizers) increases output volatility. Using data from various U.S states, they show that more fiscal restraints, by making government expenditure less responsive to changes in income, can significantly increase output volatility. They obtain these results by proceeding in two stages. First, using data from 1971-1992 for U.S states, they show that fiscal controls reduce the cyclical variability of the fiscal balance by around 40%.[7] Second, they use the U.S block of IMF's MULTIMOD model and perform simulations to analyse how a 40% reduction in the cyclical variability of the fiscal balance affects output. Their simulations indicate that changes of such magnitude in the variability of fiscal balances increase output volatility by around 20%.[8] On the basis of these results, they conclude that more stringent fiscal constraints

[6] They argue that it may be worth thinking about what type of automatic stabilizers work well with supply shocks.

[7] Using data from the OECD member countries, they obtained similar results.

[8] They also argue in their paper that limited experiments with models of other countries give similar results.

unambiguously increase output volatility. They obtain similar results when data from several OECD countries is used. In this case also, they find that a move towards a more stringent fiscal policy, increases output volatility.

However using data from roughly the same period, Alesina and Bayoumi (1996) obtain radically different results. They argue that although balanced-budget rules help to enforce fiscal discipline, they do not lead to any increase in output variability. To analyse the impact of balanced-budget rules on output stability, they use data on U.S states from 1965-1992 and regress the variability of state output on the standard deviation of the change in state surplus, the average level of gross state product level, the percentage of state product from mining and on a dummy variable for southern states. They show that there is no evidence that more stringent budget rules have led to an increase in output volatility. To explain their findings, they argue that although more rigid fiscal rules lead to more fiscal discipline, they do not entail a higher output volatility because the stabilizing role of fiscal policy at the state level is not very important and hence the choice of fiscal policy does not matter at this level. They do acknowledge however that at the national level, more stringent fiscal rules may have a significant impact on output stabilization.

Since these two studies use very similar data set, data period and obtain very different results, this deserves some explanation. Bayoumi and Eichengreen's (1995) results depend heavily on the IMF's MULTIMOD model. Hence, it may be possible that their results are model specific and would be sensitive to changes in model specifications. However, as argued in their paper, they obtain similar results when different versions of the model are used and this may be evidence that their results are in fact robust. On the other hand, as pointed out by Levinson (1998), since Alesina and Bayoumi (1996) do not control for unobserved state characteristics, they implicitly assume that fiscal policy has the same impact in small and large states and this may be the reason why their results are different from those of Bayoumi and Eichengreen (1995). Levinson (1998) argues that if state characteristics are taken into consideration, Alesina and Bayoumi's (1996) results may be overturned. He argues that while it is not directly apparent that on average, states with stricter budget rules have experienced higher output volatility; however, among states where fiscal policy matters the most, (large states in his study), output volatility has been higher. According to Levinson (1998), if state characteristics are taken into consideration, (he considers mostly large states) states with more strict budget rules have experienced higher output volatility compared to states which have more flexible fiscal regimes. For this reason, he argues that strict annual budget targets amplify output shocks and increase output volatility.

Support for flexible fiscal policy regimes is also provided by Weise (1996) who uses a VAR model of the U.S. economy and finds that a countercyclical fiscal policy (and monetary policy) has played an important role in output stabilization. In his model, the monetary reaction function is assumed to be invariant to changes in the fiscal policy reaction function. This is not a very interesting assumption as we know from the Lucas critique that the reaction function of the monetary authority is likely to change following a change in the fiscal regime. It is very likely that a move towards more fiscal discipline, by inducing the monetary authority to change its reaction function, can be more stabilizing for output. As a result, a more rigid fiscal regime may not necessarily imply a bigger output volatility. Hence, Weise's (1996) results may be very different if this endogeneity of monetary policy is allowed. This issue is very important when considering alternative fiscal regimes and is often ignored by many studies. Future studies analyzing this issue have to take into consideration the endogenous response of monetary policy when fiscal policy changes.

Using anecdotal evidence, Taylor (2000) argues that monetary policy-making has been easier in many countries in the last ten years because fiscal policy has been implemented in a systematic fashion (in the sense of a rule). According to Taylor (2000), this may partly explain why monetary policy has been so successful in keeping inflation low and output near potential for the last ten years in the United States. Based on this evidence, he argues that using a countercyclical fiscal policy does not necessarily reduce output volatility but rather introduces more uncertainty in the monetary policy making process and hence makes the latter more difficult to implement. He concludes that given the success of monetary policy, fiscal policy should be more systematic and should only be used for long term goals.[9] This interaction between monetary and fiscal policy has been largely ignored in the literature. If a rigid fiscal policy can reduce the uncertainty surrounding the conduct of monetary policy, thus making monetary policy-making easier, it is not surprising why in the 1990s, output volatility has been relatively low despite fiscal policy being rigid in many countries.

---

[9] His results imply that fiscal policy should not react to surprises even when governments are operating under a flexible regime.

Some of the issues raised by Taylor (2000) are also discussed in Canzeroni and Diba (1996). They argue that if a government is perceived as accumulating excessive debt by financial markets, this can jeopardize the central bank's ability to achieve its long-run price stability goal and hence impact on output stability. According to Canzeroni and Diba (1996), if the fiscal authority can credibly satisfy the intertemporal budget constraint, a "dominant monetary regime" will prevail and the central bank will have full control of the price level. On the other hand, if the fiscal authority is not viewed as being able to satisfy its intertemporal budget constraint, the price level may have to rise to deflate the real value of nominal debt. In that case, price stability may be beyond the control of the monetary authority. Since it is more likely that the intertemporal budget constraint will be satisfied under a rigid fiscal regime than under a flexible regime, monetary policy may be easier to conduct under a rigid fiscal regime.[10] Hence these findings are similar to the anecdotal evidence presented by Taylor (2000). A rigid fiscal regime makes it easier for policymakers to implement monetary policy and this in turn result in a better control over output and inflation.

The above paper is also closely linked to the literature on the fiscal theory of the price level (FTPL). According to the FTPL, an independent central bank is not sufficient to guarantee price stability: sound monetary policy must be coupled with a good fiscal policy. Many papers which have examined this issue conclude that sound monetary policy

---

[10] A similar finding can be found in Dixit and Lambertini (2001) who argue that fiscal discretion "destroys monetary commitment". For this reason, fiscal discipline may be justified.

may not be the only requirement for price stability. The choice of fiscal policy is also very important for nominal stability.[11]

Empirical evidence on the implications of alternative fiscal regimes on output stability has been mixed although evidence tends to favour flexible fiscal regimes. My work on alternative fiscal regimes although theoretical sheds light on many of the issues raised above. It also demonstrates theoretically, using a series of alternative models, that a move towards rigid fiscal rules can decrease output volatility. However, since my findings fill only a small gap in this literature, it motivates further research on this topic.

3. The Macro Models

The structure of the macroeconomic models I use in this chapter is explained in this section. It is to be noted that these models are limited in several ways. They concern closed economies and stochastic shocks are modeled in a fairly rudimentary fashion. Nevertheless, expectations are rational, reasonable microeconomic foundations have been provided and models of this sort now represent the mainstream framework for analytical work on stabilization policy. The models are defined by twelve equations, and the notation is explained immediately following the list of equations.

$$Y_t = A - \Omega(1-\tau)[(i_t - [E_t(p_{t+1} - p_t)]) - \bar{r}] + \psi G_t + \lambda B_{t-1} + u_t \quad (1a)$$

$$Y_t = E_t(Y_{t+1}) - \Omega(1-\tau)[(i_t - [E_t(p_{t-1} - p_t)]) - \bar{r}] + [G_t - E_t(G_{t+1})] + u_t \quad (1b)$$

[11] For a review on the FTPL, see Christiano and Fitzgerald (2000). See also Schmitt-Grohé and Uribe (2000) who analyse the implications for price level determination when a balanced -budget rule is combined with three different monetary regimes. Their main conclusion is that given the monetary regime, balanced-budget rules may have important consequences for nominal stability.

$$p_t - p_{t-1} = \theta(Y_{t-1} - \overline{Y}_{t-1}) + (E_{t-1}(\bar{p}_t) - \bar{p}_{t-1}) + v_t \quad (2a)$$

$$p_t - p_{t-1} = \theta(Y_t - \overline{Y}_t) + (E_t(p_{t+1}) - p_t) + v_t \quad (2b)$$

$$E_{t-1}(p_{t+1} - p_t) = 0 \quad (3a)$$

$$E_{t-1}(p_t) = 0 \quad (3b)$$

$$G_t = \delta\tau Y_t + (1-\delta)\overline{G} - (\delta(1-\tau))B_{t-1} \quad (4)$$

$$B_t = \bar{r}(1-\delta)(G_t - \tau Y_t) + [1 + (1-\delta)(\bar{r}(1-\tau) - \phi)]B_{t-1} \quad (5)$$

$$\overline{Y}_t = (1 + x_t) \quad (6)$$

$$u_t = \rho u_{t-1} + \varepsilon_t \quad (7a)$$

$$v_t = \eta v_{t-1} + \xi_t \quad (7b)$$

$$x_t = \gamma x_{t-1} + \alpha_t \quad (7c)$$

The variables are:

B stock of indexed government bonds outstanding at the end of each period, measured as a proportion of trend GDP, $z_t = (1+\phi)z_{t-1}$. Since each bond is a promise to pay one unit of purchasing power per year, B also denotes real interest payments on the debt (measured as a proportion of trend GDP)

E expectations operator, based on information available at the point in time denoted by the time subscript

G government spending on goods and services, measured as a proportion of trend GDP, $z_t = (1+\phi)z_{t-1}$

ϕ long-run growth rate

τ proportional income tax rate

t time subscript

δ index of fiscal regime. A flexible (rigid) regime is obtained when $\delta = 0$ ($\delta = 1$)

p logarithm of the price level. The first difference of p is the inflation rate; $\bar{p}$ is (the logarithm of) the equilibrium price level – that level of price which would make output equal the natural rate at that point in time

i nominal interest rate. ($\bar{i}$ and $\bar{r}$ are respectively the equilibrium nominal and real interest rate)

u, v, x stochastic demand and supply shocks: the ε, ξ and α parts have zero means, constant variances, no serial correlation, and zero covariance

Y real output, measured as a proportion of trend GDP, $z_t = (1 + \phi)z_{t-1}$

$\bar{Y}$ the natural rate – the level of real output that is sustainable in full equilibrium (measured as a proportion of trend GDP)

All the slope coefficients (the Greek letters) are assumed to be positive; ϕ, ρ, η and γ lie between zero and one. The structure of each equation is now explained.

Equation (1a) and (1b) are IS relationships. Equation (1a) is a so-called "textbook" or "old" IS function. Aggregate demand depends inversely on the real interest rate, implying that higher real interest rate depresses spending by household and firms. Moreover, output depends positively on government spending on goods and on interest payments households receive on the stock of bonds they possess at the beginning of each period. This last effect means that with this equation, the model does not impose pure Ricardian equivalence which would imply $\lambda = 0$. However, it can be shown that λ drops out of the reduced-form equation for real output (see equation (15)), so this controversy turns out not to be relevant here. Finally, u_t is interpreted as a stochastic demand shock.

Since this "textbook IS" equation does not have very strong theoretical justification, McCallum (1995), Kerr and King (1996) and McCallum and Nelson (1999b) have argued that the traditional IS relationship should be replaced by a more forward looking "expectational" or "intertemporal IS" relation which under reasonable conditions is implied by dynamic optimizing behaviour. This equation is given by (1b).

Equation (1b) is thus another IS equation which I will use to test the sensitivity of my results. This "expectational" or "intertemporal IS" has now become standard in this literature and has to a large extent replaced the "textbook IS". It is optimally derived and embodies an explicit theory of household behaviour – the Ramsey (1928) consumption function:

$$E_t(C_{t+1}) - C_t = \Omega(1-\tau)[(i_t - [E_t(p_{t+1} - p_t)]) - \bar{r}] \tag{8}$$

If the rate of time preference of the representative agent is β (which makes the full-equilibrium pre-tax interest rate, $\bar{r}$, equal $\frac{\beta}{(1-\tau)}$) and the instantaneous utility function involved in the intertemporal optimization is $[\ln C + \omega \ln G - \sigma N^2]$, this equation is a linear approximation of the appropriate first-order condition as long as Ω is interpreted as the mean value of consumption.[12]

If the production side of the economy is ignored (that is, if we consider an endow-

[12] This utility function could be easily replaced by the more commonly used CES specification If such is the case, Ω would be interpreted as the interest sensitivity of consumption. Although I attempt to perform a wide variety of sensitivity tests on my model and since I want to limit the amount of these tests to a reasonable number, I leave this change for future work.

ment economy, as in McCallum and Nelson (1999b) and Kerr and King (1996)) this consumption function can be combined with the standard resource constraint given below[13]

$$Y_t = C_t + G_t \tag{9}$$

Equation (1b) is then obtained by combining equation (7a) and (8) and the forward first difference of equation (9). The latter is given by equation (10) below:

$$E_t(Y_{t+1}) - Y_t = [E_t(C_{t+1}) - C_t] + [E_t(G_{t+1}) - G_t] \tag{10}$$

Substituting equation (8) into equation (10) above, I get equation (11) below (after some simplification)

$$E_t(Y_{t+1}) - Y_t = \Omega(1-\tau)[(i_t - [E_t(p_{t+1} - p_t)]) - \bar{r}] + E_t(G_{t+1}) - G_t \tag{11}$$

Equation (1b) is obtained by rearranging the above equation and adding an error term u_t which is interpreted as a demand shock.

Since agents are infinitely lived in this model, Ricardian equivalence holds perfectly and bonds do not appear in this equation. Equation (1b) shows that in addition to a demand shock, aggregate demand depends inversely on the real rate of interest and positively on both expected future output and the expected change in government spending on goods. As this equation imposes a unit coefficient on the expected output term, any expected change in output will change actual output by the same amount.

The "intertemporal IS" shares some similarities with the "textbook IS" but there are nevertheless important differences. For example, in the "intertemporal IS" equation, expected future output plays a very important role in the determination of current output

[13] I assume that the capital stock is fixed and investment is exogenous

whereas there is no such term in the "textbook IS" equation. Although this equation is implied by optimizing dynamic behaviour and is thus attractive on theoretical grounds, however, it has an important shortcoming.

As this relationship is completely forward looking, it does not impart any inertia on output. Consequently, impulse response functions for output from this equation do not display the hump-shaped response which is usually observed from the data or when VAR models are simulated. This is why, on empirical grounds, the lagged value of output is often included in this equation.[14] Including the lagged output term in equation (1b) can be important if one is concerned about the empirical performance of the model. However, if one is analyzing specific theoretical issues and/or is not primarily concerned about how closely the model match business cycles data (such as in this chapter), the lagged output term can be ignored.[15]

Equation (2a) defines the first of two models of aggregate supply. This type of supply function is often referred to as the P-Bar supply function and microfoundations for this equation have been provided by Mussa (1981) and McCallum (1980, 1994). In full equilibrium, output equals the natural rate, while in any one period output is demand-determined since the price of goods is predetermined. Prices adjust through time by an amount equal to the expected change in the equilibrium price level, the lagged output gap and a cost-push shock. In this model, the current cost-push shocks are the only things that keep

---

[14] The inclusion of the lagged output term in equation (1b) can be rationalized and justified by habit formation or by the presence of rule-of-thumb consumers. See for example Fuhrer (1998) and Amato and Laubach (2001).

[15] I experimented with a lagged output term in the IS equation. This did not have any qualitative effect on my results.

prices from being entirely pre-determined at each point in time.

This model involves two appealing properties (from a New Keynesian perspective); prices are predetermined at each point in time (in the face of demand shocks) and the natural-rate hypothesis is fully respected. However, this supply function has two main weaknesses. It is not forward-looking and does not fit the data very well since it generates considerably less persistence in inflation compared to what is typically observed in the data.[16]

Equation (2b) is my alternative supply function which is preferred by many modern business-cycle analysts. I refer to this supply function as Calvo aggregate supply. By including equation (2b) for part of my study, I ensure that my analysis embraces the paradigm which Goodfriend and King (1997) have dubbed the "New Neoclassical Synthesis" and which is favoured by Clarida, Galì and Gertler (1999) in their survey and by many others. Roberts (1995) has labeled equation (2b) the "New Keynesian Phillips Curve" and he has shown that it is observationally equivalent to Rotemberg's (1987) quadratic cost-of-adjustment model and to Calvo's (1983) model of sticky prices.[17]

This specification involves forward-looking agents and multi-period overlapping contracts. I assume for simplification that there is no discount factor (so that the coefficient on expected future inflation is unity, as in Roberts (1995)). In this alternative formulation, prices are somewhat less sticky (compared to equation (2a)); the current (not the lagged) output gap is involved, and the current expectation of future inflation (not the

[16] See Fuhrer and Moore (1995) for more details.

[17] See Yun (1996), Rotemberg and Woodford (1998, 1999) and Walsh (1999, page 218) for a derivation. Appendix II presents a compact version of the derivation of equation (2b).

lagged anticipation of the current "core" inflation) is involved. As in the P-Bar supply function, the term v_t is interpreted as a cost-push shock and is assumed to follow an AR(1) process.[18]

The Calvo supply function is usually criticized on two grounds. First, in the absence of serially correlated errors, it displays very little persistence in inflation and hence cannot account for the inertia in inflation that appears in the data. To correct for this shortcoming, the error term is assumed to be serially correlated. Second, it does not satisfy the strict version of the natural rate hypothesis which postulates that monetary policy cannot keep output above its potential permanently. However, since I assume that the coefficient on future inflation is one, the deviations from the strict natural rate hypothesis will be negligible and hence this criticism can be ignored.

In Calvo's (1983) model, each firm faces a constant probability of not being able to adjust its price in every period. This probability is assumed to be state-independent (this makes aggregation easier) and determines the degree of price stickiness in the model. For example if the probability that a firm can change its price in a given quarter is 0.25, then prices will remain fixed on average for about a year.[19] Thus, in Calvo's model, current aggregate prices are a function of past period's prices as some firms cannot adjust their prices but also of expected future prices as firms know that there is a probability that they may not be able to change their prices for a given number of periods. Calvo's (1983) model is usually completed by assuming that real marginal cost is positively related to the

---

[18] It may also reflect systematic pricing errors as suggested by King (2000).

[19] If s is the probability that a firm is able to change its price in a given quarter, then prices will remain fixed on average for 1/s.

output gap and hence can be proxied by the latter. This step has been labeled as "heroic" by King (2000, pages 62-63). However, as shown in Appendix II, this step is not so "heroic" after all as the relationship between real marginal cost and the output gap can be easily derived using a simple model where capital is assumed to be fixed. The parameter θ which is a function of the probability of firms adjusting prices, is interpreted as the slope of the Phillips curve.

Monetary policy is defined by equation (3a) and (3b). The central bank is assumed to be either a price level targeter or a future inflation targeter. In this essay, I do not compare price level targeting to inflation targeting but rather investigate the robustness of my results when the monetary regime is allowed to change.[20] Since price level targeting is not a common central bank practice, and since the results are almost the same under both monetary regimes, I will report the results pertaining to inflation targeting only.[21] Equation (3a) involves the common approach – that the central bank targets the expected *future* inflation *rate*. In this case, the central bank strictly targets future inflation (price level). At each point in time, the central bank sets the nominal interest rate to ensure that, at least expectationally, the zero future inflation (price level) target is met.

Although strict inflation targeting explicitly assumes that the central bank does not put any weight on real output, Batini and Haldane (1999) have argued that this approach is nevertheless "real output encompassing," since it involves the central bank caring indi-

[20] For more on this issue, see for example Lebow, Roberts and Stockton (1992), Kiley (1998), Dittmar, Gavin and Kydland (1999), Svensson (1999b) and Vestin (2000).

[21] The results are qualitatively the same under price level targeting and inflation targeting when the P-Bar supply function is used and very similar when the Calvo supply function is used.

rectly about real output in the short run For example, in my specification, I assume that the central bank adjusts interest rates so that inflation at least expectationally in the next two periods will be zero. The longer this horizon, the smoother is the path of real output. If the central bank did not care at all about output, the horizon within which it would seek to return inflation to zero will likely be shorter. The fact that the central bank allows inflation not to return to its target immediately, implies that such policy in indeed "output encompassing".

Fiscal policy is defined by equations (4) and (5). Since the tax rate is constant, the polar extreme options for the government are as explained in the previous section. The government must either adjust its level of spending at each point in time to preclude a budget deficit or surplus from ever emerging, or it must run a deficit or surplus and let the amount of bonds outstanding adjust accordingly. I refer to the first option as the "Hoover" or rigid approach since it involves a specific annual deficit target (in this case zero) that is met no matter what. I refer to the second case as the "Keynes" or flexible approach, since it is the policy recommended by conventional Keynesian analysis. Equations (4) and (5) are nested equations of these two extremes and they are explained below.

As just noted, under "Hoover", government spending always adjusts so that the budget is balanced at each point in time:

$$G_t = \tau Y_t - (1 - \tau)B_{t-1} \tag{4a}$$

and since under this fiscal regime, the bond stock never changes, I have the following equation for the bond stock:

$$B_t - B_{t-1} = \Delta B_t = 0 \tag{5a}$$

A "flexible" fiscal policy is feasible in this setting only if the long-run average growth rate, ϕ, exceeds the after-tax real interest rate. I assume that this condition is met, so that the two polar extremes for fiscal policy can be compared. Thus, the "flexible" option is one in which government spending is kept constant at:

$$G_t = \overline{G} \tag{4b}$$

and the stock of bonds changes each period by an amount that precisely equals the budget deficit:

$$B_t - B_{t-1} = \bar{r}[G_t + (1 - \tau - \phi)B_{t-1} - \tau Y_t] \tag{5b}$$

This last relationship is a linear approximation of the nonlinear government financing identity: $\Delta B(1/r)$ = current deficit, with the linear approximation taken at full-equilibrium values. ($\bar{r}$ is the full-equilibrium interest rate).

In specifying equations (4a), (4b), (5a) and (5b), I have assumed that the fiscal authority has access to the same information as do private agents when making their expenditure decisions. Equations (4) and (5) represent weighted averages of the two G and B equations respectively. For example if equations (4a) and (4b) are combined, equation (4) emerges and the flexible (rigid) approach is obtained if $\delta = 0$ ($\delta = 1$). Similarly, when equations (5a) and (5b) are combined, equation (5) is obtained and the two polar cases can be examined by varying the value of δ from 0 to 1. Hence the flexible regime is obtained when $\delta = 0$ while the rigid regime is obtained by setting $\delta = 1$.

Equation (6) describes full-employment output, which without the stochastic shock x_t would be constant at full-employment level (which is normalized to be equal to one). The shock term x_t is interpreted here as a supply shock. Finally, equations (7a), (7b) and (7c) are respectively the stochastic demand, cost-push and supply shocks.[22] I assume that all the different stochastic innovations, ε_t, ξ_t and α_t have zero mean and are uncorrelated with each other at all leads and lags.

4. Results

In this section, I present my results by considering various models and shocks. It is to be noted that throughout my analysis, the central bank is assumed to target future inflation.[23] Whenever possible, I derive analytically the unconditional variances for output and compare the two fiscal regimes on the basis of this information. However, since analytical solutions are so complicated and cannot be derived in some cases, I resort to numerical methods to present my results. Some intuition for my findings are offered in section 4.6.

4.1 Methodology

To examine the built-in stability implications of alternative fiscal policy rules (changing δ from 0 to 1), I must first derive the solution equation for the variance of real output. To do so, I use the undetermined coefficients solution method. Three trial solutions are assumed: that current output, current price, and the end-of-period bond stock are

---

[22] Since the output gap captures movements in marginal costs associated with variations in excess demand, the cost-push shock reflects any other factors that might affect expected marginal costs The supply shock is defined as a shock to the natural-rate of output

[23] The results involving price level targeting are either qualitatively and/or quantitatively similar in most cases.

linear functions of the previous values of Y, p, u, v, B and x, the three current white-noise error terms, and a constant.

The three trial solutions are given by the following equations below:

$$Y_t = a_0 + a_1 Y_{t-1} + a_2 p_{t-1} + a_3 u_{t-1} + a_4 v_{t-1} + a_5 \varepsilon_t + a_6 \xi_t$$

$$+ a_7 B_{t-1} + a_8 x_{t-1} + a_9 \alpha_t \quad (12a)$$

$$p_t = b_0 + b_1 Y_{t-1} + b_2 p_{t-1} + b_3 u_{t-1} + b_4 v_{t-1} + b_5 \varepsilon_t + b_6 \xi_t$$

$$+ b_7 B_{t-1} + b_8 x_{t-1} + b_9 \alpha_t \quad (12b)$$

$$B_t = c_0 + c_1 Y_{t-1} + c_2 p_{t-1} + c_3 u_{t-1} + c_4 v_{t-1} + c_5 \varepsilon_t + c_6 \xi_t$$

$$+ c_7 B_{t-1} + c_8 x_{t-1} + c_9 \alpha_t \quad (12c)$$

Using these equations, thirty reduced-form parameters are identified.[24] Using these reduced-form parameters, the variance of output is then calculated. To explain how the variance of output is derived, I take the simplest case and focus on the "textbook IS" function (equation (1a)), P-Bar supply specification (equation (2a)) and inflation targeting.

To solve the models, I proceed as follows: first to obtain the reduced form for the demand equation, I solve equation (1a) for i_t, then take the E_{t-1} operator through the result and I obtain equation (13) below.

$$E_{t-1}(i_t) = \left[\frac{1}{\Omega(1-\tau)}\right][A - E_{t-1}(Y_t) + [\Omega(1-\tau)E_{t-1}(p_{t+1} - p_t)] \quad (13)$$

---

[24] Detailed explanation of the undetermined coefficient solution technique and of the derivation of asymptotic variances is available in Scarth (1996, page 105).

$$+ \psi E_{t-1}(G_t) + \lambda B_{t-1} + E_{t-1}(u_t) + \Omega(1-\tau)\bar{r}]$$

I use equation (3a), (4) and (7a) to eliminate respectively $E_{t-1}(p_{t+1} - p_t)$, $E_{t-1}(G_t)$ and $E_{t-1}(u_t)$ from equation (13) above and what emerges is the central bank's interest-rate setting rule, given by equation (14) below:

$$i_t = \left[\frac{1}{\Omega(1-\tau)}\right][A - (1-\psi\delta\tau)E_{t-1}(Y_t) + \psi(1-\delta)\bar{G} + (\lambda - \delta(1-\tau))B_{t-1} \tag{14}$$

$$+ \rho u_{t-1} + \Omega(1-\tau)\bar{r}]$$

First, to proceed with identifying the reduced-form coefficients, I follow McCallum and Nelson (1999) and substitute this interest-rate expression back into equation (1a). After several substitutions, I obtain equation (15) which I refer to as the aggregate demand equation.

$$Y_t = E_{t-1}(Y_t) + \left[\frac{1}{(1-\psi\delta\tau)}\right][\Omega(1-\tau)(E_t(p_{t+1}) - p_t) + \varepsilon_t] \tag{15}$$

I then use the trial solutions for Y_t and p_t to generate expressions for all endogenous variables (except current output) in the demand equation. After many substitutions and algebraic manipulations, I establish ten identifying restrictions by comparing the result to the trial solutions for Y_t.

A second set of ten identifying restrictions is obtained by solving the demand equation (equation (15)) for p_t, and then using this relationship, I generate expressions for $p_t - E_{t-1}(\bar{p}_t)$ and $p_{t-1} - \bar{p}_{t-1}$. These expressions are then substituted in the aggregate supply relationship, given by equation (2a) and using the trial solutions once more, another ten identifying restrictions are obtained. In doing so, I use the definition that

$p_t = \bar{p}_t$ when $Y_t = \bar{Y}_t$. Finally, a third set of identifying restrictions is obtained using the bond equation (equation (5)). After substituting for G_t in that equation using equation (4), the trial solutions are again used and the last set of identifying restrictions is obtained.

Solving all thirty identifying restrictions, the following solution for real output emerges:

$$Y_t = a_0 + a_1 Y_{t-1} + a_4 v_{t-1} + a_5 \varepsilon_{t-1} + a_8 x_{t-1} \tag{16}$$

where $a_0 = 1 - a_1$, $a_1 = 1 - \frac{\theta\Omega(1-\tau)}{(1-\psi\delta\tau)}$, $a_4 = -\frac{\Omega\eta(1-\tau)}{(1-\psi\delta\tau)}$, $a_5 = \frac{1}{(1-\psi\delta\tau)}$ and

$a_8 = \gamma - a_1$

From equation (16), I can easily derive the expression for the variance of real output and this is given by equation (17) below:

$$Var(Y) = \left[\frac{a_5^2}{1-a_1^2}\right] Var(\varepsilon) + \left[\frac{1}{1-a_1^2}\right]\left[\left(\frac{a_4^2}{1-\eta^2}\right) + \left(\frac{2a_1a_4}{1-a_1\eta}\right)\left(\frac{a_4\eta}{1-\eta^2}\right)\right] Var(\xi) \tag{17}$$

$$+ \left[\frac{1}{1-a_1^2}\right]\left[\left(\frac{a_8^2}{1-\gamma^2}\right) + \left(\frac{2a_1a_8}{1-a_1\gamma}\right)\left(\frac{a_8\gamma}{1-\gamma^2}\right)\right] Var(\alpha)$$

This solution involves the assumption that a_1 has a magnitude less than one.[25] This assumption and the condition that the growth rate exceeds the after-tax interest rate constitute the stability conditions of this version of the model.

---

[25] If a_1 has a magnitude greater than one, the solution for output will be explosive. Moreover, if a_1 is a negative fraction, output will have a saw-tooth pattern.

4.2 Results under "Textbook IS", P-Bar Aggregate Supply and Inflation Targeting.

The variance of output under a demand shock for both polar cases is presented below. When the Keynesian policy ($\delta = 0$) is involved, the variance is given by:

$$Var(Y) = \left[\frac{1}{1-(1-\theta\Omega(1-\tau))^2}\right]Var(\varepsilon) \qquad \text{"Keynes"} \qquad (18)$$

While in the "Hoover" case ($\delta = 1$), it is given by the expression below

$$Var(Y) = \left[\frac{1}{1-\left(1-\frac{\theta\Omega(1-\tau)}{1-\psi\tau}\right)^2}\right]\left[\frac{1}{1-\psi\tau}\right]^2 Var(\varepsilon) \qquad \text{"Hoover"} \qquad (19)$$

As previously argued conventional wisdom supports a flexible fiscal policy, that is a shift from the flexible approach to a rigid approach must raise the variance of real output. Using equations (18) and (19), it can be shown that the variance under "Keynes" is unambiguously smaller and therefore conventional wisdom *must* be supported in this case.[26]

Moreover, these two equations above illustrate well the trade-off which exists between the impact and the persistence effect. Although the impact effect is higher under the rigid case as compared to the flexible case (the impact effect under "Keynes" is $Var(\varepsilon)$ whereas it is $\left[\frac{1}{1-\psi\tau}\right]^2 Var(\varepsilon)$ under "Hoover"), the persistence effect is less pronounced under the rigid approach (the first term in square brackets is smaller under the "Hoover" as compared to the flexible case).[27] Hence as argued in the introduction, although a flexible fiscal policy mitigates the impact effect of a given shock, such type of

[26] See Appendix I for more details.

[27] I assume that $(1-\psi\tau)$ is a positive fraction. This condition holds under reasonable parameters.

policy on the other hand can weaken and delay the eventual recovery and this is why a rigid approach to fiscal policy can be more stabilizing for output. However, in this example, since the benefits of a lower impact multiplier outweighs the destabilizing features of bond-financed deficit (persistence effect), conventional wisdom is supported.

So far, my analysis has focused on a demand shock. If a cost push shock is considered, the expression for the variance of output indicates that conventional wisdom is again supported since the variance under the flexible regime is unambiguously smaller. In this case also, the benefits of a lower impact effect under the flexible case is not outweighed by the higher persistence effect generated by this regime. Hence, overall, the flexible approach to fiscal policy wins.[28]

When a supply shock is considered, the expression for the variance of output is so complicated that nothing definite can be concluded on an a priori basis. For this reason, I do not report any analytical results for this shock. Instead, I resort to numerical values and calculate the variance of output for each model. Parameter values are selected such that the model dynamics reflect those of an annual model. The following baseline values are assumed for the parameters. The slope of the short-run Phillips curve θ is set at 0.5 (this is close to values assumed by Ball (1999) and Fortin (1997)), the tax rate τ is set at 0.25 while the interest elasticity of aggregate demand when the "textbook IS" function is used is set at 0.75 (these are values close to DeLong and Summers (1986) and Ball (1999)).[29] When the "intertemporal IS" is used, the mean value of consumption is set at

---

[28] The analytical results for this case are shown in Appendix I.

[29] I have experimented with a higher value for τ, more precisely $\tau = 0.5$. This made no qualitative difference to my results.

0.8.[30] A value of unity is assumed for the standard expenditure multiplier ($\psi = 1$, see Mankiw and Scarth 1995, p286) and the serial correlation coefficients (ρ, η, γ) are assumed to be 0.5.

In addition to the baseline values, to test for the robustness of my results, I perform several sensitivity tests on the parameters of the model. Since my model contains many parameters, it is impossible to provide sensitivity tests on all of them. This is why only a limited number of sensitivity tests is provided.[31] I select the parameters for which there is usually the least amount of consensus among economists on the values they might take. I assume a low and a high value for the following parameters: $\theta = (0.25, 0.75)$, $\Omega = (0.375, 1.5)$, $\rho = \eta = \alpha = (0.1, 0.9)$ [32] I do not provide any sensitivity tests on the other parameters of the model.

Table 1 presents my results when baseline values are used while Tables 2-4 present the results when alternative values are used. To interpret Tables 1-4, I define the RD index as the ratio of the variance of output for a demand shock under the "Hoover" case compared to the Keynesian case. I have a similar definition for the RC and RS index which respectively represents an index of the variance of output when cost-push and supply shocks are involved. Values for RD, RC and RS that are greater than one imply that the analysis supports the conventional approach to fiscal policy. For example, the top-left entry of Table 1, RD=1.41, indicates that output volatility that accompanies demand

[30] Thus, Ω is set at 0.75 in the baseline case when the "textbook IS" is used and at 0.8 when the "intertemporal IS" is used

[31] I have however experimented with many sets of parameters They make no qualitative difference to my results.

[32] The sensitivity tests for Ω is performed only when the "textbook IS" is used.

shocks is higher when the rigid approach to fiscal policy replaces the flexible approach. Thus, the rigid approach is supported only if the entries in the different tables are fractions.

Moreover, in these tables, the "textbook IS" refers to equation (1a) while the "intertemporal IS" refers to equation (1b). "Textbook IS1" and "Textbook IS2" in Tables 2-4 represent the "textbook IS" function when the value of Ω is set respectively at 0.375 and 1.5. Low serial correlation refers to the case where ρ, η, γ are set at 0.1 while high serial correlation implies setting these parameters to 0.9. Finally AS1 refers to the case where the P-Bar supply function is used (equation (2a)) while AS2 implies that the Calvo supply function is used (equation (2b)).

From Table 1, it is not surprising to see that the RD and RC index is greater than one (the RD index is 1.41 while the RC index is 1.27) for the case involving P-Bar aggregate supply and the "textbook IS" since I have already shown analytically that the variance of output under the flexible approach to fiscal policy is unambiguously lower for these two shocks. The reader can easily verify in Tables 2-4 that the RD and RC index for the case involving P-Bar aggregate supply and the "textbook IS" is always greater than one, indicating that conventional approach is always supported.

As mentioned earlier, the results for the case involving the "textbook IS", the P-Bar supply function and a supply shock are too complicated to be derived analytically. For this case, I resort exclusively to numerical solutions. Table 1 shows that if baseline values are assumed, the RS index is a fraction (RS index is 0.23) indicating that a rigid approach to fiscal policy minimizes output volatility. However, when alternative parameter values are assumed, Table 4 shows that the rigid approach is not always supported when the "textbook IS" and P-Bar supply functions are involved. For example, if higher coefficients for the slope of the Phillips curve, interest rate elasticity and serial correlation are assumed, it can be shown that the flexible approach to fiscal policy minimizes output volatility in this case (the RS index is 1.13). Moreover, as shown in Table 4, the results under the "textbook IS", P-Bar supply function and a supply shock are not robust since my sensitivity tests reveal that the RS ratio varies between being a fraction and being greater than one.

4.3 Results under the "Intertemporal IS", P-Bar Aggregate Supply and Inflation Targeting

If a more forward looking model is adopted, one which embraces the "intertemporal IS" function, the results are dramatically different, at least for a demand shock. In that case, the flexible approach receives less support in general. As in section 4.2, I will present analytical results whenever possible and always resort to numerical examples. The variance for output when the "intertemporal IS" is used is given by

$$Var(Y) = \left[\frac{1}{1-a_1^2}\right]\left[\left(\frac{a_4^2}{1-\eta^2}+a_6^2\right)+\left(\frac{2a_1a_4}{1-a_1\eta}\right)\left(\frac{a_4\eta}{1-\eta^2}+a_6\right)\right]Var(\xi) \qquad (20)$$

$$+\left[\frac{a_5^2}{1-a_1^2}\right]Var(\varepsilon)+\left[\frac{1}{1-a_1^2}\right]\left[\left(\frac{a_8^2}{1-\gamma^2}+a_9^2\right)+\left(\frac{2a_1a_8}{1-a_1\gamma}\right)\left(\frac{a_8\gamma}{1-\gamma^2}+a_9\right)\right]Var(\alpha)$$

where $a_1 = 1-\frac{\theta\Omega(1-\tau)}{\Theta}$, $a_5 = \frac{1}{\Theta-(1-\delta\tau)a_1}$, $a_4 = -\frac{\Omega\eta(1-\tau)}{\Theta}$,

$$a_6 = \frac{(1-\delta\tau)a_4}{\Theta-(1-\delta\tau)a_1},\ a_8 = \gamma - a_1,\ a_9 = \frac{(1-\delta\tau)a_8}{\Theta-(1-\delta\tau)a_1} \text{ and}$$

$$\Theta = 1-\delta\tau+\delta\bar{r}\tau(1-\tau)(1-\delta)^2$$

The variance under both fiscal regimes is first analysed under a demand shock. The variance under the flexible case is given

$$Var(Y) = \left[\frac{1}{1-(1-\theta\Omega(1-\tau))^2}\right]\left[\frac{1}{\theta\Omega(1-\tau)}\right]^2 Var(\varepsilon) \qquad \text{"Keynes"} \qquad (21)$$

and the variance under the rigid regime is given by

$$Var(Y) = \left[\frac{1}{1-(1-\theta\Omega)^2}\right]\left[\frac{1}{\theta\Omega(1-\tau)}\right]^2 Var(\varepsilon) \qquad \text{"Hoover"} \qquad (22)$$

For stability reasons and for the model to be consistent with a non-saw-tooth approach to its steady state - $(1 - \tau)$ must lie between 1 and $\theta\Omega$. This set of restrictions imply that $Var(Y)$ in equation (21) exceeds $Var(Y)$ equation (22), since the term in the first square bracket is unambiguously lower under "Hoover", so that it is the rigid fiscal policy that delivers the lower output volatility. It is interesting to note also that when the more forward looking version of the model is used, the impact effect under both regimes for a demand shock is the same. However, since the economy recovers at a faster rate under "Hoover", it is the latter that minimizes output volatility. Hence, unlike the case involving the "textbook IS", a move towards a rigid fiscal regime does not increase the volatility of output. This result proves that conventional wisdom - that variations in the budget balance over the cycle are desirable - may not apply in the more micro-based setting of modern macroeconomics.

There is another reason why the Keynesian approach is not supported here. As mentioned in my introduction, since a rigid approach to fiscal policy avoids the destabilizing feature of a bond financed deficit, the central bank finds it appropriate to put less weight on stabilizing long-term expectations and more weight on stabilizing output. As a result of this interaction between fiscal and monetary policy, the rigid approach to fiscal policy can be *more* not *less* stabilizing for output.

To illustrate the above argument, it is instructive to consider how the interest rate setting equation of the central bank simplifies when the two polar cases are considered. Ignoring the error term, the central bank's rate-setting equation is given by

$$i_t = \dot{i} + \left[\frac{1}{\Omega(1-\tau)}\right]E_{t-1}[Y_{t+1} - Y_t] \qquad \text{"Keynes"} \qquad (23)$$

$$i_t = \dot{i} + \left[\frac{1}{\Omega}\right]E_{t-1}[Y_{t+1} - Y_t] \qquad \text{"Hoover"} \qquad (24)$$

where $\dot{i}$ is the equilibrium nominal interest rate.[33] According to equations (23) and (24), the central bank raises the interest rate above its neutral or equilibrium value to dampen demand whenever it expects output to be rising.[34] This policy is motivated by the bank's desire to limit future inflation. By comparing equations (23) and (24), one can see that the central bank reacts less forcefully when a rigid fiscal policy is in place. This analysis verifies that the monetary policy reaction function *is* dependent on fiscal policy – as stressed

---

[33] The equilibrium nominal and real interest rates are equal since expected inflation is zero in equilibrium.

[34] Equations (23) and (24) can be easily reexpressed in terms of the output gap. In that case, it is appropriate for the central bank to react to the expected change in the output gap. This result is similar to Walsh (2001) who shows that a fully optimizing central bank operating in a discretionary policy environment achieves better social outcomes if it focuses on output gap changes and not the output gap

in the introduction. This endogeneity of monetary policy – with the bank becoming more passive as the fiscal authority becomes more rigid -- is one of the things that can make it sensible for the fiscal authority to reject the basic lesson of the 1930s.

I now return to the interpretation of the variance of output given by equation (20). When a cost-push shock is considered, my results suggest that the variance under the "Hoover" approach is lower compared to the flexible approach. The RC index is slightly lower than one, indicating that the variance of output under the rigid approach is unambiguously lower. These results are reported Table 3. For example, the RC index when all sensitivity tests are performed hovers around 0.95, indicating that the variance under the rigid approach to fiscal policy is on average around 5% less than under the flexible approach.

If the supply shock is considered, as in the case involving the "textbook IS", the results are ambiguous and depend on the parameters of the model. Table 4 shows that unless the supply shock is very persistent, the rigid approach to fiscal policy minimizes output volatility. However, if baseline values are assumed, my results indicate that under this shock, the rigid approach to fiscal policy dominates the flexible regime. Hence my results provide (at least for baseline values) more support for the rigid approach to fiscal policy when the "intertemporal IS" and the P-Bar supply function are involved instead of the "textbook IS", indicating that the destabilizing portion of a flexible fiscal policy is amplified when forward-looking agents are involved.

4.4 Results under "Textbook IS", Calvo Aggregate Supply and Inflation Targeting

So far, my sensitivity test has involved only the demand portion of the model. In this and subsequent section, I investigate how my results change when the P-Bar aggregate supply is replaced by that of Calvo. Things are more definite when the Calvo supply function (equation (2b)) is used instead of the P-Bar supply function (equation (2a)). If a demand shock is considered, the variance for output under "Keynes" is given by

$$Var(Y) = Var(\varepsilon) \qquad \text{"Keynes"} \qquad (25)$$

while the variance under the rigid approach is

$$Var(Y) = \left[\frac{1}{1-\psi\tau}\right]^2 Var(\varepsilon) \qquad \text{"Hoover"} \qquad (26)$$

From these two equations, one can see that the variance under the flexible approach is unambiguously smaller compared to the rigid approach. Hence, replacing the P-Bar supply function by the Calvo's supply function does not alter my results when the "old IS" function and a demand shock are involved.

If a cost-push shock is considered, it is clear that the variance of output is identical under both regimes. In both cases, the variance is given by

$$Var(Y) = \left[\frac{\eta^2}{\theta^2(1-\eta^2)}\right] Var(\zeta) \qquad \text{both regimes} \qquad (27)$$

A similar result is obtained if the supply shock is considered. In this case also, the variance under both regimes is identical and is given by

$$Var(Y) = \left[\frac{\gamma^2}{1-\gamma^2}\right] Var(\alpha) \qquad \text{both regimes} \qquad (28)$$

4.5 Results under "Intertemporal IS", Calvo Aggregate Supply and Inflation Targeting

My final set of results involves having both a forward-looking demand and supply side. By following the procedure outlined above, the reader can verify that the variance of output (given below) under the flexible case for a demand shock must be lower. Hence, conventional wisdom is supported under this model.

$$Var(Y) = Var(\varepsilon) \qquad \text{"Keynes"} \qquad (29)$$

$$Var(Y) = \left[\frac{1}{1-\tau}\right]^2 Var(\varepsilon) \qquad \text{"Hoover"} \qquad (30)$$

If cost-push and supply shocks are considered, a similar result is obtained as in the case involving the "textbook IS" and Calvo AS. The "Hoover" and Keynesian policies deliver the *same* output volatility under both shocks.

Under the cost-push shock, the variance of output is given by:

$$Var(Y) = \left[\frac{\eta^2(2-\eta^2)}{\theta^2(1-\eta^2)}\right] Var(\xi) \qquad \text{both regimes} \qquad (31)$$

while the variance under the supply shock is given by:

$$Var(Y) = \left[\frac{\gamma^2}{1-\gamma^2}\right] Var(\alpha) \qquad \text{both regimes} \qquad (32)$$

Hence when the Calvo aggregate supply function is involved, the sensitivity testing across alternative demand functions does not alter the results. The same thing cannot be said when the P-Bar supply function is involved. It appears, therefore, as in many questions in macroeconomics, that the verdict concerning a major issue is sensitive to variations in the specification of the short-run aggregate supply relationship.

The results are summarized in Table 5 below. My results indicate that in a number of cases, conventional wisdom - that a flexible fiscal policy reduces output volatility - is not supported (although there is no overwhelming support for the rigid case also). Hence, my results are in contrast to some of the empirical findings discussed in section 2 and do provide more support for the rigid approach than what is typically found in the literature

Table 5: Summary of the best fiscal regime in each model.

	P-Bar AS	**Calvo AS**
"Textbook" IS		
Demand shock	Flexible	Flexible
Cost-push shock	Flexible	Tie
Supply shock	ambiguous	Tie
"Intertemporal" IS		
Demand shock	Rigid	Flexible
Cost-push shock	Rigid	Tie
Supply shock	ambiguous	Tie

4.6 Some Intuition for the Results

Table 5 shows clearly that the choice of aggregate supply and demand is important in the determination of the best fiscal regime. For example, there is more support for the rigid approach under the P-Bar aggregate supply and with the forward-looking IS and there is more support in general for the Keynesian approach with Calvo's model of price setting, at least for a demand shock. I have already offered some interpretation for some of the results. The standard discussion of built-in stability tends to stress the lower impact effect that accompanies the flexible approach to fiscal policy and under-appreciate (or ignore) the favourable (lower) persistence effect that accompanies the rigid approach to fiscal policy. The intuition behind this latter effect follows from the fact that the debt accumulated during the early phase of a recession (when the flexible policy is pursued) must be paid back later on in the business cycle. Thus, while the flexible approach lessens the magnitude of any recession initially, it delays and weakens the eventual recovery. From my results involving the P-Bar supply function, one can see that this second effect does not matter much when agents are completely backward-looking. However, it does matter when agents are more forward-looking and this is why a rigid approach to fiscal policy can win. Some explanations for this result is provided below.

If the government is running a flexible fiscal regime and financing its deficit by issuing more bonds, agents know that the accumulated debt will have to be paid down in the future and hence expect output to fall in the future. This will have important implications on current output if agents are forward-looking and if the "intertemporal IS" is involved. When this IS is used, since current output is a function of future output (there is a unit coefficient on the expected output term), if agents expect future output to be low, they will lower their current spending and hence current output will fall. As a result of this added channel, a flexible fiscal policy loses some of its ability to insulate the economy from shocks. It appears that when this effect is made less powerful, the stabilizing dimension of the rigid approach to fiscal policy becomes the dominant consideration and this is why a rigid approach can be more stabilizing with the "intertemporal IS" is involved.

However, the above does not explain why a rigid approach to fiscal policy does not receive a similar support when the "intertemporal IS" is used but this time with the Calvo aggregate supply. Things are different here because prices (and hence output) adjust faster under the Calvo supply function. Since prices are less sticky under this supply function, output returns to equilibrium at a faster rate. As a result, the destabilizing aspect of a flexible fiscal policy (the degree of persistence) becomes less important and this is why the rigid fiscal regime does not win in this case. A similar explanation can be used to explain why in general I find more support for the flexible fiscal regime under the Calvo supply function compared to the P-Bar supply function.

My results also indicate that the flexible approach to fiscal policy receives more support when demand shocks are involved.[35] Except for the case involving the P-Bar supply function and the "intertemporal IS", the Keynesian approach is always preferred to the rigid approach when demand shocks are involved. On the other hand, with the two other shocks, the flexible approach to fiscal policy receives less support in general. Some intuition for this result can be had by considering an adverse cost-push shock (or supply shock).

When such a shock occurs, prices increase while output falls.[36] As inflation increases beyond its target and since the central bank is an inflation targeter, it will increase interest rates to bring inflation back to equilibrium. This increase in interest rates,

---

[35] This result is similar to some extent to those of Cohen and Folette (1999). They make a distinction between aggregate supply and demand shocks and their effects on output and find that higher automatic stabilizers stabilize output following a demand shock but can hinder the adjustment process under a supply shock.

[36] On the other hand, with a demand shock such a trade-off does not exist

in turn, further exacerbates the initial fall in output and thus magnifies the impact effect of the negative shock. Although a flexible approach to fiscal policy helps to mitigate the impact effect on output of a negative supply shock, however, its role as an automatic stabilizer is weakened since the negative effects of the initial shock are exacerbated by the subsequent rise in interest rates. Consequently, as the short-run stabilizing role of a flexible fiscal policy is made less powerful, the stabilizing dimension of a rigid fiscal policy thus becomes more important. This is why a rigid approach is more likely to be preferred under supply and/or cost-push shocks.

Overall, my results support the claim made in the introduction of the paper - that the verdict concerning the flexible versus the rigid approach to fiscal policy depends on whether the model allows for forward-looking behaviour on the part of agents. The fact that the results are somewhat mixed makes my analysis consistent with earlier studies. The early modeling exercises (for example, Gorbet and Helliwell (1971) and Smyth (1974)) stressed a significant note of skepticism concerning the efficacy of fiscal built-in stabilizers. My analysis provides an modern update and suggests that there is a firmer basis for this skepticism if analysts embrace the "New Neoclassical Synthesis". Thus, it may not be so surprising after all, that US states with stringent budget-balancing rules do not have higher output variability than states without such rigid rules.

5. Concluding Remarks

With the adoption of firm annual budget-balance targets, fiscal policy in many countries has become more rigid in recent years. This change has been motivated by the desire to bring long-term viability and credibility to fiscal policy. But with the prospect of this rigid approach being extended into the indefinite future, some economists (including many recent articles in *The Economist*) are beginning to express concern that long-term credibility is being bought at the expense of increased short-term volatility in real output and employment.[37]

To investigate this question, I have analysed a macro model which allows me to consider varying degrees of price stickiness and forward-looking behaviour. The results are mixed but does provide some support in favour of a rigid fiscal regime. With particularly sticky prices (McCallum's specification of aggregate supply) and a forward looking aggregate demand at least for demand shocks, the Keynesian approach is rejected. In this case, the rigid approach to fiscal policy – which specifies an annual balanced-budget target *whatever* the state of the cycle – is supported. With less sticky prices (Calvo's specification of aggregate supply), the support for the Keynesian approach rises - especially if demand shocks are important.

The contribution of this chapter lies in identifying the key questions for future work, and in demonstrating that models which reflect the new paradigm in stabilization policy analysis may threaten the support macroeconomists can offer for the widespread view that the flexible approach to fiscal policy brings lower output volatility. However, more definite conclusions for actual policy making must await two developments: empirical work to better discriminate between the alternative specifications of aggregate supply

[37] For example, *The Economist* magazine (August 25, 2001, p 13) contains an article that criticizes Europe's stability pact (that sets a binding ceiling of 3 percent of GDP on Euro-zone countries budget deficits). It is noted that "... as the euro area faces the possibility of its first recession ... the stability pact must not only preclude any fiscal easing but even trammel the operation of fiscal 'automatic stabilizers'."

and demand and between the alternative sources of disturbances, and work which poses this question in an open-economy environment. The latter is discussed at length in the next chapter.

Appendix I

(i) Variance under "Textbook IS", P-Bar Aggregate Supply and Inflation Targeting.

Demand Shock

$$Var(Keynes) = \left[\frac{1}{\theta\Omega(1-\tau)[2-\theta\Omega(1-\tau)]}\right]Var(\varepsilon) \tag{A1.1}$$

$$Var(Hoover) = \left[\frac{1}{\theta\Omega(1-\tau)[2(1-\psi\tau)-\theta\Omega(1-\tau)]}\right]Var(\varepsilon) \tag{A1.2}$$

For stability, $(1-\psi\tau)$ is assumed to be less than one and positive, then

$$\frac{Var(Hoover)}{Var(Keynes)} = \frac{2-\theta\Omega(1-\tau)}{2(1-\psi\tau)-\theta\Omega(1-\tau)} > 1 \tag{A1.3}$$

Cost-Push Shock

$$Var = \left[\frac{1}{1-a_1^2}\right]\left[\left(\frac{a_4^2}{1-\eta^2}\right)+\left(\frac{2a_1a_4}{1-a_1\eta}\right)\left(\frac{a_4\eta}{1-\eta^2}\right)\right](Var(\xi)) \tag{A1.4}$$

It can be shown that

$$\frac{Var(Hoover)}{Var(Keynes)} = \left[\frac{2-\theta\Omega(1-\tau)}{2(1-\psi\tau)-\theta\Omega(1-\tau)}\right] > 1 \tag{A1.5}$$

(ii) Variance under "Intertemporal IS", P-Bar Aggregate Supply and Inflation Targeting.

Demand Shock

$$Var(Keynes) = \left[\frac{1}{1-a_{1K}^2}\right]\left[\frac{1}{\theta\Omega(1-\tau)}\right]^2 Var(\varepsilon) \text{, where } a_{1K} = 1-\theta\Omega(1-\tau) \tag{A1.6}$$

$$Var(Hoover) = \left[\frac{1}{1-a_{1H}^2}\right]\left[\frac{1}{\theta\Omega(1-\tau)}\right]^2 Var(\varepsilon) \text{, where } a_{1H} = 1-\theta\Omega \tag{A1.7}$$

(A1.8)

Since $a_{1H}^2 < a_{1K}^2 < 1$, hence $1 - a_{1K}^2 < 1 - a_{1H}^2$, implying that

$$\frac{Var(Hoover)}{Var(Keynes)} = \frac{1-a_{1H}^2}{1-a_{1K}^2} < 1 \tag{A1.9}$$

Appendix II

In this section, I present a compact version of how equation (2b) of the text is derived. For more details, See Calvo (1983), Yun (1996), Galì and Gertler (1999) and Walsh (1999, p 218-220).In Calvo's model, each firm faces a constant probability s of being able to change its price in every period. This probability is assumed to be state-independent and the average time over which prices are fixed is given by $\frac{1}{s}$. For example, in a quarterly model, if the probability that a firm is able to change its price is 0.25, then prices will remain fixed on average for 4 quarters. Thus, in Calvo's model, current aggregate prices are a function of past period's prices as some firms cannot adjust their prices but also of expected future prices as firms know that there is a probability that they may not be able to change their prices for a given number of periods. Following Rotemberg (1987), the firm is assumed to minimize the expected present discounted value of a quadratic loss function that depends on the deviation between the price chosen by the firm p_{it} and nominal unit costs c_t, subject to a Poisson process that determines how firms change their prices.

Hence firms minimize the following quadratic loss function given by:

$$\sum_{j=0}^{\infty} (1-s)^j \beta^j E_t(p_{it} - c_t)^2 = (p_{it} - c_t) + (1-s)\beta E_t(p_{it} - c_{t+1})^2 + \dots \tag{A2.1}$$

where β is the discount factor. The first-order condition is given by

$$p_{it} \sum_{j=0}^{\infty} (1-s)^j \beta^j - \sum_{j=0}^{\infty} (1-s)^j \beta^j E_t c_{t+1} \tag{A2.2}$$

Let $\tilde{p}_t$ denotes the price set by all firms adjusting their price. Thus

$$\tilde{p}_t = [1-(1-s)\beta]\sum_{j=0}^{\infty}(1-s)^j\beta^j E_t c_{t+1} \quad \text{(A2.3)}$$

Hence prices set by all firms who are able to change their prices are a weighted average of current and expected values of the unit marginal cost. Rearranging (A2.3), one obtains

$$\tilde{p}_t = [1-(1-s)\beta]c_t + [(1-s)\beta]E_t(\tilde{p}_{t+1}) \quad \text{(A2.4)}$$

The aggregate price level p_t is given by $p_t = s\tilde{p}_t + (1-s)p_{t-1}$ (A2.5)

Rearranging equation (A2.5) after updating one period and taking expectations at time t, one obtains,

$$sE_t(\tilde{p}_{t+1}) = E_t(p_{t+1}) - (1-s)p_t \quad \text{(A2.6)}$$

Using (A2.4) and multiplying it by s and then substituting in for $E_t(\tilde{p}_{t+1})$ using (A2.6), I have equation (A2.7) below

$$s\tilde{p}_t = s[1-(1-s)\beta]c_t + [(1-s)\beta][E_t(p_{t+1}) - (1-s)p_t] \quad \text{(A2.7)}$$

Substituting (A2.7) in (A2.5), I have

$$p_t = s[1-(1-s)\beta]c_t + [(1-s)\beta][E_t(p_{t+1}) - (1-s)p_t] + (1-s)p_{t-1} \quad \text{(A2.8)}$$

Denoting $mc_t = c_t - p_t$ as the log of the real marginal cost, substituting for c_t in the equation above and rearranging, I obtain

$$\pi_t = \left[\frac{s}{1-s}\right][1-(1-s)\beta]mc_t + \beta E_t(\pi_{t+1}) \quad \text{(A2.9)}$$

Equation (A2.9) is the New Keynesian Phillips curve.

To express marginal cost in terms of the output gap, I proceed in the following way:

I assume that there is complete wage flexibility and the labour supply satisfies the following condition:

$$N_t = \sigma\left(\frac{W_t}{P_t}\right)\left(\frac{1}{C_t}\right) \tag{A2.10}$$

where $\sigma = \dfrac{1}{2\psi}$

I assume that the production function is given by the equation below

$$Y_t = \bar{K}^{1-\vartheta} N_t^{\vartheta}, \tag{A2.11}$$

Real marginal cost is given by $MC_t = \left(\dfrac{W_t}{P_t}\right)\left(\dfrac{1}{MPL_t}\right)$ (A2.12)

where MPL is the marginal product of labour and it is given by

$$MPL_t = \frac{\vartheta Y_t}{N_t} \tag{A2.13}$$

Let lower-case letters denote the natural log of the associated upper-case variables. Taking the logarithm of equations (A2.10)-(A2.13), I obtain respectively,

$$n_t = \ln\sigma + w_t - p_t - c_t \tag{A2.14}$$

$$y_t = (1-\vartheta)\bar{k} + \vartheta n_t \tag{A2.15}$$

$$mc_t = w_t - p_t - mpl_t \tag{A2.16}$$

$$mpl_t = \ln\vartheta + y_t - n_t \tag{A2.17}$$

Using equation (A2.14) and solving for w_t, I obtain

$$w_t = n_t - \ln\sigma + p_t + c_t \tag{A2.18}$$

Substituting equations (A2.18) and (A2.17) in equation (A2.16), I obtain

$$mc_t = 2n_t - \ln\sigma - \ln\vartheta + c_t - y_t \tag{A2.19}$$

The resource constraint is given by

$$y_t = \mu c_t + (1-\mu)g_t \tag{A2.20}$$

Substituting equations (A2.15) and (A2.20) in (A2.19), I obtain

$$mc_t = 2\left[\frac{y_t}{\vartheta} - \left(\frac{1-\vartheta}{\vartheta}\right)\bar{k}\right] - \ln\sigma - \ln\vartheta + \left(\frac{1-\mu}{\mu}\right)(y_t - g_t) \tag{A2.21}$$

Since marginal cost is equal to price in equilibrium, the real marginal cost in equilibrium is zero.

$$\overline{mc_t} = 2\left[\frac{\bar{y}_t}{\vartheta} - \left(\frac{1-\vartheta}{\vartheta}\right)\bar{k}\right] - \ln\sigma - \ln\vartheta + \left(\frac{1-\mu}{\mu}\right)(\bar{y}_t - \bar{g}_t) = 0 \tag{A2.22}$$

Subtracting equation (A2.22) from equation (A2.21), I obtain,

$$mc_t = \left[\frac{2}{\vartheta} + \left(\frac{1-\mu}{\mu}\right)\right][y_t - \bar{y}_t] - \left[\frac{1-\mu}{\mu}\right][g_t - \bar{g}_t] \tag{A2.23}$$

Under "Keynes", since government expenditure is a constant, the expression for marginal cost simplifies to

$$mc_t = \left[\frac{2}{\vartheta} + \left(\frac{1-\mu}{\mu}\right)\right][y_t - \bar{y}_t] = \Phi_k[y_t - \bar{y}_t] \tag{A2.24}$$

where $\Phi_k = \frac{2}{\vartheta} + \left(\frac{1-\mu}{\mu}\right)$

Under "Hoover", $(g_t - \bar{g}_t) = \tau(y_t - \bar{y}_t)$

The expression for marginal cost then simplifies to

$$mc_t = \left[\frac{2}{\vartheta} + \left(\left(\frac{1-\mu}{\mu}\right)(1-\tau)\right)\right][y_t - \bar{y}_t] = \Phi_h[y_t - \bar{y}_t] \tag{A2.25}$$

where $\Phi_h = \frac{2}{\vartheta} + \left(\frac{1-\mu}{\mu}\right)(1-\tau)$

Hence since $\Phi_h \neq \Phi_k$, this implies that the slope of the Phillips curve under the two fiscal regimes will be different. However, since Φ_k and Φ_h differ by less than one percent in value, I assume that the marginal cost is identical under "Hoover" and "Keynes". As a result, Calvo's aggregate supply function is obtained by substituting equation (A2.24) in equation (A2.9). By doing so, one obtains

$$\pi_t = \left[\frac{\Phi s}{1-s}\right][1-(1-s)\beta][y_t - \bar{y}_t] + \beta E_t(\pi_{t+1}) \tag{A2.26}$$

where $\Phi_h = \Phi_k = \Phi$

By setting β to 1, $\theta = \left[\frac{\Phi s}{(1-s)(1-\alpha)}\right][1-(1-s)]$ and adding an error term, I obtain equation (2b) in the text.

Table 1: Values of RD (Demand Shock), RC (Cost-Push Shock) and RS (Supply Shock) Index for Baseline Parameters under Inflation Targeting

	RD Index	RC Index	RS Index
AS1 - P-Bar			
"Textbook" IS	1.41	1.27	0.23
"Intertemporal" IS	0.80	0.96	0.14
AS2 - Calvo			
"Textbook" IS	1.78	1.00	1.00
"Intertemporal" IS	1.17	1.00	1.00

Table 2: Values of RD Index (Demand Shock) for Various Parameters under Inflation Targeting

	Low Serial Correlation ($\rho, \eta, \gamma = 0.1$)		**High Serial Correlation** ($\rho, \eta, \gamma = 0.9$)	
	$\theta = 0.25$	$\theta = 0.75$	$\theta = 0.25$	$\theta = 0.75$
AS1 - P-Bar				
"Textbook" IS1 (Ω=0.375)	1.35	1.39	1.35	1.39
"Textbook" IS2 (Ω=1.5)	1.41	1.76	1.41	1.76
"Intertemporal" IS	0.77	0.83	0.77	0.83
AS2 - Calvo				
"Textbook" IS1 (Ω=0.375)	1.78	1.78	1.78	1.78
"Textbook" IS2 (Ω=1.5)	1.78	1.78	1.78	1.78
"Intertemporal" IS	1.06	1.16	1.24	1.52

Table 3: Values of RC Index (Cost-Push Shock) for Various Parameters under Inflation Targeting

	Low Serial Correlation (ρ, η, γ = 0.1)		High Serial Correlation (ρ, η, γ = 0.9)	
	θ = 0.25	θ = 0.75	θ = 0.25	θ = 0.75
AS1 - P-Bar				
"Textbook" IS1 (Ω=0.375)	1.34	1.37	1.18	1.10
"Textbook" IS2 (Ω=1.5)	1.38	1.66	1.08	1.06
"Intertemporal" IS	0.99	0.99	0.95	0.96
AS2 - Calvo				
"Textbook" IS1 (Ω=0.375)	1.00	1.00	1.00	1.00
"Textbook" IS2 (Ω=1.5)	1.00	1.00	1.00	1.00
"Intertemporal" IS	1.00	1.00	1.00	1.00

Table 4: Values of RS Index (Supply Shock) for Various Parameters under Inflation Targeting

	Low Serial Correlation (ρ, η, γ = 0.1)		High Serial Correlation (ρ, η, γ = 0.9)	
	θ = 0.25	θ = 0.75	θ = 0.25	θ = 0.75
AS1 - P-Bar				
"Textbook" IS1 (Ω=0.375)	0.71	1.62	0.03	1.65
"Textbook" IS2 (Ω=1.5)	0.56	1.49	1.40	1.13
"Intertemporal" IS	0.49	0.25	2.14	1.10
AS2 - Calvo				
"Textbook" IS1 (Ω=0.375)	1.00	1.00	1.00	1.00
"Textbook" IS2 (Ω=1.5)	1.00	1.00	1.00	1.00
"Intertemporal" IS	1.00	1.00	1.00	1.00

Chapter 3

Alternative Public Spending Rules in an Open Economy Framework.

1. Introduction

While conventional wisdom supports a flexible approach to fiscal policy for output stabilization, using several models which embrace the "New Neoclassical Synthesis" framework, I have demonstrated in the second chapter that in a number of cases, a flexible fiscal regime does not necessarily minimize output volatility, especially when sticky prices and a forward-looking IS are involved. Chapter 2 provides various reasons to account for this counter-conventional result. However, since the analytical underpinnings of built-in stability in chapter 2 are explored in a closed-economy setting, no definite conclusions, especially for actual policy-making can really emerge. The purpose of this chapter is to re-examine many of the issues raised in the previous chapter but this time using a series of small open economy models with intermediate imports.

Extending the analysis to an open economy framework is important, especially if one wants to verify whether policy recommendations reached in a closed economy model can be carried over to an open economy framework. It may be possible that policy prescriptions reached in a closed economy setting cannot be replicated when the same model is extended to an open economy framework.[1] For example, Walsh (1999b) shows that none of the results which characterize optimal monetary policy in a closed economy setting carry over to the open economy. On the other hand, Clarida, Galì and Gertler (2001, page 248) argue that under "certain conditions, the monetary policy design problem for the small open economy is isomorphic to the problem of the closed economy." However, their result refers specifically to the type of policy rule which the central bank uses and hence does not apply to the numerous other issues facing closed and open economies. They do however acknowledge that open economy models will give quantitatively different results than closed economy models and this in itself is an important detail. Since Walsh (1999b) and Clarida, Galì and Gertler's (2001) results pertain only to monetary policy, this chapter helps to shed light on this issue from a fiscal policy perspective.

As discussed in chapter 1, besides extending the analysis of chapter 2 to a small open economy framework, I introduce several changes in this chapter. These changes are mostly motivated by practical reasons and are discussed below and in sections 2 and 3. First, unlike chapter 2 where the central bank is assumed to be either a price level or an inflation targeter, I assume in this chapter that the monetary authority is either an inflation or an exchange rate targeter. I do not consider price level targeting as the findings from chapter 2 indicate that the results under this monetary regime are almost identical to those under inflation targeting and hence there are no additional benefits to examine alternative fiscal regimes under both of these monetary targeting regimes. Moreover, since exchange

---

[1] Open-economy models introduce additional channels through which aggregate demand is affected. As a result, the task of the monetary authority becomes more complex. For example, the exchange rate is another key factor the monetary authority may want to consider in its decision making process

rate targeting has been gaining more attention recently, it is worthwhile to examine how sensitive my results on fiscal policy are if such a targeting regime is adopted.

A second important change made in this chapter concerns the solution method. As the models involved in this chapter are more complex compared to the closed economy models used in the previous chapter, I do not attempt to solve them analytically. Instead, I apply the numerical solutions used and described in Backus and Driffill (1986), Currie and Levine (1993, chapter 6) and Soderlind (1999). The solution methods used in this chapter are described in more detail in section 3 and in Appendix II.

This change has several implications. Since the solution algorithm is set up in such a way that a loss function has to be specified, I do not evaluate the two fiscal regimes exclusively based on their ability to minimize output volatility but rather on their ability to minimize a weighted sum of the unconditional variance of the output gap and the unconditional variance of the deviations of inflation from its target, assumed to be zero for convenience.

As the central bank has an explicit weight on output stabilization, this implies that in this chapter, the central bank targets either inflation or the exchange rate in a flexible manner instead of strictly targeting expected future inflation as in chapter 2.[2] However, as argued by Batini and Haldane (1999), although strict inflation targeting assumes that the central bank does not put any explicit weight on real output, this does not necessarily mean that it does not care about output. They argue that strict future inflation targeting is

[2] Strict targeting is dominated by flexible targeting in almost all of the cases examined. This is why it is not considered in this chapter.

nevertheless "real output encompassing," since it involves the central bank caring indirectly about real output in the short run. As a result, expected future inflation targeting is not so different from flexible inflation targeting.

As the central bank targets either inflation or the exchange rate in a flexible manner, this implies that the relative weight it assigns to output stabilization under these two monetary regimes must be derived This weight is optimally derived in the model and depends on several factors, particularly on the fiscal regime in place and on how persistent shocks are. In my analysis, I describe the central bank as being conservative if it has a stronger dislike for inflation compared to society and thus assigns a bigger weight on inflation stabilization compared to the latter.[3] Many studies have argued that the weight the central bank assigns to inflation increases when shocks are persistent. For example, Clarida, Galì and Gertler (1999) find that when cost-push shocks are persistent, it is optimal for the central bank to assign more weight on stabilizing inflation. Walsh (1999b) obtains a similar result for a persistent demand shock. My findings support these claims and are discussed in section 4.

The use of this new solution method also implies that a different timing regarding when the central bank sets the interest rate has to be assumed. In the second chapter, the interest rate setting rule is optimally derived and the central bank is assumed to set the interest rate before observing current shocks. On the other hand, in this second essay, as

[3] As mentioned previously, society's loss function is assumed to be a weighted average of the variance of the output-gap and inflation. As a reference point, I assume that society assigns a weight of 1 on the variance of inflation and 0.5 on the variance of the output-gap. The central bank has a stronger dislike for inflation than society if it chooses to allocate a bigger weight on inflation in its loss function than society does

my models are more complex and because of the new solution algorithm, I have no choice but to make the less appealing assumption that the central bank has to set the interest rate at the same time current shocks are revealed.

The final change involves the aggregate supply function. In the previous essay, two types of aggregate supply are assumed: the popular model of Calvo (1983) and the P-Bar aggregate supply. However, in this essay, the P-Bar aggregate supply is replaced by the Fuhrer-Moore (1995) aggregate supply. More details about this change are contained in section 2.

My findings in this chapter are very similar to those obtained in chapter 2. When a demand shock is simulated, I find that the flexible fiscal regime receives more support when the "textbook IS" is used and less support when the 'intertemporal' IS is involved. However, unlike chapter 2, I find that my results for the demand shock are less dependent on the type of supply function used. For example, in the previous chapter, under a demand shock, a rigid fiscal regime is preferred to a flexible regime only when the "intertemporal IS" and the more sticky aggregate supply (the P-Bar supply function) are involved. However, in the open economy framework, I find more support for the rigid approach even if the less sticky supply function (Calvo aggregate supply) is used. My results indicate that irrespective of the supply function, the rigid approach to fiscal policy does as well as the flexible approach when the "intertemporal IS" is used.

My results regarding cost-push and supply shocks are also very similar to those of chapter 2. As in the previous chapter, I find that the flexible approach to fiscal policy receives less support in general when these shocks are simulated. For example, when a cost-push is simulated, it is seen that the rigid approach to fiscal policy does as well as the flexible approach in minimizing output and inflation volatility under the Calvo aggregate supply function. I also obtain a similar result even when the Fuhrer-Moore aggregate supply function is used. Hence it seems that my results for the cost-push shock in the open-economy framework provide more support for the "Hoover" approach.

When the supply shock is simulated, I also find that the rigid approach to fiscal policy does as well as the flexible approach under both types of supply function. My results for this shock again support my earlier findings. Moreover, as in the previous chapter, I perform several sensitivity tests by choosing alternative parameter values and find that my results are indeed robust to these sensitivity tests. My findings are thus similar to those of Clarida, Galì and Gertler (2001) since most of the results I obtain in the closed economy model are replicated when the model is extended to an open economy framework.

As in Clarida, Galì and Gertler (1999) and Walsh (1999b), I also find that it is optimal for the central bank to be very conservative if shocks are expected to persist for a long period of time. For example, when I allow shocks to be more persistent in my models, I find that the central bank's relative weight on inflation increases under both fiscal regimes. Some intuition for this finding is offered in section 4.

Before presenting my models, a general comment regarding the treatment of imports is warranted. Unlike many open-economy models which assume that imported goods are finished product, the models presented in this chapter treat imports as intermediate rather than finished goods.[4] Following Scarth (1996, page 179-80), I assume that all imports are intermediate inputs and must be combined with domestic value-added in fixed proportions.[5] The assumption of intermediate goods is analytically simpler compared to what is traditionally assumed in the literature and has some attractive features.[6] For example, when imported goods are treated as inputs in the production process, there is no need to make a distinction between the producer and consumer price index. This assumption also simplifies the modelling exercise greatly since I can use a simple export function to model foreign behaviour.[7] Furthermore, I do not need to make the distinction between tradeable and non tradeable goods and hence do not have to make the common and unattractive assumption that export and import goods are perfect substitutes in the production process.

This chapter is organized as follows. Section 2 presents the various models used in this chapter. The solution method and several other issues are discussed in section 3 In Section 4, I select the values for the various parameters of my model. Section 5 and 6 respectively presents my findings and my concluding remarks. Since the work presented in this chapter is closely related to the issues raised in chapter 2, I do not present a review of the literature.

---

[4] See Gali and Monacelli (1999), Svensson (1999a, 2000), Walsh (2001), Batini and Nelson (2000) and Clarida et al. (2001) for example.

[5] In this model, there is a Leontief relationship between imports and domestic value added whereas in McCallum and Nelson (2000), a CES relationship is assumed. This is an important assumption I will use to derive the supply function.

[6] See McCallum and Nelson (2000) and McCallum (2001) for a model presentation with intermediate imports.

[7] In this and subsequent chapter, I follow McCallum and Nelson (1999b) and assume that net exports are a function of the terms of trade (see equation (7)).

2. Small Open Economy Models

As the model below is in many respects similar to the one presented in the previous chapter, my description will mainly focus on the new equations contained in this framework. The model is a small open economy model with some microfoundations and is mostly similar to those used to analyse issues related to monetary policy. It is presented below.

$$Y_t = A - \Omega(1-\tau)[(i_t - E_t(\pi_{t+1})) - \bar{r}] + \psi G_t + \lambda B_{t-1} + \lambda^f B^f_{t-1} + \eta_x s_t + u_t \tag{1a}$$

$$Y_t = E_t(Y_{t+1}) - \Omega(1-\tau)[(i_t - E_t(\pi_{t+1})) - \bar{r}] + [G_t - E_t(G_{t+1})] \tag{1b}$$

$$+ [X_t - E_t(X_{t+1})] + u_t$$

$$i_t - i^f_t = E_t(e_{t+1}) - e_t + w_t \tag{2}$$

$$s_t = (1-\eta_m)(e_{t-1} + p^f_{t-1}) + \eta_m(e_t + p^f_t) - p_t \tag{3}$$

$$G_t = \delta\tau Y_t + (1-\delta)\bar{G} - [\delta(1-\tau)]B_{t-1} \tag{4}$$

$$B_t = \bar{r}(1-\delta)(G_t - \tau Y_t) + [1 + (1-\delta)(\bar{r}(1-\tau) - \phi)]B_{t-1} \tag{5}$$

$$B^f_t = [1 + \bar{r}(1-\tau) - \phi]B^f_{t-1} - X_t \tag{6}$$

$$X_t = \gamma_x s_t \tag{7}$$

$$\pi_t = \beta[\varphi\pi_{t-1} + (1-\varphi)E_t(\pi_{t+1})] + \theta(Y_t - \bar{Y}_t) + \varepsilon_t \tag{8}$$

$$\bar{Y}_t = (1 + d_t) \tag{9}$$

$$u_t = \gamma_u u_{t-1} + \xi_t^u \tag{10a}$$

$$\varepsilon_t = \gamma_\varepsilon \varepsilon_{t-1} + \xi_t^\varepsilon \tag{10b}$$

$$d_t = \gamma_d d_{t-1} + \xi_t^d \tag{10c}$$

$$w_t = \gamma_w w_{t-1} + \xi_t^w \tag{10d}$$

The variables are the same as in the previous chapter except for the following (foreign variables are denoted by the superscript f):

π inflation rate

s real exchange rate

e nominal exchange rate

X net exports of goods

η_m index of exchange-rate pass-through. Perfect (imperfect) pass-through is obtained when $\eta_m = 1$ $(0 < \eta_m < 1)$

η_x terms of trade elasticity

d stochastic supply shock

Equation (1a) is the open economy counterpart of the "textbook IS" equation which I described in chapter 2, section 3. Aggregate demand is negatively influenced by the real interest rate, positively influenced by government expenditure on goods and services, interest payments households receive on bonds and also by a depreciation of the real exchange rate which stimulates net exports. On the other hand, equation (1b) is the open economy version of the "intertemporal IS" equation described in the previous section (equation (1b) in chapter 2). In addition to expected future output, the real interest rate, the expected change in government expenditure, aggregate demand is also influenced by the expected change in net exports. Equation (1b) is obtained by combining the first order condition for consumption (equation (8) in chapter 2) with a resource constraint and the assumption that imports are intermediate goods.[8]

Equation (2) imposes interest parity on the part of risk-neutral asset holders. This equation implies that domestic interest rates exceed foreign interest rates, if the exchange rate is expected to depreciate. The shock term w represents variables not accounted for in this equation such as the risk premium. Equation (3) defines the real exchange rate. I assume that there can be a less than perfect pass-through of movements of the nominal exchange rate on prices, so that the law of one price may not hold perfectly in some cases. When a perfect pass-through of the exchange rate is allowed, $\eta_m = 1$ and the usual definition for the real exchange rate is obtained. However if $0 < \eta_m < 1$, there is an imperfect pass-through of exchange rate movements on prices.[9] The degree of exchange rate pass-

---

[8] To obtain equation (1b), the resource constraint $Y_t = C_t + G_t + X_t$ is combined with the Euler equation, $E_t(C_{t+1}) - C_t = \Omega(1-\tau)[(i_t - (E_t(p_{t+1} - p_t))) - \bar{r}]$.

[9] The speed of the pass-through is reduced when $0 < \eta_m < 1$. The pass-through can also be specified as in chapter 5. In this essay, there is actually a limit on the degree of exchange rate pass-through. As discussed in the next chapter, even when the pass-through is specified in that manner, it does not make any difference to the results.

through can potentially have important consequences on the choice of the monetary regime. For example, in Devereux and Lane (2001), with a low exchange rate pass-through, targeting the overall CPI instead of the GDP deflator or an exchange rate peg is recommended. This is because with a low degree of exchange rate pass-through, policy-makers can allow a volatile exchange rate to stabilize the economy in the face of external shocks while being less concerned that the volatility in the exchange rate will destabilize the overall price level.

Equations (4) and (5) describe the fiscal portion of the model and are respectively similar to equations (4) and (5) of chapter 2. Since I assume that the government borrows only from domestic residents, foreign assets do not enter in any of these equations. Equation (6) describes the change in foreign indebtedness. This equation assumes that foreigners acquire claims on domestic residents, whenever the current account suffers a deficit. This occurs when net interest payments on the foreign debt exceed net exports. To preclude any instability, I again assume that the long-run average growth rate exceeds the after tax real interest rate. Equation (7) assumes that net exports are a function of the real exchange rate. Since imports are intermediate goods in the model, I assume that only foreign behaviour is involved in exports.

Equation (8) is the aggregate supply relationship and this equation nests two popular supply functions commonly used for monetary policy analysis. This equation collapses to Calvo's model of staggered price adjustment if $\varphi = 0$ and to a 'hybrid' supply function if $0 < \varphi < 1$. The hybrid function has been derived by Fuhrer and Moore (1995) using a model with two period overlapping wage contracts and by Galì and Gertler (1999) using a model of staggered prices with a proportion of producers setting their prices according to a rule of thumb.[10]

There are a lot of disagreements over the value of φ and pinning down its value remains a challenge. Furher and Moore (1995) for the U.S and Smets (2000) for the Euro area argue in favour of a value of 0.5 for φ. On the other hand, Galì and Gertler (1999) and Galì, Gertler and López-Salido (2001) find evidence that φ is around 0.2 while Rudebusch (2000), based on U.S data, concludes that a plausible range for this coefficient is anywhere between 0 and 0.6. Since I am less concerned about how my model fits the data, pinning down the exact value of φ is not as important here. As I tend to favour 'compromise' values in my choice of parameter values, I set φ to 0.5 and hence follow Furher and Moore (1995).[11]

Two issues warrant comments regarding the aggregate supply function. In this chapter, instead of assuming the P-Bar supply function, I have replaced the latter with the Fuhrer-Moore supply function. In chapter 2, I was particularly interested in obtaining analytical results while at the same time having a supply function which could generate more price stickiness than Calvo's. The P-bar supply function was thus a good choice. However, in this chapter, as only numerical simulations are used to derive my results, the P-Bar supply function loses some of its appeal. Moreover, as the Fuhrer-Moore supply function is set up on the assumption that it is a good way of introducing more stickiness in the

[10] Fuhrer-Moore (1995) argue that this hybrid specification fits the US data relatively well and outperforms the purely forward looking aggregate supply function of Calvo's.

[11] I have experimented with various values of φ. These changes however do not affect my results.

economy, there is a lesser need to have both the P-Bar and Fuhrer-Moore supply relationships.[12]

A second general comment on equation (8) relates to the absence of an explicit exchange rate term in this equation despite being an open economy aggregate supply function. The supply function used in this model thus differs from open economy versions used in Walsh (1999b) and McCallum and Nelson (2000). The supply function in Walsh (1999b) contains an explicit exchange-rate term while in McCallum and Nelson (2000), the exchange-rate enters the aggregate supply function indirectly through its influences on the natural rate of output. In this model, it is shown in Appendix I that the exchange rate does not enter the aggregate supply function directly as in Walsh (1999b) or indirectly through the natural rate output term as in McCallum and Nelson (2000).

The main reasons for these differences are very simple. In Walsh (1999b), imports are treated as consumer goods but not as intermediate products. Hence in his model, there is a clear distinction between the producer and consumer price index. However, in this model since I assume that all imports are intermediate goods, I do not need to make such a distinction and this is why my supply function is different from Walsh's (1999b). Although McCallum and Nelson (2000) also treat imports as intermediate goods in their model, nevertheless they have a different supply function since they assume a CES production relationship between imports and domestic value added instead of a Leontief relationship as assumed here. Though my production function is a special case, nonetheless, it

[12] The P-Bar and Calvo supply functions generate less persistence in inflation compared to the Fuhrer-Moore aggregate specification. As a result, the latter fits the data better.

is appropriate that there be no exchange rate term in the natural rate equation or directly in the aggregate supply equation (see Appendix I for more details).

Equation (9) describes full-employment output, which without the stochastic shock d_t would be constant at full-employment level (which is normalized to be equal to one). The shock term d_t is interpreted here as a supply shock. Finally, equations (10a), (10b), (10c) and (10d) are respectively the stochastic demand, cost-push, supply and interest-parity shocks. I assume that all the different stochastic innovations, ξ^u, ξ^ε, ξ^d and ξ^w have zero mean and are uncorrelated with each other at all leads and lags. There is also an equation that defines the overall price level as a weighted average of the domestic price level and the exchange rate but since this equation is not needed to solve the model, it is not included in the basic framework.

3. Central Bank Preferences and Model Solution

In the previous chapter, the model is solved by assuming trial solutions and analytical results about the variance of output are subsequently derived. However, in this chapter, since the models presented are more complex, they are solved using numerical methods only. Furthermore, as mentioned in the introduction, I do not evaluate the two fiscal regimes based on their ability to minimize output fluctuations. Instead, I take a more general approach and evaluate the two polar cases using a loss function comprising of the unconditional variances of the output-gap and the deviations of inflation from its target. Society's loss function is given by equation (11) below:

$$L = E\sum_{t=0}^{\infty}\beta^{t}[\Lambda(Y_{t+i}-\bar{Y}_{t+i})^{2}+(\pi_{t+i}-\pi^{T})^{2}], \qquad \Lambda > 0 \tag{11}$$

where β is society's discount factor.

I assume that society assigns a weight of one on inflation stabilization and 0.5 on output stabilization ($\Lambda = 0.5$).[13] Society's loss is thus minimized whenever the output gap and the deviation of inflation from its target is zero.[14]

As mentioned previously, since I do not derive analytical results in this chapter, I resort to numerical methods developed and described by Backus and Driffill (1986), Currie and Levine (1993, chapter 6) and Soderlind (1999) to solve the model. These numerical methods are briefly discussed below and in Appendix II. Finally, the model is solved by assuming that the central bank lacks commitment and optimally targets either inflation or the exchange-rate in a discretionary and flexible manner. Hence, I assume that the central bank's loss function may differ from society's loss function. This and many other related issues are discussed below.

Many recent studies have shown that with forward looking behaviour, the optimal policy response when the central bank is able to precommit to a policy rule is inertial (See Woodford (1999) for example).[15] This is because a policy that keeps interest rates high for a long period of time will influence agent's future inflation expectations in a favoura-

---

[13] Rotemberg and Woodford (1998) and Woodford (1999) provides a formal derivation of such a function. They show that this loss function can be derived (under certain assumptions) as a quadratic approximation of a utility based-welfare function of a representative consumer. However, as shown by Fuhrer (1998), if demand and inflation persistence are present, this loss function may not be appropriate

[14] For convenience, I assume that the inflation target is zero and is state independent

[15] This "history dependence" was originally demonstrated by Kydland and Prescott (1980)

ble way. In these models, if expected future inflation is influenced in a favourable manner, this will also have a positive and favourable impact on current inflation since the latter depends on expected future inflation.

However, as demonstrated by Kydland and Prescott (1977), although optimal, the outcome under commitment is not time-consistent. This is because the central bank will always have an incentive to renege on its promises once the effects of a given shock have dissipated as it may no longer be optimal to commit to the same policy.[16] I do not consider the commitment outcome but rather assume that the central bank acts under discretion, more precisely under optimal discretion.

It is well-known from the pioneering work of Kydland and Prescott (1977) and Barro and Gordon (1983) that a monetary authority which has an overambitious output target, will under discretion experience an inflation rate above its target without any gain in output (inflation bias problem). Rogoff (1985), Persson and Tabellini (1993), Walsh (1995) and Svensson (1997) have shown that proper institutional design can eliminate the inflation bias and hence improve the outcome under pure discretion while at the same time circumventing the time-consistency problem.[17]

---

[16] Recently, Woodford (1999) has argued that policy under precommitment are always time-consistent. To explain his argument he introduces the concept of "timeless perspective". According to Woodford (1999), the initial date at which the commitment plan is determined is not important if the policy is formed from a "timeless perspective", that is if the policy is the one the central bank "would have wished to commit itself at a date far in the past." Although policy under Woodford's "timeless perspective" would be time-consistent, the assumption that the central bank can credibly commit to such plan remains open (see McCallum and Nelson (2001))

[17] Pure discretion is the case where a benevolent central bank has the same preferences as society On the other hand, under optimal discretion, the central bank's loss function can differ from that of society It assigns a bigger weight on inflation stabilization compared to society if it has stronger dislike for inflation.

For example, Rogoff (1985) argues that, appointing a conservative central bank which has a stronger dislike for inflation than society, reduces the inefficiency associated with the inflation bias that is obtained under pure discretion. However, within the theoretical framework of Barro and Gordon (1983), Lockwood, Miller and Zhang (1998) have shown that the case for a conservative central bank does not necessarily hinge on an over-ambitious output target. They argue that a conservative central bank is advantageous if output and employment are persistent.

Moreover, in the now standard "New Neoclassical Synthesis" framework, it has been shown that welfare can be improved by delegating monetary policy to a central bank with a loss function which is different from society's, even if a zero output gap is targeted.[18] Hence, within the New Keynesian literature, a conservative central bank which assigns more weight to inflation than society or which chooses an optimal discretionary targeting regime can improve the purely discretionary outcome even if a zero output gap is targeted.

The reason for these gains is simple. A conservative central bank, by imparting a high degree of inertia in interest rates, mimics the outcome under commitment and hence improves the inflation-output-gap trade-off. On the other hand, since such inertial behaviour of interest rates is absent under pure discretion, the outcome under the latter is worse. Using the New Keynesian framework, several studies have shown precisely this. For example, Clarida, Galì and Gertler (1999) in their survey and Walsh (1999b) argue that

[18] In this model, the central bank is assumed to target a zero output gap, as a result no inflation bias of the Barro-Gordon type arises.

delegating monetary policy to a conservative central bank improves the purely discretionary solution if the economy is hit respectively by persistent cost-push and demand shocks. A similar type of result is obtained by targeting for example the nominal income growth (Jensen (2002)), output gap growth (Walsh (2001)), price level (Vestin (2000)), money growth (Söderström (2001)) or by smoothing nominal interest rates (Sack and Wieland (2000)). All of these papers show that a history-dependent rule can be obtained under discretion if either of these policies is followed. In all cases, the optimal targeting regime improves the purely discretionary outcome since the inertial movement of interest rates helps to improve the inflation-output-gap trade-off.

In this chapter, I assume that the central bank optimally targets either inflation or the exchange rate in a flexible manner. The loss function of the monetary authority takes the following form:

$$L^c = E\sum_{t=0}^{\infty}\beta^t[\Lambda^c(Y_{t+t}-\bar{Y}_{t+t})^2+h_1\pi_{t+t}^2+h_2e_{t+t}^2] \qquad (12)$$

The weight the central bank assigns to inflation or the exchange rate in its loss function will depend on several factors. I assume that the central bank's discount factor is identical to that of society's. Inflation targeting is defined as the case where $h_2 = 0$ while $0 < h_1 < \infty$. Since I focus on flexible targeting regimes, the monetary authority also places some weight on the real side of the economy and in this case I assume that $\Lambda^c = \Lambda = 0.5$.[19]

[19] A value of 1 is also frequently used in the literature based on the idea that the central bank cares equally about inflation and output stabilization. I follow Svensson (2000) and set the value to 0.5. I experimented with different values but this made little difference to my results.

Depending on its preferences, the central bank may attach a higher or lower value to h_1 compared to society. The central bank is described as conservative in Rogoff's (1985) sense or having a dislike for inflation if $h_1 > 1$ (it assigns a bigger weight to inflation compared to society). As h_1 approaches infinity, this implies that the central bank strictly targets inflation as the relative weight on output becomes very small. On the other hand, if $0 < h_1 < 1$, the central bank attaches a greater importance to output stabilization compared to society. This can be justified by the fact that even with a higher value on output stabilization, the central bank faces a more favourable inflation-output gap trade-off and hence chooses to be less conservative than society.[20]

If the monetary authority is targeting the exchange rate, $h_1 = 0$ and $0 < h_2 < \infty$. In this case also, I assume that the central bank cares about the real side of the economy and places some weight on the output gap. Λ^c is again set at $\Lambda = 0.5$. As h_2 approaches infinity, this implies that the monetary authority opts for absolute pegging of the exchange rate. To find the optimal value of h_1 or h_2, a grid search is performed and the value that minimizes the loss function is selected as the optimal value.[21]

To apply the solution methods of Soderlind (1999) and to solve the model, it is first formulated in state-space form.

---

[20] For more on this issue see Svensson(1997) and Beetsma and Jensen(1999).

[21] The increment value for h_1 or h_2 is set at 0.05. I have experimented with a finer grid but this made little difference to my results.

$$\begin{bmatrix} x_{1t+1} \\ E_t x_{2t+1} \end{bmatrix} = A \begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} + B i_t + \zeta_{t+1} \qquad (13)$$

where x_{1t} is a vector of current and predetermined state variables, x_{2t} is a vector of forward looking state variables and ζ_{t+1} is a vector of error terms. The central bank's problem is to solve the linear quadratic problem given by the following loss function,

$$L^c = E\left[\sum_{t=1}^{\infty} \beta^{t-1} Z_t Q Z_t\right] \qquad (14)$$

by choosing the sequence for interest rates $\{i_t\}_{t=1}^{\infty}$

where the minimization is subject to equation (13), Q is a matrix of preference parameters and Z_t is a vector of goal variables. The solution to equation (13) is obtained by applying the numerical methods implemented in Backus and Driffill (1986), Currie and Levine (1993) and Soderlind (1999). This program imposes the condition that there are no explosive and multiple solutions. I evaluate the different policy regimes by conducting numerical simulations and then calculate in each case the loss function value of society. Appendix II gives more details about how the model is solved and how it is set up.

4. Numerical Simulations

Since I resort to numerical simulations to illustrate my results, I have to choose values for the different parameters of my model. For many of my parameters, I select similar values as in the previous chapter. As argued previously, the choice of the baseline parameters for an annual projection of the model is not an easy task as there are strong disagreements in the literature about the values some of these parameters might take. For this reason, I offer some sensitivity tests on some of the parameters of the model. Moreover, since I am mostly interested in comparing the performance of different regimes, I do not make any presumption whatsoever to make the model match the data in detail.[22]

Concerning the "textbook IS" function given by equation (1a), as in chapter 2, the interest "elasticity" of demand, Ω is assumed to be equal to 0.75 while the terms of trade elasticity, η_x is assumed to be equal to 0.25. This three-to-one ratio captures a common rule of thumb about IS coefficients.[23] Some sensitivity tests are performed on the interest and terms of trade elasticity of demand. In all cases, however, the three-to-one ratio between these two parameters is kept.

I again assume a value of unity for ψ, the standard expenditure multiplier (see Mankiw and Scarth (1995, p286)). λ and λ^f are set at unity also although the choice for these parameters are harder to justify. I have considered other values for these three parameters but found it made little difference to my results. For this reason, I do not report any sensitivity tests on these parameters.

In equation (1b), as in chapter 2, I assume a similar value for Ω, i.e., 0.8. The tax rate τ is again set at 0.25. γ, the net export elasticity is set at 1 and no sensitivity test is

---

[22] Values are chosen so as to have a reasonable response of output, inflation, interest rate and exchange rate

[23] A typical estimate of the monetary conditions ratio for a small open economy is between 1.5 and 3.5. See Duguay (1994) and Gerlach and Smets (2001) for example.

reported on this value also. For the aggregate supply function, in the case of Calvo's model, φ is set at 0 and at 0.5 in the case of Furher and Moore's. θ, the slope of the Phillips curve is set at 0.5. As in chapter 2, a sensitivity test is also performed on the slope of this parameter by assuming a higher and lower value (0.25, 0.75). With full pass-through of the exchange rate, η_m is set at 1 and at 0.5 in cases where there is less than a perfect pass-through.

The model is simulated by assuming that the economy is hit by stochastic shocks. I follow Svensson (2000) and set the standard deviations of the shock terms at 0.01, all covariance terms to zero and the first-order serial correlation coefficients to 0.5 in the baseline case.[24] As in chapter 2, I compare the two polar fiscal regimes by simulating three shocks: a demand, cost-push and supply shock. I then perform several sensitivity tests to verify if my results are robust or not. The baseline parameter values are illustrated in Table 1 below while the alternative parameter values are indicated in brackets.

[24] The covariance matrix of the shocks can be obtained using a VAR. However, since my main objective is to compare policy regimes and obtain approximate numerical results, the simple approach used here is appropriate. Using a VAR to construct the structural shocks would be appropriate if the model is used for forecasting purposes. However, even a VAR is not without problems since it would require the proper identification restrictions.

Table 1: Summary of Baseline Values[25]

$\Omega = 0.75$ when eq (1a) is used (0.375, 1.5)	$\delta = 0$ if fiscal policy is flexible
$\Omega = 0.8$ when eq (1b) is used.	$\delta = 1$ if fiscal policy is rigid.
$\psi = \lambda = \lambda^f = 1$	$\varphi = 0$ if Calvo
$\eta_x = 0.25$ (0.125, 0.5)	$\varphi = 0.5$ if Furher and Moore
$\tau = 0.25$	$\sigma_{\xi^u} = \sigma_{\xi^\varepsilon} = 0.01$
$\bar{r} = 0.04$	$\sigma_{\xi^w} = \sigma_{\xi^\lambda} = 0.01$
$\gamma_x = 1$	$\gamma_{u,\varepsilon,\lambda,w} = 0.5$ (0.1, 0.9)
$\theta = 0.5$ (0.25, 0.75)	$\eta_m = 1$ (0.5)
$\beta = 0.96$	
$\phi = 0.041$	

5. Results

My results are reported in Tables 2-10. Tables 2-4 show the results when baseline values are assumed for a demand, cost-push and supply shock respectively. In all tables. "Textbook IS" refers to the case where equation (1a) is used while the "New IS" refers to the case where equation (1b) is used. "Calvo AS" refers to the case where φ is set at 0 in equation (8) and "Fuhrer-Moore" refers to the case where φ is set at 0.5. The parameter h_1 refers to the optimal weight on inflation when the monetary authority is targeting inflation. As previously argued, if $h_1 > 1$, this implies that the central bank has a stronger dislike for inflation compared to society and hence monetary policy, in Rogoff's (1985) sense, is delegated to a conservative central bank. On the other hand, h_2 is the optimal

[25] Alternative values are shown in brackets.

weight the central bank assigns to the exchange rate in its loss function when it is an exchange rate targeter. As h_2 approaches infinity, this implies that the central bank is opting for absolute exchange rate targeting. If $0 < h_2 \leq 1$, the central bank opts for modest exchange rate targeting.

When baseline parameter values are assumed (Tables 2-4), the serial correlation coefficients are set to 0.5 and there is a perfect pass-through of exchange rate movements on prices. These assumptions are subsequently relaxed. I rank the two polar fiscal regimes according to their ability to minimize society's loss function. Moreover, as in the previous chapter I define the RD index as the ratio of the loss function value for a demand shock under "Hoover" compared to "Keynes". I have a similar definition for the RC and RS index which respectively represents an index of the ratio of the loss function value when cost-push and supply shocks are involved. Values for RD, RC and RS that are greater than one imply that the analysis supports the conventional approach to fiscal policy. In addition, to the RD, RC and RS index and the loss function value, the standard deviation of various endogenous variables are presented in the baseline case. These standard deviations are however not shown when the sensitivity tests are presented.

Consider Table 2 which shows the results for a demand shock when baseline parameter values are assumed. It is seen that the loss function value for cases involving the "textbook IS" function is *always* lower under a flexible regime compared to the rigid approach, irrespective of the type of monetary regime and supply function. For example, the RD index is around 1.80 when the "textbook IS" is involved, indicating that conventional wisdom - that a flexible fiscal regime is more stabilizing for the economy - is supported. It is to be noted also that the variances of both the output gap and inflation are unambiguously lower under the flexible regime. Hence when the "textbook IS" is involved, moving from a rigid to a flexible fiscal regime involves a 'free lunch'. Moreover, while it is optimal for the central bank to be conservative when it is targeting inflation (h_1 is always greater than one), it is optimal to target the exchange rate in a modest fashion.

The results are very different when the "intertemporal IS" is considered. A flexible fiscal regime receives less support in this case. For example, if the monetary authority targets inflation, the rigid approach to fiscal policy does as well as the flexible approach (the RD index is one under both supply functions). However, if the monetary authority targets the exchange rate, as the RD index is less than one, this indicates that a rigid fiscal regime is preferred to the flexible regime (the RD index in Table 1 when the Calvo aggregate supply function is involved is 0.857, while under the Fuhrer-Moore aggregate supply function it is 0.929). Hence conventional wisdom does not receive a lot of support when the "intertemporal IS" and the Fuhrer-Moore aggregate supply function are involved.

My results for a demand shock are thus similar to those obtained in the closed economy model (Chapter 2, section 4) for cases involving the "textbook IS" but are slightly different when the "intertemporal IS" is involved. With the latter, I find a stronger support for the rigid fiscal policy in the open economy as compared to the closed economy model. While a rigid fiscal regime was supported in the closed economy only when the P-Bar supply function was involved and not under the Calvo supply function, on the other hand, in the open-economy model, the rigid fiscal regime does as well as the flexible regime even under the Calvo supply function.

I have already offered some intuition in chapters 1 and 2 why the rigid approach to fiscal policy might be preferred to the flexible approach. While the impact effect of a negative shock can be lower under a flexible fiscal policy compared to a rigid fiscal policy (the increase in the budget deficit acts as an automatic stabilizer), the ensuing recession can last longer, since the government has to work down the accumulated debt. As in the closed-economy model, I find (at least for a demand shock) that this destabilizing feature of a flexible fiscal regime is not important unless agents are forward-looking.

The intuition behind this result is simple. When the government is running a deficit, agents know that at some point in time in the future, the government will have to pay down the debt and hence anticipate that output will fall in the future. When the "intertemporal IS" is involved, since current output depends on future output, as agents anticipate that future output will fall, they reduce current consumption and this in turn reduces current output. Although a flexible fiscal policy helps to dampen any initial adverse shock, its ability to do so is limited when the "intertemporal IS" is involved. Moreover, with sticky prices, the destabilizing feature of a flexible fiscal policy is accentuated. This is because it takes more time for the economy to recover from a negative shock when prices are sticky.

My results also suggest that the negative dimension of a flexible fiscal policy is more important under exchange rate targeting compared to inflation targeting. Since the exchange-rate acts as a shock absorber under inflation targeting, the government can afford to do less to stabilize the economy. On the other hand, when the central bank is targeting the exchange rate, the exchange rate no longer acts as a shock absorber and the government has to do more and run bigger budget deficits (compared to inflation targeting) to stabilize the economy. As a result, the destabilizing feature of a flexible fiscal policy (higher persistence) is more important under exchange rate targeting compared to inflation targeting. This is why a rigid approach to fiscal policy is more likely to win under exchange rate targeting when agents are forward-looking.

My results are very different when a cost-push shock is assumed. When baseline values are considered, the loss function value under the rigid and flexible fiscal policy is almost identical. It is seen in Table 3, that the RC index is virtually one under both IS and aggregate supply functions, indicating that the rigid approach to fiscal policy does as well as the flexible approach. Compared to a demand shock, the results under a cost-push shock are very different: the choice of fiscal policy does not matter as both fiscal regimes yield virtually the same value for the loss function. My results for a cost-push shock in the open economy framework are thus very similar to those obtained in the closed economy model, especially when the Calvo aggregate supply function is used.

My results are also similar to the closed economy model when supply shocks are considered, especially when Calvo's supply function is involved. Table 4 indicates that the RS index is almost one in all cases, implying that the loss function value under the two fiscal regimes is virtually the same. The intuition behind these results is simple. A central bank which is targeting inflation will respond to a negative supply or cost-push shock by increasing interest rates. This will in turn depress output. If the supply or cost-push shock is expected to persist, it is optimal for the central bank to keep interest rates high for a long period of time. As a result, this contractionary policy will have a prolong negative effect on output. Although a flexible fiscal regime helps the government mitigate the impact effect of a negative supply shock, nevertheless, its ability to act as a shock absorber is weakened especially if the central bank's contractionary policy is expected to persist. As a result, it makes little difference if the fiscal authority is conducting fiscal policy in a rigid or flexible manner.[26]

As mentioned previously, I perform several sensitivity tests by changing the values some of the parameters take in the model. The results of my sensitivity tests are shown in Tables 5-10. It is clear from these tables that the results are virtually unchanged when these sensitivity test are performed. For example, Table 5 allows for an imperfect pass-through of exchange rate movements on prices.[27] It is seen in Table 5 that the results are virtually unchanged from the baseline case if an imperfect pass-through is allowed. In the case of a demand shock, the Keynesian approach is preferred when the "textbook IS" is used and this regime receives less support when the "intertemporal IS" is used. The results for the cost-push and supply shocks are also very similar to the baseline case, although in this case, the flexible approach receives more support when the "textbook IS" is used.

---

[26] Although I can appeal to the same intuition given in the closed economy model to explain why the choice of the fiscal regime does not matter when the central bank is targeting inflation under a cost-push and supply shock, finding a similar explanation when the central bank is an exchange rate targeter is more difficult

[27] The degree of exchange rate pass-through usually has important implications on the choice of the optimal monetary regime, in particular on the choice of the index of prices to target. For example, with a perfect pass-through of prices, because exchange rate movements are quickly reflected in prices, it may be optimal to target the GDP deflator instead of the overall CPI. On the other hand, if there is an imperfect pass-through, it usually does not make any difference whether the GDP deflator or the overall CPI is targeted (see Devereux (2000) and chapter 4 for more details).

Table 6 presents the results when the interest and exchange rate "elasticities" are altered in the "textbook IS" function. My findings are again very similar to the baseline case. The flexible approach to fiscal policy receives more support when the "textbook IS" is involved while the "Hoover" approach receives more support when the 'intertemporal' IS is used. Tables 7 and 8 present my results when the degree of serial correlation is changed. Several interesting results emerge from these two tables. Although the choice of the fiscal regime is virtually unaffected when I allow for different degrees of serial correlation, I find that for persistent supply and cost-push shocks, it is optimal for the central bank to target inflation more aggressively when the "intertemporal IS" is involved. In this model, it does so by increasing the weight on inflation in its loss function. For example, when a high degree of serial correlation is assumed (correlation coefficient of 0.9), it is seen in Table 7, that the central bank assigns a very large weight on inflation (h_1 becomes bigger) and in some cases, it is even optimal for it to strictly target inflation (for example for the "intertemporal IS", Fuhrer-Moore, supply shock case).

This result is similar to Clarida, Galì and Gertler (1999) who also find that it is optimal for the central bank to be more conservative when cost-push and supply shocks are positively correlated. Their findings are however for a closed economy model. The intuition behind this result is simple. If supply or cost-push shocks are expected to persist, inflation will remain high for a long period of time. In this case, it is optimal for the central bank to impart a lot of inertia in interest rates. By doing so, the central bank will influence agent's future inflation expectations in a favourable way. In this model, since current inflation depends on expected future inflation (partially in Fuhrer-Moore case), by keeping policy tight for a prolonged period, it will influence agent's future inflation expectations in a favourable way and hence current inflation.

Although a conservative central bank does not directly imply inertia in monetary policy, it is nevertheless the optimal behaviour when there is positive autocorrelation in supply or cost-push shocks. Moreover, my results also support the findings of Walsh (1999b) who argue that it is optimal to have a conservative central bank if demand shocks are expected to persist. In this case also, for cases involving the "intertemporal" IS, the weight the central bank assigns to inflation is much higher compared to society.

A final comment on my results regards the interaction between monetary and fiscal policy in the model. As argued in chapters 1 and 2, since fiscal policy is part of the system, monetary policy adjusts whenever the fiscal regime changes. In particular, since a more rigid fiscal policy avoids the destabilizing feature of a bond financed deficit, the central bank finds it appropriate to put less weight on stabilizing long-term expectations and more weight on real output. As a result, a rigid fiscal policy can be *more* stabilizing for the economy.

Although I find this result to be very strong in chapter 2, in this chapter, this result does not hold in all the cases. Nevertheless, it is seen in Tables 2-10, that the central bank preferences are indeed dependent on the type of fiscal regime in place. In a number of cases (e.g., Table 2, "New IS" and Fuhrer-Moore, Table 6, "New IS") the central bank assigns less weight on inflation stabilization and more weight on output stabilization when fiscal policy is rigid (h_1 is smaller under "Hoover" in that case). This endogenous reaction of monetary policy can be an important determinant in explaining why a rigid fiscal regime can be preferred. Traditional analyses of fiscal policy have not allowed for such an endogenous reaction of monetary policy.

6. Concluding Remarks

My results in this chapter are very similar to those obtained in chapter 2, indicating that the findings regarding which fiscal regime minimizes fluctuations in the economy can be carried over to an open economy framework. As in the closed economy model, the results are mixed. With a "textbook IS" function and a demand shock, conventional wisdom regarding fiscal policy tends to be supported. On the other hand, with the "intertemporal IS", a rigid approach to fiscal policy does as well flexible approach. In the latter case, my results in the open economy framework is less dependent on the type of aggregate supply assumed.

Since my results in the open economy framework are very similar to those obtained in the previous chapter when the closed economy model is used, they provide support for the findings of Clarida, Galì and Gertler (2001) who find that the "monetary policy design problem for the small open economy is isomorphic to the problem of the closed economy." As Clarida, Galì and Gertler's (2001) results pertain only to monetary policy, this chapter has confirmed that this result also applies to fiscal policy.

Given my findings in this and the previous chapter, my results indicate that the rigid approach to fiscal policy should be given more consideration in policy circles Although, I have theoretically demonstrated that it is possible that a rigid approach to fiscal policy can be as stabilizing for output as the more traditional Keynesian approach, nevertheless my analysis remains very stylized and highly dependent on the type of model I have assumed. With new data and with the increasing number of countries adopting budget rules, it would be interesting to see if empirical support for a rigid fiscal policy has increased.

Appendix I

When deriving Calvo's aggregate supply function, a common assumption which is usually made is that the real marginal cost is positively related to the output gap, (see Appendix I, chapter 2). I present below how the output gap can be derived from real marginal cost under the assumption of intermediate imports.

I assume that each unit of output requires a unit of intermediate imports and a unit of domestic value added, i.e., intermediate inputs must be combined with domestic value added in fixed proportions to produce a given unit of output (see Scarth (1996) for more details). This is shown below.

$$Y = min(V, IM) \tag{A1.1}$$

where Y denotes output, V is value added (I assume a Cobb-Douglas domestic value added function) and IM is intermediate imports. Since firms must combine domestic value added with intermediate inputs, I obtain

$$Y = V = IM = F(N) \tag{A1.2}$$

Let $\frac{W}{P}$, E, N and TC denote real wage, real exchange rate (the relative price of intermediate imports), employment and total cost faced by firms.

Thus

$$TC = \left(\frac{W}{P}\right)N + \alpha EY \tag{A1.3}$$

and

Real marginal cost, MC, is given by

$$MC = \left(\frac{W}{P}\right)\left(\frac{1}{MPL}\right) + \alpha E \qquad (A1.4)$$

where MPL is the marginal product of labour.

I assume a Cobb-Douglas production function for the domestic value added function:

$$Y = \bar{K}^{1-\omega} N^{\omega} \qquad (A1.5)$$

Hence, the marginal product of labour is given by $MPL = \frac{\omega Y}{N}$ (A1.6)

As in chapter 2, Appendix II, I assume that there is complete wage flexibility, so the supply of labour satisfy the following condition:

$$N_t = \sigma\left(\frac{W_t}{P_t}\right)\left(\frac{1}{C_t}\right) \qquad (A1.7)$$

Denoting logs of upper case variables by lower case letters and assuming that the initial steady-state value for E is unity, I have the following equations (using A1.4-A1.7).

$$mc = (1-\alpha)(w - p - mpl) + \alpha \ln(\alpha E) \qquad (A1.8)$$

$$y = (1-\omega)\bar{k} + \omega n \qquad (A1.9)$$

$$mpl = \ln\omega + y - n \qquad (A1.10)$$

$$n = \ln\sigma + w - p - c \qquad (A1.11)$$

The resource constraint is given by

$$y = \Phi_1 c + \Phi_2 g + (1 - \Phi_1 - \Phi_2)x \qquad (A1.12)$$

By proceeding in the same fashion as in Chapter 2, Appendix II, one obtains the following expression for marginal cost

$$mc = (1-\alpha)\left[\frac{2(y-(1-\omega)\bar{k})}{\omega} - \ln\sigma - \ln\omega + \Phi_3 y - \Phi_4 g - \Phi_5 x\right] + \alpha\ln(\alpha E) \qquad \text{(A1.13)}$$

where $\Phi_3 = \frac{1-\Phi_1}{\Phi_1}$, $\Phi_4 = \frac{\Phi_2}{\Phi_1}$ and $\Phi_5 = \frac{1-\Phi_1-\Phi_2}{\Phi_1}$

Setting $\overline{mc}$ to zero and denoting the latter as the level of marginal cost that would prevail when $y = \bar{y}, g = \bar{g}, x = \bar{x}$ for a given value of the real exchange rate, one obtains from equation (A1.13)

$$\overline{mc} = (1-\alpha)\left[\frac{2(\bar{y}-(1-\omega)\bar{k})}{\omega} - \ln\sigma - \ln\omega + \Phi_3 \bar{y} - \Phi_4 \bar{g} - \Phi_5 \bar{x}\right] + \alpha\ln(\alpha E) \qquad \text{(A1.14)}$$

By subtracting the above equation from equation (A1.13), I obtain the following:

$$mc = \Phi_6(y-\bar{y}) - \Phi_7(g-\bar{g}) - \Phi_8(x-\bar{x}) \qquad \text{(A1.15)}$$

where $\Phi_6 = (1-\alpha)\left[\frac{2}{\omega} + \left(\frac{1-\Phi_1}{\Phi_1}\right)\right]$, $\Phi_7 = (1-\alpha)\Phi_4$ and $\Phi_8 = (1-\alpha)\Phi_5$

Under "Keynes", since $g = \bar{g}$,

$$mc = \Phi_6(y-\bar{y}) - \Phi_8(x-\bar{x}) \qquad \text{(A1.16)}$$

Under "Hoover", since $(g-\bar{g}) = \tau(y-\bar{y})$

$$mc = \Phi_9(y-\bar{y}) - \Phi_8(x-\bar{x}) \qquad \text{(A1.17)}$$

where $\Phi_9 = (1-\alpha)\left[\frac{2}{\omega} + \left(\frac{1-\Phi_1}{\Phi_1}\right) - \left(\frac{\Phi_2}{\Phi_1}\right)\right]$

As there is less than 1% difference between Φ_6 and Φ_9, I make the same assumption as in Chapter 2, Appendix II and set $\Phi_6 = \Phi_9$.

Furthermore, since the coefficient in front of the $(x - \bar{x})$ term in my aggregate supply function (under both "Hoover" and "Keynes") is very small, I set it to zero.[28]

Hence the expression that relates marginal cost to the output gap is given by

$$mc = \Phi_6(y - \bar{y}) \qquad \text{(A1.18)}$$

[28] This coefficient is approximately equal to 0.02 I performed several sensitivity tests and found the value of this coefficient to be always close to zero

Appendix II

In this section, I present how the model is formulated in state-space form. For ease of exposition, I assume that the IS function is given by equation (1b), there is full pass-through of exchange rate movements on prices, hence $\eta_m = 1$ and foreign interest rates and prices are exogenous.[29]

The model is given by equations (1b) - (10d). To formulate the model in state-space form, some transformations are needed.

From equation (3), with $\eta_m = 1$,

$$s_t = e_t + p_t^f - p_t \tag{A2.1}$$

Lagging the equation above, I obtain the equation below

$$s_{t-1} = e_{t-1} + p_{t-1}^f - p_{t-1} \tag{A2.2}$$

subtracting (A2.2) from (A2.1), I have

$$s_t - s_{t-1} = e_t - e_{t-1} + \pi_t^f - \pi_t \tag{A2.3}$$

writing (A2.3) forward and taking expectations at time t, I obtain

$$E_t(s_{t+1}) = E_t(e_{t+1}) - e_t + E_t(\pi_{t+1}^f) - E_t(\pi_{t+1}) + s_t \tag{A2.4}$$

Using equation (2) to eliminate $[E_t(e_{t+1}) - e_t]$ in equation (A2.4) and using equation (9), I obtain the equation (A2.5)

[29] This section follows closely the solution method described in Söderström (2000)

$$E_t(s_{t+1}) = (i_t - i_t^f - w_t) - E_t(\pi_{t+1}) + (e_t - e_{t-1}) - \pi_t + s_{t-1} \quad \text{(A2.5)}$$

To eliminate $E_t(\pi_{t+1})$, $E_t(G_{t+1})$ and $E_t(s_{t+1})$ from equation (1b), equations (4), (8) and (A2.5) are used and the resulting equation is given by (after some simplification):

$$\Delta_1 Y_t = \Delta_2 E_t(Y_{t+1}) - \Delta_3 i_t + \Delta_4 \pi_t - \Delta_5 \pi_{t-1} - \Delta_6 \varepsilon_t + \Delta_7 B_{t-1} + \Delta_8 w_t \quad \text{(A2.6)}$$

$$+ u_t + \Delta_9 \bar{Y}_t$$

where Δ_i are function of the parameters of the model.

Rearranging the above equation and denoting the output gap by

$ygap_t = Y_t - \bar{Y}_t$, I obtain:

$$E_t(ygap_{t+1}) = \frac{1}{\Delta_2}(\Delta_1 ygap_t + \Delta_3 i_t - \Delta_4 \pi_t + \Delta_5 \pi_{t-1} + \Delta_6 \varepsilon_t - \Delta_7 B_{t-1} - \Delta_8 w_t \quad \text{(A2.7)}$$

$$- u_t - \Delta_{19} \bar{Y}_t)$$

where $\Delta_{19} = \Delta_9 + \gamma_d - \Delta_1$

To obtain the other two forward looking equations, equations (2) and (8) are used,

From equation (2)

$$E_t(e_{t+1}) = i_t - i_t^f + e_t - w_t \quad \text{(A2.8)}$$

from equation (8),

$$E_t(\pi_{t+1}) = \Delta_0(\pi_t - \phi\beta\pi_{t-1} - \varphi(Y_t - \bar{Y}_t) - \varepsilon_t) \quad \text{where } \Delta_0 = \frac{1}{\beta(1-\phi)} \quad \text{(A2.9)}$$

The other equation in the system are the predetermined variables and the following equations:

$$B_t = -\Delta_{10} ygap_t + \Delta_{11} B_{t-1} + \Delta_{12} \bar{Y}_t \quad \text{(A2.10)}$$

$$B_t^f = \Delta_{17} B_{t-1}^f - \gamma_x (s_{t-1} + e_t - e_{t-1} - \pi_t) \quad \text{(A2.11)}$$

$$G_t = \delta\tau ygap_t - \rho B_{t-1} + \Delta_{18} \bar{Y}_t \quad \text{(A2.12)}$$

Equations (A2.10), (A2.11), (A2.12) are obtained by manipulating equations (4)-(6).

The complete system is given by equations (A2.3), (A2.7), (A2.8), (A2.9), (A2.10), (A2.11), (A2.12) and (10a)- (10d)

The vector of predetermined state variables (n_1=12)is given by v_{1t} where

$$v_{1t} = [u_t,\ d_t,\ \varepsilon_t,\ w_t,\ B_{t-1},\ G_{t-1},\ B_{t-1}^f,\ s_{t-1},\ ygap_{t-1},\ \pi_{t-1},\ e_{t-1},\ i_{t-1}]$$

and the vector of forward-looking variables (n_2=3) is given by

$$v_{2t+1} = [ygap_{t+1},\ \pi_{t+1},\ e_{t+1}] \quad \text{(A2.13)}$$

The vector of disturbances is given by

$$\zeta_{t+1} = \{\xi_{t+1}^u,\ \xi_{t+1}^d,\ \xi_{t+1}^\varepsilon,\ \xi_{t+1}^w,\ 0_{11x1}\} \quad \text{(A2.14)}$$

The model can thus be written in state-space form with

$$\begin{bmatrix} v_{1t+1} \\ E_t v_{2t+1} \end{bmatrix} = A \begin{bmatrix} v_{1t} \\ v_{2t} \end{bmatrix} + Bi_t + \zeta_{t+1} \quad \text{where,} \quad \text{(A2.15)}$$

The A and B matrices are respectively (15x15) and (15x1) of zeros except for

$A(1,1) = \gamma_u$, $A(2,2) = \gamma_d$, $A(3,3) = \gamma_\varepsilon$, $A(4,4) = \gamma_w$,

$A(5,2) = \Delta_{12}$, $A(5,5) = \Delta_{11}$, $A(5,13) = -\Delta_{10}$,

$A(6,2) = \Delta_{15}$, $A(6,5) = -\Delta_{14}$, $A(6,13) = \delta\tau$

$A(7,7) = \Delta_{13}, A(7,8) = -\gamma_x, A(7,11) = \gamma_x, A(7,14) = \gamma_x, A(7,15) = -\gamma_x$

$A(8,8) = 1, A(8,11) = -1, A(8,14) = -1, A(8,15) = 1$

$A(9,13) = 1, A(10,14) = 1, A(11,15) = 1$

$$A(13,1) = -\frac{1}{\Delta_2}, A(13,2) = -\frac{\Delta_{19}}{\Delta_2}, A(13,3) = \frac{\Delta_6}{\Delta_2}, A(13,4) = -\frac{\Delta_8}{\Delta_2}$$

$$A(13,5) = -\frac{\Delta_7}{\Delta_2}, A(13,10) = \frac{\Delta_5}{\Delta_2}, A(13,13) = \frac{\Delta_1}{\Delta_2}, A(13,14) = -\frac{\Delta_4}{\Delta_2},$$

$A(14,2) = \varphi\Delta_0, A(14,3) = -\Delta_0, A(14,10) = -\phi\beta\Delta_0, A(14,13) = -\varphi\Delta_0$

$A(14,14) = \Delta_0$

$A(15,4) = -1, A(15,15) = 1$

$$B(12,1) = 1, B(13,1) = \frac{\Delta_3}{\Delta_2}, B(15,1) = 1$$

For convenience, the different targeting regimes are analyzed by defining a goal function. The vector of goal variables (n_3=8) is defined by

$$Z_t = [\pi_t, ygap_t, s_t, e_t, i_t, \Delta i_t, B_t^f, B_t] \tag{A2.16}$$

The goal variables can be written in terms of the state variables as

$$Z_t = C_v v_t + C_i i_t$$

where C_v and C_i are respectively (8x15) and (8x1) matrices of zeros except for

$C_v(1,14) = 1, C_v(2,13) = 1.$

$C_v(3,8) = 1, C_v(3,11) = -1, C_v(3,14) = -1, C_v(3,15) = 1$

$C_y(4, 15) = 1, C_y(6, 12) = -1,$

$C_y(7, 7) = \Delta_{13}, C_y(7, 8) = -\gamma_x, C_y(7, 11) = \gamma_x, C_y(7, 14) = \gamma_x, C_y(7, 15) = -\gamma_x,$

$C_y(8, 2) = \Delta_{12}, C_y(8, 5) = \Delta_{11}, C_y(8, 13) = -\Delta_{10}$

$C_i(5, 1) = 1, C_i(6, 1) = 1$

The central bank minimizes the loss function given by

$$L^c = Z_t'QZ_t \tag{A2.17}$$

where Q is the matrix of preferences parameters and is given by the diagonal $[\lambda_\pi, \lambda_{ygap}, \lambda_s, \lambda_e, 0, \lambda_i, \lambda_{bf}, \lambda_b]$.

The targeting regimes are obtained by assigning appropriate values to the different λ's. For example in the case of inflation targeting all the $\lambda's$ are set to zero except λ_{ygap} =0.5 and λ_π is optimized.

Under discretion, the central bank's loss function can be written as

$$L^c = Z_t'QZ_t \tag{A2.18}$$

$$L^c = \begin{bmatrix} y'_t & i'_t \end{bmatrix} \begin{bmatrix} C_y' \\ C_i' \end{bmatrix} Q \begin{bmatrix} C_y & C_i \end{bmatrix} \begin{bmatrix} y_t \\ i_t \end{bmatrix}$$

$$= y'_tC'_yQC_yy_t + y'_tC'_yQC_ii_t + i'_tC'_iQC_yy_t + i'_tC'_iQC_ii_t$$

$$= y'_tH_1y_t + y'_tH_2i_t + i'_tH'_2y_t + i'_tH_3i_t \tag{A2.19}$$

where $H_1 = C'_yQC_y$, $H_2 = C'_yQC_i$ and $H_3 = C'_iQC_i$

Under discretion, the central bank reoptimizes each period and has no incentive to deviate. Moreover, private agents when forming their expectations incorporate this restriction. It follows that the forward looking variables for the contemporaneous period will only depend on the period's predetermined variables.

As a result, the optimal rule will be a function of predetermined variables only. This implies that in a stationary solution the following restriction holds, $v_{2t} = Gv_{1t}$. In my case the matrix G is a 1x15 vector. More details about the stationary solution can be found in Soderlind (1999).

The stationary solution is given by

$$L^c = v'_{1t}Vv_{1t} + \frac{\beta}{1-\beta}trace(V\Sigma_{v_1v_1}dt) \qquad \text{(A2.20)}$$

where the matrix V is the value function from the model solution and the optimal rule takes the following form:

$$i_t = -Fv_{1t} \qquad \text{(A2.21)}$$

The predetermined and forward looking variables are given by

$$v_{1t+1} = Mv_{1t} + \zeta_{1t+1} \qquad \text{(A2.22)}$$

and $v_{2t} = Nv_{1t}$ (A2.23)

where $M = A_{11} + A_{12}N + -B_1F$.

To find the covariance matrix of v_{1t}, the goal variable is partitioned as follows

$$Z_t = C_v v_t + C_t t_t = \begin{bmatrix} C_{v1} & C_{v2} \end{bmatrix} \begin{bmatrix} v_{1t} \\ v_{2t} \end{bmatrix} + C_t F v_{1t}$$

$$= \begin{bmatrix} C_{v1} & C_{v2} \end{bmatrix} \begin{bmatrix} v_{1t} \\ N v_{1t} \end{bmatrix} + C_t F v_{1t} = C_z v_{1t} \qquad \text{(A2 24)}$$

where $C_z = C_{v1} + C_{v2} N + C_t F$

The covariance matrix of the goal function is then given by $C_z \Sigma_{v1} C_z'$, where Σ_{v1} is the variance-covariance matrix of v_{1t}.

Table 2: Demand Shock - RD Index with Baseline Values

	Calvo's AS				Fuhrer-Moore AS			
	Textbook IS		New IS		Textbook IS		New IS	
	Flex	Rigid	Flex	Rigid	Flex	Rigid	Flex	Rigid
Inflation T								
Loss	0.329	0.587	0.017	0.017	0.610	1.091	0.002	0.002
sd π	0.769	1.028	0.066	0.066	1.199	1.604	0.060	0.061
sd output gap	1.203	1.607	0.070	0.069	1.416	1.893	0.107	0.105
sd e	2.661	3.569	1.391	1.398	4.766	6.403	1.397	1.402
sd G	0.000	0.398	0.000	0.017	0.000	0.469	0.000	0.026
optimal h_1	1.05	1.05	1.05	1.05	1.05	1.05	1.30	1.25
Ex Rate T								
Loss	0.287	0.511	0.007	0.006	0.610	1.099	0.014	0.013
sd π	0.668	0.891	0.128	0.123	1.206	1.620	0.208	0.199
sd output gap	1.183	1.580	0.145	0.133	1.404	1.882	0.166	0.158
sd e	1.193	1.548	1.197	1.243	2.341	3.072	1.134	1.178
sd G	0.000	0.391	0.000	0.033	0.000	0.466	0.000	0.039
optimal h_2	0.35	0.35	0.05	0.05	0.20	0.20	0.05	0.05
RD index								
Inflation T	1.784		1.000		1.789		1.000	
Ex Rate T	1.780		0.857		1.802		0.929	

Loss = loss function, sd π = std deviation of inflation, sd e = std deviation of the nominal exchange rate, sd G = std deviation of government expenditure. optimal h_1 = optimal weight on inflation targeting and optimal h_2 = optimal weight on exchange rate targeting. RD index = loss function value (rigid)/loss function value (flex).

Table 3: Cost-Push Shock - RC Index with Baseline Values

	Calvo's AS				Fuhrer-Moore AS			
	Textbook IS		New IS		Textbook IS		New IS	
	Flex	Rigid	Flex	Rigid	Flex	Rigid	Flex	Rigid
Inflation T								
Loss	0.593	0.594	0.399	0.400	1.709	1.722	0.498	0.498
sd π	1.448	1.450	0.840	0.838	2.313	2.324	0.647	0.643
sd output gap	0.743	0.742	1.334	1.339	1.722	1.722	1.774	1.777
sd e	4.119	4.094	3.895	3.983	8.202	8.230	3.309	3.345
sd G	0.000	0.184	0.000	0.331	0.000	0.426	0.000	0.440
optimal h_1	0.70	0.70	1.55	1.55	0 95	0.95	1.50	1.50
Ex Rate T								
Loss	0.529	0.529	0.302	0.302	1.844	1.872	0.495	0.486
sd π	1.325	1.320	0.725	0.726	2.375	2.388	0.733	0.640
sd output gap	0.849	0.867	1.167	1.166	1.862	1.888	1.698	1.751
sd e	2.329	2.224	0.449	0.632	4.414	4.270	0.116	0.163
sd G	0.000	0.214	0.000	0.289	0.000	0.467	0.000	0.433
optimal h_2	0.20	0.20	1.00	0.80	0.20	0.20	3.95	3.25
RC index								
Inflation T	1.002		1.003		1.008		1.000	
Ex Rate T	1.000		1.000		1.015		0.982	

Loss = loss function, sd π = std deviation of inflation, sd e = std deviation of the nominal exchange rate, sd G = std deviation of government expenditure, optimal h_1 = optimal weight on inflation targeting and optimal h_2 = optimal weight on exchange rate targeting. RC index = loss function value (rigid)/loss function value (flex).

Table 4: Supply Shock - RS Index with Baseline Values

	Calvo's AS				Fuhrer-Moore AS			
	Textbook IS		New IS		Textbook IS		New IS	
	Flex	Rigid	Flex	Rigid	Flex	Rigid	Flex	Rigid
Inflation T								
Loss	1.040	1.051	0.002	0.002	3.391	4.025	0.003	0.003
sd π	1.363	1.372	0.062	0.064	2.818	3.076	0.053	0.052
sd output gap	2.147	2.155	0.095	0.088	3.353	3.645	0.140	0.137
sd e	4.732	4.775	3.028	2.863	11.23	12.29	5.398	5.236
sd G	0.231	0.815	0.231	0.297	0.231	1.153	0.231	0.298
optimal h_1	1.05	1.05	1.65	1.45	1.05	1.05	2.90	2.75
Ex Rate T								
Loss	0.913	0.917	0.024	0.020	3.429	4.078	0.164	0.136
sd π	1.192	1.194	0.229	0.203	2.859	3.121	0.686	0.626
sd output gap	2.112	2.119	0.314	0.270	3.329	3.625	0.608	0.553
sd e	2.127	2.075	2.590	2.531	5.548	5.917	4.306	4.317
sd G	0.231	0.802	0.231	0.354	0.231	1.140	0.231	0.413
optimal h_2	0.35	0.20	0.05	0.05	0.20	0.20	0.05	0.05
RC index								
Inflation T	1.011		1.000		1.187		1.000	
Ex Rate T	1.004		0.833		1.189		0.830	

Loss = loss function, sd π = std deviation of inflation, sd e = std deviation of the nominal exchange rate, sd G = std deviation of government expenditure, optimal h_1 = optimal weight on inflation targeting and optimal h_2 = optimal weight on exchange rate targeting. RS index = loss function value (rigid)/loss function value (flex).

Table 5: RD, RC and RS Index with Imperfect Pass-Through (η_m = 0.5)

	Calvo's AS				Fuhrer-Moore AS			
	"Textbook IS"		"New IS"		"Textbook IS"		"New IS"	
	Flex	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**
Inflation T								
Demand shock								
Loss	0.653	1.508	0.002	0.002	1.913	5.106	0.003	0.003
optimal h_1	1.00	0.95	1.25	1.20	1.00	1.30	1.50	1.45
C-Push shock								
Loss	1.315	1.797	0.409	0.410	6.099	9.543	0.497	0.498
optimal h_1	0.65	0.65	1.70	1.70	1.15	1.30	1.75	1.75
Supply shock								
Loss	2.064	2.699	0.003	0.003	10.62	18.82	0.004	0.003
optimal h_1	1.00	0.95	2.00	1.70	1.20	1.30	4.00	3.75
RD Index	2.309		1.000		2.669		1.000	
RC Index	1.367		1.002		1.565		1.002	
RS Index	1.308		1.000		1.772		0.965	
Ex Rate T								
Demand shock								
Loss	0.532	1.263	0.013	0.011	2.107	5.749	0.027	0.024
optimal h_1	0.45	0.45	0.05	0.05	0.15	0.10	0.05	0.05
C-Push shock								
Loss	1.082	1.428	0.311	0.305	7.204	11.43	0.936	0.903
optimal h_1	0.30	0.30	110	110	0.15	0.10	160	240
Supply shock								
Loss	1.693	2.161	0.311	0.305	11.83	21.33	0.936	0.903
optimal h_1	0.45	0.45	110	110	0.15	0.10	160	240
RD Index	2.374		0.846		2.729		0.889	
RC Index	1.320		0.981		1.587		0.965	
RS Index	1.276		0.981		1.803		0.965	

Table 6: RD, RC and RS Index with Low and High IS Coefficients

	Calvo's AS				Fuhrer-Moore AS			
	"Textbook IS1" (Ω = 0.375)		"Textbook IS2" (Ω = 1.5)		"Textbook IS1" (Ω = 0.375)		"Textbook IS2" (Ω = 1.5)	
	Flex	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**
Inflation T								
Demand shock								
Loss	0.272	0.483	0.381	0.691	0.864	1.668	0.948	1.733
optimal h_1	0.85	0.85	1.25	1.25	1.00	1.00	1.00	1.00
C-Push shock								
Loss	0.520	0.521	0.704	0.707	1.177	1.181	2.870	2.910
optimal h_1	0.85	0.85	0.85	0.85	1.00	1.00	0.85	0.85
Supply shock								
Loss	0.605	0.530	2.142	2.564	1.330	1.337	11.89	16.64
optimal h_1	0.85	0.85	1.25	1.25	1.05	1.00	1.00	1.00
RD Index	1.776		1.814		1.931		1.828	
RC Index	1.002		1.004		1.003		1.014	
RS Index	0.876		1.197		1.005		1.399	
Ex Rate T								
Demand shock								
Loss	0.248	0.440	0.320	0.575	0.423	0.756	0.964	1.761
optimal h_1	0.80	0.55	0.25	0.25	0.40	0.30	0.15	0.15
C-Push shock								
Loss	0.460	0.461	0.638	0.641	1.249	1.261	3.187	3.241
optimal h_1	0.40	0.30	0.10	0.10	0.35	0.30	0.10	0.10
Supply shock								
Loss	0.552	0.483	1.794	2.133	0.881	0.886	12.10	16.90
optimal h_1	0.80	0.55	0.25	0.25	0.20	0.20	0.15	0.15
RD Index	1.774		1.797		1.787		1.827	
RC Index	1.002		1.005		1.010		1.017	
RS Index	0.875		1.189		1.006		1.397	

Table 7 - RD, RC and RS Index when Serial Correlation Coefficients $\gamma_{u,\varepsilon,d}$ = 0.9

	Calvo's AS				Fuhrer-Moore AS			
	"Textbook IS"		"New IS"		"Textbook IS"		"New IS"	
	Flex	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**
Inflation T								
Demand shock								
Loss	0.492	0.881	0.005	0.005	0.901	1.633	0.005	0.005
optimal h_1	1.05	1.05	35	35	1.05	1.05	35	35
C-Push shock								
Loss	2.852	2.858	2.492	2.492	4.923	4.958	2.551	2.552
optimal h_1	1.25	1.25	4.75	4.70	1.10	1.10	3.95	3 85
Supply shock								
Loss	1.568	1.583	0.005	0.005	5.106	6.058	0.005	0.005
optimal h_1	1.05	1.05	99	93	1.05	1.00	230	230
RD Index	1.791		1.000		1.812		1.000	
RC Index	1.002		1.000		1.007		1.000	
RS Index	1.010		1.000		1.186		1.000	
Ex Rate T								
Demand shock								
Loss	0.432	0.770	0.696	0.653	0.914	1.648	1.356	1.307
optimal h_1	0.35	0.30	0.05	0.05	0.20	0.20	0.05	0.05
C-Push shock								
Loss	2.824	2.844	2.185	2.186	5.155	5.214	2.499	2.503
optimal h_1	0.50	0.50	0.80	0.60	0.20	0.20	53	63
Supply shock								
Loss	1.378	1.383	3.702	3.409	5.138	6.114	6.489	6.181
optimal h_1	0.30	0.30	0.10	0.10	0.20	0.20	0.10	0.10
RD Index	1.782		0.938		1.803		0.964	
RC Index	1.007		1.000		1.011		1.002	
RS Index	1.004		0.921		1.190		0.953	

Table 8: RD, RC and RS Index when Serial Correlation Coefficients $\gamma_{u,\varepsilon,d}$ = 0.1

	Calvo's AS				Fuhrer-Moore AS			
	"Textbook IS"		"New IS"		"Textbook IS"		"New IS"	
	Flex	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**
Inflation T								
Demand shock								
Loss	0.185	0.332	0.002	0.002	0.342	0.616	0.002	0.002
optimal h_1	1.00	1.05	0.90	0.90	1.00	1.00	1.15	1.15
C-Push shock								
Loss	0.252	0.252	0.178	0.178	0.776	0.780	0.251	0.251
optimal h_1	1.05	1.05	0.95	0.95	0.80	0.80	1.20	1.20
Supply shock								
Loss	0.590	0.596	0.002	0.002	1.923	2.284	0.003	0.003
optimal h_1	1.00	1.05	1.00	0.95	1.00	1.00	1.45	1.35
RD Index	1.795		1.000		1.801		1.000	
RC Index	1.000		1.000		1.013		1.000	
RS Index	1.010		1.000		1.188		1.000	
Ex Rate T								
Demand shock								
Loss	0.164	0.292	0.003	0.003	0.348	0.626	0.005	0.005
optimal h_1	0.20	0.25	0.05	0.05	0.15	0.20	0.05	0.05
C-Push shock								
Loss	0.237	0.237	0.145	0.145	0.843	0.852	0.255	0.250
optimal h_1	0.15	0.15	0.60	0.60	0.10	0.10	1.00	1.00
Supply shock								
Loss	0.523	0.524	0.005	0.004	1.954	2.322	0.002	0.002
optimal h_1	0.20	0.25	0.05	0.05	0.15	0.20	0.05	0.05
RD Index	1.780		1.000		1.799		1.000	
RC Index	1.000		1.000		1.011		0.980	
RS Index	1.002		0.859		1.188		0.733	

Table 9: RD, RC and RS Index when Slope of Aggregate Supply, θ = 0.25

	Calvo's AS				Fuhrer-Moore AS			
	"Textbook IS"		"New IS"		"Textbook IS"		"New IS"	
	Flex	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**
Inflation T								
Demand shock								
Loss	0.217	0.387	0.002	0.002	0.321	0.569	0.005	0.005
optimal h_1	1.70	1.70	0.90	0.90	1.40	1.40	1.35	1.30
C-Push shock								
Loss	0.752	0.753	0.739	0.742	2.478	2.489	1.418	1.419
optimal h_1	0.90	0.90	1.45	1.45	1.15	1.15	1.75	1.75
Supply shock								
Loss	0.478	0.422	0.002	0.002	0.998	1.001	0.005	0.005
optimal h_1	1.70	1.70	1.00	0.95	1.40	1.45	1.45	1.55
RD Index	1.783		1.000		1.773		1.000	
RC Index	1.001		1.004		1.004		1.001	
RS Index	0.883		1.000		1.003		1.000	
Ex Rate T								
Demand shock								
Loss	0.198	0.353	0.004	0.004	0.315	0.564	0.010	0.010
optimal h_1	0.40	0.40	0.05	0.05	0.25	0.25	0.05	0 05
C-Push shock								
Loss	0.698	0.700	0.572	0.572	2.741	2.775	1.400	1.388
optimal h_1	0.15	0.15	0.30	0.30	0.15	0.15	0.75	0.60
Supply shock								
Loss	0.441	0.388	0.006	0.006	1.002	1.014	0.027	0.022
optimal h_1	0.40	0.40	0.05	0.005	0.25	0.25	0.05	0.05
RD Index	1.783		1.000		1.790		1.000	
RC Index	1.003		1.000		1.012		0.991	
RS Index	0.880		1.000		1.012		0.815	

Table 10: RD, RC and RS Index when Slope of Aggregate Supply, $\theta = 0.75$

	Calvo's AS				Fuhrer-Moore AS			
	"Textbook IS"		"New IS"		"Textbook IS"		"New IS"	
	Flex	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**	**Flex**	**Rigid**
Inflation T								
Demand shock								
Loss	0.487	0.872	0.001	0.001	1.018	1.832	0.001	0.001
optimal h_1	0.75	0.75	1.25	1.20	0.85	0.85	1.45	1.40
C-Push shock								
Loss	0.528	0.530	0.228	0.228	1.476	1.489	0.250	0.250
optimal h_1	0.50	0.50	1.60	1.60	0.80	0.80	1.55	1.50
Supply shock								
Loss	2.101	2.327	0.002	0.002	8.895	11.56	0.003	0.003
optimal h_1	0.75	0.75	1.75	1.75	0.85	0.85	1.75	1.75
RD Index	1.791		1.000		1.800		1.000	
RC Index	1.004		1.000		1.001		1.000	
RS Index	1.107		1.000		1.300		1.000	
Ex Rate T								
Demand shock								
Loss	0.418	0.745	0.010	0.009	1.044	1.886	0.021	0.019
optimal h_1	0.30	0.25	0.05	0.05	0.20	0.20	0.05	0.05
C-Push shock								
Loss	0.465	0.466	0.182	0.182	1.591	1.615	0.258	0.248
optimal h_1	0.20	0.20	1.95	1.95	0.15	0.15	6.5	6.5
Supply shock								
Loss	1.803	1.988	0.081	0.067	9.124	11.90	0.563	0.491
optimal h_1	0.30	0.25	0.05	0.05	0.20	0.20	0.05	0.05
RD Index	1.782		0.950		1.807		0.950	
RC Index	1.002		1.000		1.015		0.961	
RS Index	1.102		0.827		1.304		0.872	

Chapter 4

Monetary Policy and Built-In Stability

1. Introduction

The costs and benefits of alternative monetary/exchange rate policies have captured attention once again. At least three developments have contributed to this renewed interest: the currency crises in the late 1990s, the launching of the Euro in 1999, and the growing interest in globalization in general. At the same time, analytical developments in macroeconomics make it unappealing for economists to respond to the renewed interest in this question simply by reminding policy-makers of standard results in the literature. In particular, since much of the existing literature involves descriptive, not optimization-based, macro models, this work is now regarded as unreliable.

For example, the classic Mundell (1963)-Fleming (1962) analysis indicates that monetary-aggregate targeting allows the exchange rate to act as a shock absorber. In particular, a decrease in foreign demand has no effect on real output when domestic currency depreciation is permitted. It is well known that extensions to the basic model of Mundell (1963)-Fleming (1962) weaken this insulation property. For instance, with a direct (supply-side) effect of the exchange rate on the price level, a depreciating currency is cost-increasing and cannot fully insulate the economy from demand shocks.[1] The insulation property of a flexible exchange rate under monetary targeting is also threatened if there is an overshooting of the exchange rate. As a result, output can fall *more* (in the short run following a drop in demand) with monetary-aggregate targeting than it does with exchange rate targeting, when both supply-side effects and exchange rate expectations are involved. One proof of this outcome - that the exchange rate can act as a shock *amplifier* - is contained in Myers and Scarth (1990); their analysis involves McCallum's (1980) specification for sticky prices and a central bank that targets the money supply. With increased interest in both micro foundations and alternative monetary policies, further examination of the fragility of the basic Mundell-Fleming theorems is worthwhile.

Goodfriend and King (1997) have advised that work in this area (the analysis of alternative monetary regimes) embrace their "New Neoclassical Synthesis" and in particular, incorporate the "expectational *IS* curve" that is derived in Kerr and King (1996), McCallum and Nelson (1999b) and which is extensively described in chapters 2 and 3. In his recent graduate-level text, Walsh (1999, p. 206) agrees with this advice; he stresses that "including expected future output as a determinant of aggregate demand can have important implications for the analysis of interest-rate monetary-policy rules."

While chapters 2 and 3 have focused on the implications of alternative fiscal regimes on output stability, this chapter on the other hand, shifts the focus of the thesis from fiscal policy to monetary policy and uses a series of stylized macroeconomic models to compare the performance of three monetary policy regimes: price-level targeting, wage-rate targeting and exchange rate targeting. The purpose of this chapter is to contrib-

---

[1] In this case, the aggregate supply curve shifts to the left.

ute to the issue of which variable should guide monetary policy. Since the focus of this chapter is on alternative monetary policy regimes and to make my comparison stark, I will ignore issues regarding alternative fiscal regimes and hence do not model the government sector. There is also another important change made in this chapter and which departs from the analysis described in chapters 2 and 3. All the models in this chapter are cast in continuous rather than in discrete time.[2] This change enables me to introduce certain types of shocks that are more easily simulated in continuous rather than in discrete-time models.

In this chapter, I examine the implications of alternative monetary policies for both the effect on output of a one-time (unexpected) change in demand, and the effect on the amplitude of the business cycle that accompanies an ongoing (anticipated) cycle in demand. Moreover, I assume that the alternative monetary/exchange rate policy choice does not generate different outcomes concerning long-term inflation and each one of them offers the central bank a credible nominal anchor to achieve its long-run goal of price stability. Since these three alternative monetary policy regimes do not generate a different long-term outcome, the choice among these targeting regimes can be made on the basis of which one delivers the most built-in stability in the short-run.

All the models presented in this chapter involve model-consistent exchange rate expectations and (through the existence of intermediate imports) supply-side effects of exchange rate changes.[3] The first model is descriptive, while the second and third allow for more thorough-going micro foundations and forward-looking behaviour - first on the

[2] The models presented in this chapter can be regarded as modern versions of the model of Buiter and Miller (1981) which in turn builds on the seminal work of Dornbusch (1976) model.

[3] The models in this chapter share a similar framework to those presented in chapter 3.

supply side (with multi-period overlapping wage contracts), and then on the demand side (with the Ramsey theory of consumption). To clarify the impact of each change in model specification, I introduce them one at a time, and I pose the same questions at each stage.

My results are easy to summarize and indicate that either a price-level or wage-rate targeting strategy can do as well as - or better than - exchange rate targeting in all the models. However, exchange rate targeting often scores second best while the other two monetary regimes switch between the first and third rankings. In particular, if attention is focused on persistent changes in demand, exchange rate targeting emerges as an appealing compromise approach - given model uncertainty.

This chapter is organized as follows. Additional introductory remarks are included in the remainder of this section. A concise survey of the recent literature on monetary regimes is offered in section 2. The structure of the three models is explained in section 3. Solution procedures and the choice of the parameter values are explained in sections 4 and 5. My results and concluding remarks are contained respectively in sections 6 and 7.

Before presenting the literature review, four general issues warrant comment at the outset. First, many analysts regard a fixed exchange rate as an impossible policy in today's world of mobile financial capital. In this setting, a promise of currency convertibility with only fractional foreign exchange reserves is not credible. This legitimate concern does not threaten my analysis, however, since *none* of the monetary policies that I consider involve any promise of ongoing convertibility. Instead, I consider three options that the central bank can choose for "leaning against the wind" in a flexible exchange rate setting. Without entering the foreign exchange market at all, the bank can adjust the domestic interest rate in the short run with a view to targeting any one of the overall price level, the GDP price deflator (which in my case amounts to the wage rate), or the exchange rate. As long as there is price stability in the rest of the world, all three policies give the economy its nominal anchor that leads to long-run domestic price stability.

A second generic issue has been raised by Goodfriend and King (1997), as they acknowledge both the existence of, and the policy implications of, nominal rigidities. They stress that the appropriate policy response to nominal rigidity is to make the current value of that nominal variable the target of monetary policy. When the value one must accept for that price is made equal to the value that is desirable for that variable, the fact that it is sticky ceases to be a problem. According to this approach, then, the central bank should target neither the exchange rate nor the overall price level. Instead, it should target only the component of prices that is sticky. For the models in this paper, this approach requires targeting an index of wage rates. One of my interesting findings is that, contrary to what Goodfriend and King (1997) predict, this is not the best policy in all cases by any means.

A third issue relates to the choice of the different monetary regimes I have chosen to investigate. I do not consider inflation targeting in my analysis but rather other targeting regimes which have not received a lot of attention from the literature. Inflation targeting has been extensively studied by many (Kiley (1998), Rudebusch and Svensson (1999), Svensson (1999b, 2000), Vestin (2000), Walsh (2001)) and most of these recent studies use a very similar framework to the one presented in section 3. For this reason and to keep my analysis as compact as possible, I do not consider inflation targeting in this chapter.

A fourth and final issue concerns whether models should be cast in discrete or continuous-time. Discrete-time models are common but since I am introducing certain types of shocks that are more easily simulated in continuous-time rather than in discrete-time, I choose to cast my model using the former.

2. Literature Review

Research on issues related to the conduct of monetary policy has a very long tradition in macroeconomics. For example, Fisher (1945) and Wicksell (1965) argue in favour of price level targeting. Friedman (1959) suggests having a monetary rule where the quantity of money would grow at a constant rate, sufficient to accommodate trend productivity growth. Mundell (1963)/Fleming (1962), on the other hand investigate the relative efficiency of fixed and flexible exchange rates in helping countries to absorb economic shocks. They show that under perfect capital mobility, only fiscal policy can affect output under a fixed exchange rate regime while under floating rates, monetary policy should be used. Poole (1970) in his seminal work, analyses the classic problem of choosing between an interest rate and a monetary aggregate as a policy tool. He shows that the choice of the optimal instrument depends crucially on the nature and relative importance of the shock hitting the economy.[4] Others such as Kydland and Prescott (1977), Barro and Gordon

[4] Poole (1970) in his analysis shows that an interest-rate rule is preferred if money-based shocks are more important while a money rule leads to smaller variance for output when aggregate demand shocks are more important. Poole's (1970) analysis ignores many factors such as expectations, supply shocks and inflation. These and many other factors have been incorporated into other models which have revisited this question. For a comprehensive survey on this issue, see Friedman (1990).

(1983) and Rogoff (1985) have also greatly influenced how we come to think about monetary policy issues today.[5]

More recently, there has been a resurgence of interest in issues related to monetary policy. This comes after a long period of research which emphasizes the role of non-monetary factors in the business cycle. This resurgence is shown in the enormous volume of work and the numerous conferences on issues related to the conduct of monetary policy.[6] Two factors can explain this renewed interest. First, the inability of the real business cycle literature to explain many stylized facts and the numerous papers showing the importance of monetary factors and monetary policy in the business cycle have prompted researchers to abandon models which do not have a role for monetary policy.[7] Second recent analytical developments in macroeconomics, have made it easier for researchers to analyse these issues while embracing models with strong theoretical underpinnings.

Because of the enormous amount of information, my literature review will be mostly limited to recent studies which have compared various monetary policy regimes. As mentioned in chapters 2 and 3, recent work on the design of monetary policy has highlighted the consensus which exists among academics about the framework used to analyse monetary policy issues but also the lack of consensus on how monetary policy should be conducted or what type of monetary regime should be in place. The fact that there exist

[5] This list of course includes many other notable contributions in this area.

[6] According to Clarida, Gali and Gertler (1999, p251), there is now a "new science of monetary policy".

[7] There are numerous recent papers which have shown precisely this. For example, Christiano, Eichenbaum and Evans (1996, 1998), Leeper, Sims and Zha (1996) and Bernanke and Mihov (1998) have presented evidence of the importance of monetary shocks and the effects monetary policy has on real activity.

many different and competing findings about which monetary regime is appropriate is both interesting and puzzling since many of these results are obtained in models which share a similar framework. This might indicate that even small differences in model specification are important and this is why finding a robust monetary regime is probably as important as finding the best regime. However for some reason, the literature seems to have emphasized the latter.

The recent literature on monetary policy regimes usually distinguishes between instrument rules and targeting rules/regimes. An instrument rule expresses the instrument of a central bank, usually the short-term interest rate as a function of predetermined or forward looking variables.[8] For example, the Taylor rule is a simple instrument rule that expresses the short term interest rate as a function of the output gap and the deviations of inflation from its target. On the other hand, a targeting regime is a set of target variables or target levels (for example inflation targets) that the central bank strives to achieve, usually by minimizing a welfare function.[9]

During the last decade, most of the research on monetary policy has been geared towards finding a good instrument or targeting rule which the monetary authority can potentially use to stabilize inflation around its target and output around its potential.

[8] Svensson (1999a) distinguishes between explicit instrument and implicit instrument rules Explicit instrument rules are rules that are a function of predetermined variables only, whereas implicit instrument rules are expressed as a function of forward looking variables.

[9] The literature on targeting regime usually distinguishes between strict and flexible regime. Under a flexible targeting regime, the central bank places some weight on the real side of the economy while under strict targeting, no weight is placed on the output gap. There has been some debate on whether the central bank should target inflation in a strict or in a flexible sense. Ball (1998) and Svensson (2000) argue that strict inflation targeting in open economy models can be destabilizing because it generates large fluctuations in output and the exchange rate. I also find in chapter 3 that strict inflation targeting can sometimes lead to an unstable outcome

Research on monetary policy rules/regimes has focused mostly on four main areas: how simple rules like Taylor's perform in macro models, how robust they are, which targeting regime is optimal and how simple instrument rules compare with targeting rules. The list of papers looking at simple instrument rules and targeting regimes is very extensive.

For example, empirical studies by Taylor (1993), Judd and Rudebusch (1998), Gerlach and Schnabel (1999), Ahn (2000) and Nelson (2000) have examined if the Taylor rule can provide a reasonably good description of central bank's behaviour over a certain historical period. Most of these papers argue that the Taylor rule has captured actual policy fairly well and this result seems robust for various countries.

On the other hand, Batini and Haldane (1999), Rudebusch and Svensson (1999), Levin, Wieland and Williams (1999) and other papers contained in the volume edited by John Taylor (1999) on "Monetary Policy Rules" compare the performance of various Taylor-type rules and inflation forecast based rules (IFB) in more formal models. The same type of analysis is also performed by Leitemo and Söderström (2001) and Côté, Kuszczak, Lam, Liu and St-Amant (2002) who look at the performance of Taylor-type rules in twelve models of the Canadian economy.[10]

One of the stark conclusions from these numerous papers is that Taylor-type rules, though not optimal, perform very well compared to more complex rules. Moreover, Taylor-type rules are found to be more robust across a wide range of models compared to complex rules which are usually fine-tuned to perform well in specific models (see Levin,

---

[10] For a survey on Taylor type rules, see John Taylor's website on monetary policy rules, www.stanford.edu/~johntayl/PolRulLink.htm.

Wieland and Williams (1999)). Despite the huge popularity of Taylor-type rules among academics, policymakers and central bankers have not yet embraced them. In many central bank models, the reaction function is modelled as an IFB rule[11]. These rules are preferred since they are more forward looking and hence capture central bank behaviour better. Nevertheless, research on Taylor-type rules is still very active and several issues remain unresolved[12].

In this chapter, I do not consider any instrument rules but only targeting regimes. Of the different types of monetary regimes, inflation targeting has received by far the most attention and is often compared to other targeting regimes.[13] For example, for a long period of time, the literature on targeting regimes has focused on the debate between price level versus inflation targeting. Conventional wisdom usually supports inflation targeting over price level targeting and there are numerous reasons why this is the case.

It is generally accepted that price level targeting entails a lower price level variance but at the expense of a higher inflation and a higher output variance. This is because inflation targeting allows drifts in the price level to occur. Hence, subsequent to a shock, if inflation is pushed above its average, under inflation targeting, inflation needs to be returned to its average level only.[14] On the other hand, price level targeting penalizes price level drifts and periods of above-average (below-average) inflation must be followed by

---

[11] For example, in QPM, the main forecasting model of the Bank of Canada or FPS, the model of the Reserve Bank of New Zealand, the base case reaction function is an IFB rule. However, more recently a Taylor-type rule has been used to provide an alternative scenario to the base case in the model of QPM.

[12] To name a few, the role of the exchange rate in these rules, the uncertainty surrounding the calculation of the output gap and how much should interest rate be smoothed.

[13] For more on inflation targeting, see Laubach, Mishkin, and Posen (2000).

[14] Under inflation targeting, bygones are bygones.

periods of below-average (above-average) inflation. This implies that the variability of inflation under price level targeting is higher compared to inflation targeting. This higher variability is especially costly if nominal rigidities are present in the economy since it entails higher output variability.

However, this "conventional" view regarding the superiority of inflation targeting over price level targeting has been challenged by Svensson (1999b), Williams (1999) and Smets (2000). Svensson (1999b), for example, argues that for time-consistent monetary policies (under discretion), price level targeting does not necessarily entail a higher inflation and output variance and can even offer a "free lunch" to policymakers. This result has been shown to hold by Vestin (1999) in a forward looking model with an aggregate supply function à la Calvo. Williams (1999) also shows that the conventional view regarding price level and inflation targeting is not fully supported within the FRB/US model. Although I do not compare inflation targeting with price level targeting in this chapter, some of my results are similar to the studies mentioned above. I find a fairly strong support for price level targeting even in more backward looking versions of my models.

While research on price level versus inflation targeting has dwindled in recent years, there has been a renewed interest in other types of targeting regimes. For example, McCallum and Nelson (1999a) consider nominal income targeting while Jensen (2002) compares inflation targeting with nominal income growth targeting and finds that the latter dominates the former as nominal income growth targeting induces inertial interest rate behaviour and this helps to improve the inflation-output trade-off.[15] On the other hand, Walsh (2001) using a similar framework, argues that targeting the change in the output gap is superior to both inflation and nominal income growth targeting and hence should be adopted. He argues that output gap growth targeting also leads to inertial interest rate behaviour as this targeting regime mimics the outcome under commitment and helps to improve the discretionary outcome. A similar argument is used by Söderström (2001) to explain the superior performance of money growth targeting over inflation targeting.

Another issue which has regained attention in recent years is whether the central bank should target the exchange rate or let the exchange rate float freely. Many have argued that in a world where capital can move freely, a fixed exchange rate regime (or any other similar regimes) is not feasible and will tend to be vulnerable. For example, Chang and Velasco (1999) argue that the main lesson to be learned form the Asian crisis is that the exchange rate should be allowed to float. With the Asian and other crises, support for a fixed exchange rate regime seems to have disappeared and more and more countries are now adopting inflation targeting (flexible exchange rate) as their monetary regime. Moreover, within this literature several other issues have captured interest recently. For example, issues regarding whether the central bank should target the overall price level or the GDP deflator in a world of floating exchange rate and/or issues related to the pass-through of exchange rate movements on prices. Some of the most recent work on these issues is reviewed below.

Svensson (2000), using a model which embraces the "New Neoclassical Synthesis" framework, finds that flexible-CPI inflation targeting is superior to strict-CPI inflation

[15] Ball (1997) and Svensson (1997) on the other hand, show that nominal GDP targeting can lead to "perverse" outcomes and can even be unstable. McCallum (1997) has shown however that this result depends on the backward looking Phillips curve used by Ball (1997).

targeting and to flexible domestic inflation targeting since flexible-CPI inflation targeting stabilizes the real exchange rate and hence limits the variability of output and CPI inflation. Other such as Galì and Monacelli (2000) and Ghironi (2000) also find strong support for flexible inflation targeting and hence for a flexible exchange rate. However, in the case of Galì and Monacelli (2000), a pegged exchange rate is found to be more desirable than a Taylor rule since the latter induces too much volatility in interest rates.

The above papers assume a perfect pass-through of exchange rate movements on prices. But if this assumption is dropped, several other important findings emerge. For example, Devereux (2000) finds that if there is an imperfect pass-through of exchange rate movements on prices, a flexible exchange rate regime is preferred to a fixed exchange rate regime since it can reduce output volatility without inducing too much inflation volatility. The intuition behind this result is simple. Under an imperfect pass-through of exchange rate movement on prices, the exchange rate is still allowed to play its role of a built-in stabilizer but since exchange rate movements do not feed quickly into prices, inflation variability is limited. As a result, a flexible exchange rate under these circumstances becomes more desirable. Moreover, he also argues that since exchange rate movements do not feed very quickly into overall prices under an imperfect exchange rate pass-through, it makes no difference if the central bank targets the overall CPI or domestic inflation.

On the other hand, if there is a complete pass-through of exchange rate movements on prices, the trade-off between output and inflation volatility is more important since in this case, inflation is more volatile as exchange rate movements are quickly reflected in prices. Devereux (2000) argues that despite increased exchange rate volatility, a flexible exchange rate is still optimal but in this case, the central bank should target the price of non-traded goods instead of the overall price level. He concludes by arguing that since the degree of exchange rate pass-through is likely to be lower for developed rather than developing countries, a flexible exchange rate regime is more attractive for mature economies.

A similar type of result is found by Devereux and Engle (2000), Monacelli (1999) and Devereux and Lane (2001). For example, Devereux and Lane (2001) obtain a similar result as in Devereux (2000) when they consider alternative monetary policy regimes for an emerging market economy. They find that a flexible exchange rate regime (inflation targeting) is always preferred to a fixed exchange rate regime but the central bank should target the GDP deflator if the degree of exchange rate pass-through is perfect. The reasons behind these findings are similar to those described above.

On the other hand, Clarida, Gali and Gertler (2001) argue that if there is a perfect exchange rate pass-through, the central bank should allow the exchange rate to float but target domestic inflation rather than overall CPI. Although they do not consider various degrees of exchange rate pass-through, their findings suggest that the problem for a small open economy model is "isomorphic" to that of a closed economy model. My results support many of these findings since I find that targeting the exchange rate as a monetary regime is frequently dominated by the flexible exchange rate options. However, I find less support for targeting the sticky component of the overall price level (in my case it is the wage-rate) when there is full pass-through of exchange rate movements on prices. In fact, I find that varying the degree of exchange rate pass-through does not affect my results. Hence, my results are slightly different from those of Devereux (2000) and the other papers presented in this section. These differences probably come from different treatment of imports and in how exchange rate pass through is modelled. In Devereux (2000) and numerous other papers, imports are not intermediate goods and hence there is a clearer distinction between the GDP deflator and the overall price level. Moreover, since many of these papers model exchange rate pass-through as in chapter 3 (in a dynamic fashion), this may partially explain why I find that my results are virtually unchanged under perfect and imperfect pass-through in this chapter.[16]

3. Three Macro Models

This section presents the various models used to compare the different monetary regimes. As these model are to a large extent similar to the models presented in chapters 2 and 3, more details can be found in these chapters.

The models are defined by the following equations:

$$y = -\psi r + \delta c + \beta a \tag{1a}$$

$$\dot{y} = \psi(r - \bar{r}) + \delta \dot{c} + \beta \dot{a} \tag{1b}$$

$$c = e(1 - \Delta) + f - p \tag{2}$$

$$r = i - \pi \tag{3}$$

$$i = i^f + \dot{e} \tag{4}$$

[16] I do not use a dynamic approach to model the pass-through in this chapter for simplicity reasons. This equation would have added another order to my differential equations and would thus have made it even more difficult to solve the model. Moreover as shown by my results in chapter 3, assuming various degrees of pass-through do not alter my basic findings.

$$i = \bar{i} + \Omega[\theta p + \alpha w + (1 - \theta - \alpha)e] \quad (5)$$

$$p = w + \gamma c \quad (6)$$

$$\dot{w} = \phi(y - \bar{y}) + \pi \quad (7)$$

$$\dot{w} = \lambda(v - w) \quad (8a)$$

$$\dot{v} = \lambda[v - p - \mu(y - \bar{y})] \quad (8b)$$

All variables (except the interest rates) are defined as the logarithms of the associated item:

a	autonomous spending
c	competitiveness (the terms of trade)
e	exchange rate (value of foreign exchange)
f	price of goods in the rest of the world (in foreign currency units)
i	domestic nominal interest rate (i^f is the foreign rate)
p	domestic price
π	expected inflation rate (π^f is the foreign rate)
r	domestic real interest rate (r^f is the foreign rate)
v	value of wages settled at each point in time
w	index of wage rates
y	real output ($\bar{y}$ is the natural rate, set at zero)

All slope parameters are positive, and dots above variables indicate time derivatives. Three models are considered, and not all equations are involved in each model.

Equation (1a) is a standard *IS* relationship: demand depends positively on autonomous spending and the terms of trade, and negatively on the real interest rate. This relationship is involved in the first two models. Equation (1b) is the expectational *IS* relationship that has been recommended by Kerr and King (1996) and McCallum and Nelson (1999b). This alternative *IS* relationship is viewed as having firmer microfoundations. It follows from the Ramsey model of household spending and a log-linear approximation of the economy's resource constraint:

$$y = \psi h + \beta a + (1 - \psi - \beta)x, \tag{9}$$

where x is the logarithm of exports. Denoting the log of household spending by h, and assuming a logarithmic form for the instantaneous utility function, the Ramsey consumption function is

$$\dot{h} = r - \bar{r} \tag{10}$$

where $\bar{r}$ is interpreted as both the foreign interest real rate and the representative agent's rate of time preference.[17] In this expectational IS setting, parameters ψ and β are interpreted as the steady-state ratios of household spending and autonomous spending to total output. As in chapter 3, all imports are intermediate products (which must be combined with domestic value added in fixed proportions (as in Scarth, 1996, page 180)), so only foreign behaviour is involved in exports. Since we assume that variations in foreign GDP are captured in the autonomous spending term, we follow McCallum and Nelson (1999b) and specify that exports are proportional to the terms of trade: $x = \rho c$. Substituting this relationship into the resource constraint, taking the time derivative, and interpreting δ as $\rho(1 - \psi - \beta)$, I obtain equation (1b), which is involved in just the third of the three mod-

---

[17] Turnovsky, (1995, page 359), has a discussion of this standard, but unappealing, assumption that is involved when the Ramsey model is applied in a small open economy setting.

els discussed below.

Equation (2) defines the terms of trade. Δ is a parameter which indexes the degree to which firms "price to market." If exchange rate changes are passed on to buyers one-for-one, $\Delta = 0$ and the terms of trade are affected to the fullest extent possible. On the other hand, to specify the possibility that firms allow larger short-run variations in profit margins by not passing on exchange rate changes fully, we consider $0 < \Delta < 1$. It is noteworthy that $\Delta = 1$ is sufficient to make the terms of trade fall, not rise, with a domestic currency depreciation.[18] Following Obstfeld and Rogoff (2000), I focus on values for Δ that preclude such a "perverse" response of the terms of trade.

Equation (3) defines the relationship between nominal and real interest rates. There is a similar relationship for the rest of the world, $r^f = i^f - \pi^f$, but since I assume zero actual and expected inflation in that outside world of price stability, there is no difference between foreign real and nominal interest rates. Equation (4) imposes interest parity on the part of risk-neutral asset holders.

Equation (5) is the central bank's reaction function. This relationship involves the bank adjusting the nominal interest rate above its equilibrium value whenever either the (logarithm of the) domestic price level is above its target (a value of zero), the index of wage rates is above its target (a value of zero), or the domestic currency is below its target (also a value of zero). Price-level targeting is involved if $\theta = 1$ and $\alpha = 0$, wage-rate targeting is imposed if $\theta = 0$ and $\alpha = 1$, and exchange rate targeting is involved if $\theta = \alpha =$

18. This can be appreciated by using equations (2) and (6) to evaluate $\frac{\partial c}{\partial \Delta}$ for a given wage.

0. If there is price stability in the rest of the world, all three policies provide a nominal anchor. Equation (5) allows us to consider various degrees of leaning against the wind in all three cases. As parameter Ω approaches infinity, the authority is opting for absolute pegging of either the price level, the wage rate or the exchange rate.

Equations (6) and (7) define the supply side of the economy. Equation (6) follows from the existence of intermediate imports; the selling price of domestic goods is a weighted average of wages and the domestic price of intermediate imports: $p = \xi w + (1 - \xi)(e(1 - \Delta) + f)$. Using equation (2), this price equation can be re-expressed as equation (6), with $\gamma = \frac{(1 - \xi)}{\xi}$

Equation (7) is a standard expectations-augmented Phillips curve for wages and it is part of the first model examined below. In this first case, expectations for asset prices and goods prices are treated differently. In the auction market for foreign exchange, perfect foresight is specified. For the goods price, however, which depends on the sluggishly adjusting wage rate, agents focus on "core" inflation which they set at the average domestic inflation rate. Since zero foreign inflation is assumed, both expected and actual core inflation are zero whichever monetary targeting strategy is adopted. Thus, $\pi = 0$ in the first model.[19] Price stability is often defined as a situation in which inflation has ceased to be an important variable in the decision making of private individuals. Our baseline model is based on this assumption.

The second and third models involve a richer structure for wage adjustment - that defined by equations (8a) and (8b). These relationships represent Calvo's (1983) multi-

---

[19] Hence there is no difference between real and nominal interest rates in Model 1.

period overlapping contracts specification that is favoured by macroeconomists who put a premium on microfoundations[20]. Agents who set v, the wage that is not already determined at each point in time, base their decision on expected future values of both the cost of living and the output gap. The weights attached to each of these expected future outcomes is given by the distribution which defines the number of short and long-term wage contracts. In this specification, $\frac{1}{\lambda}$ is the average contract length. Models 2 and 3 involve this more explicit structure and forward-looking behaviour. These models also involve a more thorough-going embracing of model-consistent expectations. Instead of focusing on "core" inflation, agents are assumed to act on perfect foresight for both exchange rates and goods prices. That is, the $\pi = 0$ specification is replaced by $\pi = \dot{p}$

As already noted, in a world of price stability, a small open economy can obtain a nominal anchor by targeting any one of the price level, the wage index or the exchange rate. The purpose of this chapter is to examine whether the support that is offered by aggregative models of this sort for significant variability in the exchange rate (that is, for achieving the nominal anchor by adopting price or wage-rate targeting, not by exchange rate targeting) is robust. Do the properties of the models change to a significant degree, as the analysis shifts progressively toward increased reliance on micro-foundations? Model 1 is a descriptive structure that involves model-consistent expectations for financial variables and enough price stability that agents pay no attention to expectations of inflation. Model 2 shifts to perfect foresight for all endogenous variables - including inflation - and to a specification for sticky nominal variables that has more explicit structure and that

---

[20] The derivation of those two equations is shown in Appendix I.

involves more forward-looking behaviour. Model 3 maintains the changes of Model 2 but imposes more structure on the demand side of the goods market by relying on an explicitly forward-looking theory of private consumption. In all cases, I consider how alternative monetary policies help insulate real output from both one-time unexpected changes in autonomous spending, and from (anticipated) ongoing cycles in exogenous spending. In the latter case, autonomous spending, a, is assumed to follow a cycle defined by $a = \sin(t)$.

4. Methodology

In this section, the solution procedures used to solve the different models are explained. Since analytical results are too complicated to derive, numerical solutions are used and presented in the next section. To explain how the model is solved, I concentrate mostly on the most simple model (model 1).

4.1 Model 1

The solution of the baseline model proceeds as follows. By combining equations (2) and (6) and setting $f = 0$, I obtain equation (11):

$$e = \frac{[w + (1 + \gamma)c]}{(1 - \Delta)} \tag{11}$$

and using equations (3), (5), (6), (11) and the $\pi = 0$ assumption, I obtain the equation below:

$$r = \bar{r} + \varepsilon_1 w + \varepsilon_2 c \tag{12}$$

where

$$\varepsilon_1 = \frac{\Omega(1-(\theta+\alpha)\Delta)}{(1-\Delta)} \text{ and } \varepsilon_2 = \frac{\Omega(\theta\gamma(1-\Delta)+(1-\theta-\alpha)(1+\gamma))}{(1-\Delta)}$$

I then substitute equation (7) into the time derivative of equation (11) and the result into equation (4) to eliminate $\dot{e}$; then use equations (3) and (4) to obtain an expression for r which is substituted into equation (12). The result is

$$\dot{c} = \left[\frac{(1-\Delta)}{(1+\gamma)}\right]\left[\frac{-\phi y}{(1-\Delta)} + \varepsilon_1 w + \varepsilon_2 c\right] \tag{13}$$

Next, I substitute equation (12) into equation (1a), take the time derivative of the result, and use equations (1a), (13) and (7) to eliminate the level of c, the time change of c, and the time change of w. The result is the second line of the following matrix

$$[\dot{w} \quad \dot{y}]' = D_1[w \quad y]' + D_2[a \quad \dot{a}]' \tag{14}$$

where $D_1 = \begin{bmatrix} 0 & \phi \\ \dfrac{\varepsilon_1\delta(1-\Delta)}{(1+\gamma)} & \varepsilon_3 \end{bmatrix}, D_2 = \begin{bmatrix} 0 & 0 \\ -\varepsilon_4 & \beta \end{bmatrix}$

and

$$\varepsilon_3 = \left[\frac{(1-\Delta)}{(1+\gamma)}\right]\left[\varepsilon_2 + \frac{(\psi\varepsilon_2-\delta)\phi}{(1-\Delta)}\right] - \psi\varepsilon_1\phi, \ \varepsilon_4 = \frac{\beta\varepsilon_2(1-\Delta)}{(1+\gamma)}$$

Unique convergence requires that the determinant $|D_1| = \dfrac{-\varepsilon_1\phi\delta(1-\Delta)}{(1+\gamma)}$ be negative. Assuming $0 < \Delta < 1$, this condition is satisfied. Following any unanticipated change in autonomous spending, the economy jumps to the saddle path that is associated with the new full equilibrium. The equation of the saddle path is

$$y = \bar{y} + \kappa(w - \bar{w}) \,. \tag{15}$$

where $\bar{w}$ is the full-equilibrium value of the wage.

The slope parameter, κ, can be solved from $[\alpha \ \ \alpha\kappa]' = D_1[1 \ \ \kappa]'$ where α is the stable (negative) eigenvalue (see Scarth, 1996, p. 133-135). Thus, both the speed of adjustment that is involved as the economy proceeds along the saddle path, $-\alpha$ and the slope of the saddle path, κ, are determined from

$$\kappa = \frac{\alpha}{\phi} \quad \text{and}$$

$$\kappa(1+\gamma)(\varepsilon_3 - \alpha) + \varepsilon_1\delta(1-\Delta) = 0,$$

The first of these equations implies that the slope of the saddlepath is negative. The impact effect of a drop in autonomous spending on real output follows from the saddle path equation is thus given by:

$$\frac{dy}{da} = -\kappa\left(\frac{d\bar{w}}{da}\right) = \frac{-\kappa\beta\varepsilon_2}{\delta\varepsilon_1} > 0 \qquad (16)$$

I evaluate this impact multiplier, the speed at which this temporary real output effect is eliminated, and the cumulative (undiscounted) output loss, L, following a drop in demand (the impact multiplier divided by the adjustment speed) in numerical versions of the model below. Even for the simplest model, only one of these measures yields an expression that permits definitive qualitative conclusions; that measure is the cumulative output effect: $L = \frac{\beta\varepsilon_2}{\varepsilon_1\delta\phi}$. The reader can readily verify that, when evaluated from initial values of $\theta = \alpha = 0$, one obtains $\frac{\partial L}{\partial \theta} = \left(\frac{1}{(1+\gamma)}\right)\left(\frac{\partial L}{\partial \alpha}\right) = \frac{-\beta(1-\Delta)}{\delta\phi} < 0$. These results imply that a move away from targeting the exchange rate is necessarily preferred. To this extent, then, Model 1 supports conventional wisdom as defined by Mundell-Fleming. But a full conclusion requires a focus on the other measures of output volatility as well and specific parameter values must be considered to pursue these questions.

Thus far, the analysis has been restricted to one-time unexpected changes in demand. Anticipated ongoing cycles are examined by taking the time derivative of the second line of the matrix given by equation (14) and eliminating the $\dot{w}$ term that emerges by using the first line in the matrix, one obtains equation (17) below:

$$\ddot{y} = \varepsilon_5 y + \varepsilon_3 \dot{y} - \varepsilon_4 \dot{a} + \beta \ddot{a} \tag{17}$$

where

$$\varepsilon_5 = \frac{\varepsilon_1 \phi \delta (1 - \Delta)}{(1 + \gamma)}$$

Following Chiang (1984, p. 472), the general and particular solutions for equation (17) are respectively

$$y = Ae^{\alpha t} \tag{18}$$

$$y = B[\cos(t)] + C[\sin(t)] \tag{19}$$

where A, B and C are arbitrary constants that must be related to the underlying parameters in the model. Focusing just on cycles in this part of the analysis, I ignore one-time shocks by setting $A = 0$. The identifying restrictions for B and C are derived by substituting equation (19) and its first and second time derivatives, and the first and second time derivatives of $a = \sin(t)$ into equation (17). The coefficients of this equation are then equated to those of equation (19) and I obtain the following restrictions:

$$B = \frac{[\varepsilon_4(1 + \varepsilon_5) - \beta\varepsilon_3]}{[\varepsilon_3^2 + (1 + \varepsilon_5)^2]} \tag{20}$$

$$C = \frac{[\beta + \varepsilon_3 B]}{[1 + \varepsilon_5]} \tag{21}$$

I evaluate the cycles in output that accompany the cycles in autonomous spending by substituting these expressions for B and C into equation (19). The amplitudes of the ongoing business cycle for alternative parameter values are reported in section 5. In almost all cases (with the exceptions noted below) the peaks and troughs in the cycle for output are almost exactly in phase with those for the cycle in autonomous spending.

4.2 Model 2

As noted earlier, this section examines the fragility of the conclusions drawn from Model 1 by dropping the assumption that agents focus on the "core" inflation rate, and by considering a more explicit, optimization-based and forward-looking specification for wage adjustment. By following similar steps to what has just been explained for Model 1, the system can be reduced to a set of three first-order differential equations

$$\left[\dot{w}\ \dot{y}\ \dot{v}\right]' = D_3\left[w\ y\ v\right]' + D_4\left[a\ \dot{a}\right]' \qquad (22)$$

The elements of the D_3 and D_4 matrices are complicated and are not reported since I do not attempt to reach qualitative conclusions. For this model also, numerical solutions are reported using various parameter values for the model. In all cases, I have verified that the condition for unique convergence - that there be two positive eigenvalues and one negative one to accommodate the fact that there are two jump variables, y and v, and one sticky variable, w - is met. In this case, the stable outcome is defined by two relationships

$$y = \bar{y} + \kappa_1(w - \bar{w}) \qquad (23)$$

$$v = \bar{v} + \kappa_2(w - \bar{w})\ . \qquad (24)$$

The impact effect of an unexpected drop in demand is $\frac{dy}{da} = -\kappa_1\left(\frac{d\bar{w}}{da}\right)$ as before, with the steady-state multiplier derived from equation (22) and the slope of the stable surface is solved using equation below.

$$\left[\alpha I - D_3\right]\left[1 \; -\kappa_1 \; -k_2\right]' = \left[0 \; 0 \; 0\right]' \tag{25}$$

To examine ongoing cycles, equation (22) is re-expressed by taking time derivatives and eliminating all reference to both the levels and the time derivatives of u and v. The result is a third-order differential equation in y (containing terms in y and a ranging from no time derivative to three times derivatives). By taking the appropriate number of time derivatives of both equation (19) and $a = \sin(t)$; then substituting the results into the third-order differential equation, I obtain the reduced form parameters B and C. Numerical results are once again derived using various assumptions about the parameter values.

4.3 Model 3

The robustness of the results is tested further by extending the model to have more explicit optimization and forward-looking behaviour on the demand side of the system as well as on the supply side. This is accomplished by using the "expectational IS" relationship (equation (1b) instead of equation (1a)). To solve this model, I proceed through the same steps as outlined for Model 2. The only differences are that the result is a fourth-order differential equation for real output, and that it no longer involves the level of the a term. Instead, a term involving the fourth time derivative of a is involved instead. This latter difference is an important change. The absence of the a-level term implies that unexpected once-and-for-all changes in autonomous spending have no effect on real output - not even temporary effects.

5. Numerical Solutions

Since the analytical solutions are too complicated to reach qualitative conclusions, numerical values are chosen to illustrate my results. As in chapters 2 and 3, these values are selected so as to reflect the dynamics of an annual model. Moreover, I assume similar values as in the previous chapters for many of the parameters. The choice of these parameter values are:

ψ	interest sensitivity of demand	0.75
δ	terms of trade sensitivity of demand	0.25
γ	importance of intermediate imports	0.33
Δ	pricing-to-market parameter	0.00
ϕ	slope of short-run Phillips curve	0.50
λ	inverse of the average contract length	0.70

As in the previous chapter, I use similar values for the parameters ψ, δ and ϕ. I keep the same three-to-one ratio between ψ and δ. There are other supply-side parameters to consider. I assume that intermediate imports represent 25 percent of firms' costs, so that $\xi = 0.25$ and $\gamma = 0.33$, and, in the baseline case I assume that firms do not price to market (that is I follow Obstfeld and Rogoff (2000) and assume a value of zero for Δ). I do not vary the values for ξ and γ, but given the empirical studies summarized by Obstfeld and Rogoff (2000), I allow Δ to range up to 0.50 I also assume an average contract length in the range of 1.4 years, so $\lambda = 0.70$. There is one other parameter, μ, involved in the Calvo specification of overlapping wages. By using equations (6) and (8a) to eliminate p and $y - w$ from equation (8b), and then using the time derivative of (8a) to eliminate $\dot{y} - \dot{w}$ from the result, I have

$$\ddot{w} = -\lambda^2(\gamma c + \mu(y - \bar{y})) \tag{26}$$

So the slope of the short-run Phillips curve in the Calvo specification is $\mu\phi^2$ and I set $\phi = \mu\lambda^2$. Given values for ϕ and λ, I can easily calculate the value μ takes since $\mu = \frac{\phi}{\lambda^2}$.

Parameter β is set equal to unity, since this assumption permits a convenient reference point. β is the impact effect of a one-time change in demand on real output in Model 1 under "aggressive" exchange rate targeting (effective currency union with the rest of the world). By setting this outcome to unity, I can conveniently compare all outcomes to this base case.

θ and α are the parameters that define alternative monetary policies. Price-level targeting is involved if $\theta = 1$ and $\alpha = 0$; wage-index targeting is in effect if $\theta = 0$ and $\alpha = 1$; and exchange rate targeting is in place when $\theta = \alpha = 0$. The other monetary policy parameter is Ω. A "modest" targeting strategy is imposed with a value of unity for Ω. In this case, under price-level targeting for example, the central bank raises the interest rate by one percentage point whenever the price level is above target by one percent. An "aggressive" targeting strategy is involved if Ω is very large. In that case, the bank adjusts the interest rate so vigorously that the price level becomes effectively pegged. In the tables in section 6, I report results for both modest and aggressive cases ($\Omega = 1$ and $\Omega = 100$) for all three monetary policies.

I have experimented with a wide range of parameter values to ensure that my findings are not dependent on particular quantitative assumptions. In many cases, I have considered values that range between one half and twice the baseline value. The limits for each parameter are: $\psi = (0.375, 1.50)$, $\delta = (0.12, 0.50)$, $\phi = (0.25, 1.00)$, $\lambda = (0.50, 1.00)$ and $\Delta = (0.0, 0.50)$

6. Results

The numerical results are reported in Tables 1-5. The baseline results are reported in Table 1 for all three policies (price-level targeting, wage-rate targeting and exchange rate targeting) and for both "modest" and "aggressive" policy reactions. As mentioned earlier, robustness across alternative illustrative parameter values is just as important as robustness across model specifications. For this reason, I have considered numerous other parameter sets. Just for the modest policy reactions, I studied 18 illustrative sets of coefficient values.[21] The 18 sets stem from combining the "high," "baseline," and "low" values for the aggregate demand and supply and 2 values for the pricing-to-market parameter.[22] These results are illustrated in Tables 3-5. Table 2 on the other hand, assumes baseline values for all the parameters except for the pass-through parameter (it is set at $\Delta = 0.5$ in Table 2).

[21] The results from the aggressive approach are not reported in Tables 3-5 since they are qualitatively similar to those the "modest" approach and those of Table 1.

[22] The ratio of ψ to δ is kept constant as the size of the demand responses is varied; on the supply side, μ and λ are adjusted simultaneously to ensure that ϕ adjusts to the three values - high, baseline and low - given earlier.

The results in Table 1 indicate some surprises. For example, with the basic descriptive model and modest targeting strategies, a once-for-all demand shock affects output by the *same* amount in the short run - whether it is the price level or the exchange rate that is targeted (both have a value of 1.00). The additional variability in the exchange rate that accompanies price-level targeting involves *no* Mundell-Fleming insulation feature whatsoever. Indeed, comparing the aggressive versions of these two targeting strategies, it is seen that the biggest disruption in output occurs with price-level targeting (the impact effect increases from 1.00 to 13.89). Further, since targeting the wage index leads to an even less preferred immediate effect, the advice of Goodfriend and King (1997) is not supported. In short, as far as the impact period is concerned, allowing a more flexible exchange rate does *not* contribute to built-in stability. Apparently, the direct supply-side effect of the exchange rate, and the tendency of the exchange rate to overshoot, are sufficient to remove the insulation features of the basic Mundell-Fleming from demand shocks

However, as noted in the previous section, this can be said only for the impact period. If the speed at which the economy returns to equilibrium is taken into consideration, a flexible exchange rate regime dominates exchange rate targeting. For example, comparing price-level and exchange rate targeting, the speed at which the temporary output effect is eliminated is much faster under price-level targeting. The result is that the cumulative output loss following a drop in demand is four times larger under exchange rate targeting (10.64 under exchange rate targeting and 2.64 under price level targeting). Taking this longer term view, then, price-level targeting (but not wage-rate targeting) represents a built-in stabilizer after all.

This summary of the results is threatened to some extent when we consider ongoing cycles. Price-level targeting is no longer the most preferred policy. According to Model 1 section of Table 1 (at least for modest policy options), the amplitude in the real-output cycle is biggest with exchange rate targeting and smallest with wage-rate targeting (for the "modest" targeting, it is 0.77 under wage-rate targeting, 0.88 under price-level targeting and 0.99 under exchange rate targeting). While these differences are rather small, they are not eliminated with the passage of time. It is noteworthy that price-level targeting is *much* worse than both exchange rate and wage-rate targeting when it is the aggressive versions of each policy that are compared. However, as long as aggressive policy options are ignored, one can take the view that the disadvantage of price-level targeting concerning ongoing shocks (its second place finish with respect to this criterion) is quite small compared to the benefit that this policy offers in the face of one-time shocks (compared to both other policies). Given this, it seems reasonable to conclude that Model 1 supports price-level targeting.

As just noted, however, the applicability of this conclusion requires that an aggressive approach that attempts to peg the price level be rejected. Such a policy involves trying to change sticky wages at each point in time with a view to insulating the price level from every short-run change in the (not sticky) exchange rate. It appears that the only way this can be done is by generating very large changes in the output gap.[23] Thus, price-level tar-

[23] This outcome is apparent whether demand changes are unexpected and one-time or anticipated and ongoing. In the ongoing cycles case, the aggressive price-targeting policy does more than magnify the amplitude of the real-output cycle; it makes that cycle be very much out of phase with the autonomous spending cycle. That is what the asterisks beside several entries in the tables signify.

geting is supported - but *only* if the central bank leans against the wind *modestly* in its pursuit of this policy.

A similar result is obtained if we allow for an imperfect pass-through of exchange rate (Table 2) or if alternative parameter values are assumed (Table 3). This indicates that my results are indeed robust when alternative parameter values are considered. In Tables 2 and 3, the impact effect is also the same under price-level and exchange rate targeting but since the speed at which the economy recovers is much faster under the former regime, the cumulative output loss is much lower. When ongoing shocks are considered, the results are similar to those in Table 1. Wage-rate targeting minimizes output fluctuations but price level targeting is a close second. Hence, it appears that changing the degree of exchange rate pass-through does not alter my findings. My results are different to some extent to those of Devereux (2000) and Devereux and Lane (2001) who find that with a less than perfect pass-through, the central bank should target domestic inflation.

How robust are these conclusions? Model 2 allows for more forward-looking behaviour on the supply side, while Model 3 does the same on the demand side. In one sense, the support for exchange rate targeting is weaker in Model 2, compared to Model 1. In Model 2, one does not have to appeal to the longer-term effects to defend increased variability in the exchange rate, since even the impact effect of a one-time change in demand is smaller under both price and wage-rate targeting.

On the other hand, exchange rate targeting receives increased support if ongoing shocks are considered. With Model 2, the amplitude of the ongoing cycle in real output is much less with modest exchange rate targeting (compared to modest price-level targeting and wage-rate targeting). Other results are mixed: wage targeting has become the most appealing policy for insulating real output from one-time demand shocks, but (for ongoing shocks) moving to an aggressive approach to policy is most dangerous with this option.

The basic message from Model 1 is that modest price-level targeting is recommended. This summary is not warranted for Model 2; wage targeting yields significantly better performance in the face of one-time disturbances, while exchange rate targeting is best for coping with ongoing changes in demand. The results from Model 2 thus indicate that so long as temporary shocks are considered, targeting the sticky component of the price level is appropriate. Hence Goodfriend and King's (1997) argument is supported in this model. However, this summary is not fully supported when ongoing shocks are considered.

If alternative parameter values are considered, it is seen in Tables 2 and 4 that for temporary shocks, wage-rate targeting is always supported no matter the degree of exchange rate pass-through. However, with ongoing shocks, the results are less robust. It is seen in Table 4, that in a number of cases, wage-rate targeting is supported (for example for parameter sets 2, 7, 8) while price level targeting is supported in some other cases (for example for parameter sets 3,6). In the light of these results, Model 2 in general seems to support wage-rate targeting.

Model 3 provides the least support for exchange rate targeting, although the margins of difference are very small between this targeting regime and wage-rate targeting (the best policy) and price level targeting (the second best).[24] In this setting, one-time changes in demand have no real-output effects whatever monetary policy is followed. The only (macro stability) reason to have a preference about alternative monetary policies is that the amplitude of the output variations that accompany ongoing cycles is slightly less with either price or wage-rate targeting. There is one other difference compared to Models 1 and 2: *aggressive* targeting (in all three cases) is *helpful*, not a disaster.

An intuitive interpretation for some of these different results can be had by recalling that the stabilizing feature of flexible exchange rates is limited if there is a significant supply-side effect of the exchange rate. As we shift from Model 1 to Model 2, we have introduced forward-looking behaviour on the supply side, but not on the demand side. This difference matters when the exogenous disturbances are ongoing and can be anticipated. In Model 2, then, the supply-side effect of the exchange rate variability that accompanies both price and wage-rate targeting is magnified relative to the demand-side effect, and this is why exchange rate targeting is a better strategy in the face of ongoing cyclical shocks (in Model 2 as compared to Model 1). Once forward-looking behaviour is introduced on the demand side as well (in Model 3), the stabilizing aspect of increased exchange rate variability gets magnified. As a result, Model 3 no longer shows that exchange rate targeting is the winner in the face of ongoing demand cycles.

What final summary is warranted? On one hand, it is appealing to focus on the two most different models. These are Model 1 (which appeals most to pragmatic policy advisors) and Model 3 (which appeals to those who put a premium on micro-foundations). I find it interesting that both these models support the following general summary. First,

[24] The results are also very robust in this case (see Tables 2 and 5). Note that although wage-rate targeting is first if an ordinal ranking is taken into consideration, however, the difference between price level targeting and this regime is very small.

modest price-level targeting is not dominated by any option by more than a *very* small margin (in Model 3). Second, prudence suggests that aggressive targeting should be avoided. Since these conclusions are warranted whether I consider a descriptive model or one solidly based on optimization, it is tempting to claim that robust policy conclusions have emerged. However, Model 2 cannot be ignored. Some might interpret Model 2 as a "compromise" - lying between the simpler descriptive specification and the one that involves more explicit micro foundations. But such an interpretation is difficult, since Model 2's policy implications are rather different. This model - and only this model – offers significant support for the Goodfriend and King (1997) suggestion that the central bank target only that component of the overall price index that is sticky.

7. Concluding Remarks

This chapter has attempted to clarify some of the implications of alternative monetary policy regimes. It is based on three propositions. First, in a world of price stability, exchange rate policy does not need to focus on our desire for a stable monetary anchor. This goal is achieved with exchange rate targeting, but equally well with exchange rate flexibility combined with a monetary policy that targets either the domestic price level or the wage index. Second, since the monetary/exchange rate policy choice does not generate different outcomes concerning long-term inflation, the choice among the alternative targeting strategies can be made on the basis of which regime delivers the most built-in stability in real output. Finally, the paper is based on the belief that changes in aggregate demand represent an important source of the disturbances which generate the desire for built-in stability.

Is significant flexibility in the exchange rate needed to have built-in stability? Currency depreciation does allow the export component of demand to rise when there is a fall in autonomous spending. But currency depreciation pushes up the price level, and given interest arbitrage and forward-looking speculators in the foreign exchange market, it can also lead to higher interest rates (during the transition to the new full equilibrium) and hence to a decrease in the interest-sensitive components of aggregate demand. This possibility is accentuated when the central bank raises the interest rate in response to the price-increasing aspect of domestic currency depreciation. Partly because of this shift in monetary policy, the case for significant variability in exchange rates has required further analysis in recent years. This paper has attempted to meet part of this need.

Because there is such a variety of macro models that analysts use to consider built-in stability, I have paid particular attention to the question of robustness. I have explored how well the basic conclusions concerning built-in stability survive several important changes in model specification - changes which concern the degree to which agents are forward looking, and the degree to which each system is based on explicit optimization.

The main conclusions are easily summarized. In all three models, either a price-level or wage-rate targeting strategy can do as well as or better than exchange rate targeting. But exchange rate targeting often scores second best, and the other two monetary policies switch between the first and third-best rankings. Hence, given model uncertainty, exchange rate targeting emerges as an appealing compromise approach, especially if attention is focused on persistent changes in demand. According to this mainstream analysis, then, Europe's decision to embrace the strongest form of exchange rate targeting may be a reasonable strategy. While further research is needed to establish increased confidence in any one monetary policy regime, an important finding regarding the Goodfriend/King suggestion has emerged from this paper. They argue that the central bank should target whatever nominal variable is sticky. Despite the fact that our approach respects their general view concerning a new neoclassical synthesis, and despite the intuitive appeal of their suggestion, it is not generally supported by our analysis.

Appendix I

The derivation of equations (1a) and (8b) is explained in this section. The derivation follows Scarth (1996, p136-37) closely. Let v_t denote the log of all wages contracted in period t and let τ denote the proportion of contracts that last for one-period. Thus the proportion of contracts that last for two periods is $\tau(1-\tau)$, three-period is $\tau(1-\tau^2)$ and so on. Define w_t as the log of the overall wage index level, hence

$$w_t = \tau v_t + \tau(1-\tau)v_{t-1} + \tau(1-\tau)^2 v_{t-2} + \ldots \qquad \text{(A1.1)}$$

Lagging equation (A1.1) and multiplying the result by $(1-\tau)$, one obtains,

$$(1-\tau)w_{t-1} = (1-\tau)\tau v_{t-1} + \tau(1-\tau)^2 v_{t-2} + \tau(1-\tau)^3 v_{t-3} + \ldots \qquad \text{(A1.2)}$$

Using equation (A1.1) and subtracting equation (A1.2) from it, one obtains

$$w_t - (1-\tau)w_{t-1} = \tau v_t \qquad \text{(A1.3)}$$

This expression can be rewritten as

$$w_t - (1-\tau)w_{t-1} - \tau w_t = (\tau v_t - \tau w_t) \Rightarrow (1-\tau)(w_t - w_{t-1}) = \tau(v_t - w_t)$$

Hence $w_t - w_{t-1} = \lambda(v_t - w_t)$ where $\lambda = \dfrac{\tau}{(1-\tau)}$ (A1.4)

I assume constant returns to scale technology, hence units can be chosen so that the marginal product of labour is one and hence w_t stands for both the price level and the wage index. I further assume that v_t is set such that it depends on expected future values of both the cost of living and the output gap. The weights attached to each of these expected future outcomes is given by the distribution which defines the number of short and long-term wage contracts. Hence, the expression for v_t is given by

$$v_t = \tau[p_t + (1-\tau)p_{t+1} + (1-\tau)^2 p_{t+2} + \ldots]$$

$$+ \mu\tau[(y_t - \bar{y}) + (1-\tau)(y_{t+1} - \bar{y}) + (1-\tau)^2(y_{t+2} - \bar{y}) + \ldots] \quad \text{(A1.5)}$$

Writing (A1.5) forward one period and multiplying the equation by $(1-\tau)$, one obtains

$$(1-\tau)v_{t+1} = \tau[(1-\tau)p_{t+1} + (1-\tau)^2 p_{t+2} + (1-\tau)^3 p_{t+3} + \ldots]$$

$$+ \mu\tau(1-\tau)[(y_{t+1} - \bar{y}) + (1-\tau)(y_{t+2} - \bar{y}) + (1-\tau)^2(y_{t+3} - \bar{y}) + \ldots] \quad \text{(A1.6)}$$

Subtracting (A6) from (A5),

$$(1-\tau)v_{t+1} - v_t = (-\tau[p_t - \mu(y_t - \bar{y})]) \Rightarrow (1-\tau)(v_{t+1} - v_t) = \tau[v_t - p_t - \mu(y_t - \bar{y})]$$

Hence $v_{t+1} - v_t = \lambda[v_t - p_t - \mu(y_t - \bar{y})]$ where $\lambda = \dfrac{\tau}{(1-\tau)}$. (A1.7)

Equations (8a) and (8b) are respectively the continuous time versions of equations (A1.4) and (A1.7).

Table 1: Output Effects - Baseline Parameters

	Unexpected One-Time Change in Demand				Ongoing Demand Cycles	
	Impact Effect		Cumulative Effect		Amplitude of Cycles	
	Modest	Aggressive	Modest	Aggressive	Modest	Aggressive
Model 1						
p-target	1.00	13.89	2.64	2.64	0.88	2.18*
w-target	6.60	402	10.64	10.64	0 77	0.02*
e-target	1.00	1.00	10.64	10.64	0.99	0 99
Model 2						
p-target	1.22	2.98	1.39	1 86	3.89	1 98
w-target	0.56	0.56	0.57	0.10	1.41	2067
e-target	1.82	1.82	2.90	2.90	0.98	6 27
Model 3						
p-target	0.00	0.00	0 00	0.00	0.50	0 01*
w-target	0.00	0.00	0.00	0 00	0.49	0.01*
e-target	0.00	0.00	0.00	0.00	0.58	0.02*

Table 2: Output Effects with Imperfect Pass-Through $\Delta = 0.5$

	Unexpected One-Time Change in Demand				Ongoing Demand Cycles	
	Impact Effect		Cumulative Effect		Amplitude of Cycles	
	Modest	Aggressive	Modest	Aggressive	Modest	Aggressive
Model 1						
p-target	1.00	42.7	2.64	2 64	0.88	0 69*
w-target	5.89	401	10.64	10.64	0.81	0.03*
e-target	1.00	1.00	10.64	10.64	0.99	0 99
Model 2						
p-target	1.24	6.13	1.43	2.67	6.16	32.82
w-target	0 56	0.56	0.59	0.10	1 69	1199
e-target	1 82	1.82	2.90	2.90	0.94	2.97
Model 3						
p-target	0.00	0.00	0.00	0.00	0.54	0 01*
w-target	0.00	0.00	0.00	0.00	0.50	0 01*
e-target	0.00	0.00	0.00	0.00	0.58	0.02*

Table 3: Output Effects - Model 1 - Parameter Set 2-9

	Unexpected One-Time Change in Demand				Ongoing Demand Cycles	
	Impact Effect		Cumulative Effect		Amplitude of Cycles	
	$\Delta = 0$	$\Delta = 0.5$	$\Delta = 0$	$\Delta = 0.5$	$\Delta = 0$	$\Delta = 0.5$
Parameter Set 2						
p-target	0.99	0.99	1.32	1.32	0.79	0.79
w-target	5.89	5.89	5.32	5.32	0.66	0.69
e-target	1.00	1.00	5.32	5.32	0.97	0.97
Parameter Set 3						
p-target	1.00	1.00	5.28	5 28	0.97	0.97
w-target	7.74	6.60	21.28	21.28	0.91	0.93
e-target	1.00	1.00	21.28	21.28	1.00	1.00
Parameter Set 4						
p-target	1.00	1.00	5.28	5.28	0.97	0.97
w-target	7.74	6.60	21.28	21.28	0.91	0.93
e-target	1.00	1.00	21.28	21.28	1.00	1.00
Parameter Set 5						
p-target	0.99	0.99	1.32	1.32	0.79	0.79
w-target	5.89	5.48	5.32	5.32	0.66	0.69
e-target	1.00	1.00	5.32	5.32	0.97	0.97
Parameter Set 6						
p-target	1.00	1.00	10.56	10.56	0.99	0.99
w-target	9.48	7.74	42.56	42.56	0.96	0.98
e-target	1.00	1.00	42.56	42.56	1.00	1.00
Parameter Set 7						
p-target	1.00	1.00	2.64	2.64	0.88	0.88
w-target	6.60	5.89	10.64	10.64	0.77	0.81
e-target	1.00	1.00	10.64	10.64	0.99	0.99
Parameter Set 8						
p-target	1.00	1.00	2.64	2.64	0.88	0.88
w-target	6.60	5.89	10.64	10.64	0.77	0.81
e-target	1.00	1.00	10.64	10.64	0.99	0.99
Parameter Set 9						
p-target	0.99	0.99	0.66	0.66	0.54	0.54
w-target	5.48	5.24	2.66	2.66	0.43	0.44
e-target	1.00	1.00	2.66	2.66	0.88	0.88

Table 4: Output Effects - Model 2 - Parameters Set 2-9

	Unexpected One-Time Change in Demand				Ongoing Demand Cycles	
	Impact Effect		Cumulative Effect		Amplitude of Cycles	
	Δ = 0	Δ = 0.5	Δ = 0	Δ = 0.5	Δ = 0	Δ = 0.5
Parameter Set 2						
p-target	1.35	1.38	1.02	1 05	2.09	1 56
w-target	0.57	0.57	0.39	0.39	0.50	0 30*
e-target	2.29	2.29	2.29	2.29	0.94	0.88
Parameter Set 3						
p-target	1.14	1.15	1.88	1.95	0.50	21.38*
w-target	0.57	0.57	0.80	0.85	1.76*	1.48
e-target	1 53	1.53	3.74	3.74	0.99	0.97
Parameter Set 4						
p-target	1 10	1.12	1.60	1.67	4.52	34.67
w-target	0.72	0.72	0.91	0.97	1.16	1.09
e-target	1.41	1.41	2.89	2.89	1.02	0.98
Parameter Set 5						
p-target	1.46	1.51	1.19	1.21	1.48	1 42
w-target	0 39	0.39	0.29	0.29	2.47	2 44
e-target	2 65	2.65	2.93	2.93	0.86	0 83
Parameter Set 6						
p-target	1.07	1.07	2.16	2.28	0.47*	3.81*
w-target	0.73	0.73	0.73	1.36	1.08	1.18
e-target	1.27	1.27	3.86	3.86	1.02	1.00
Parameter Set 7						
p-target	1 28	1.31	1.57	1.61	0.62	2 10
w-target	0.40	0.40	0.43	0.44	0.37*	3 21
e-target	2.01	2.01	3.59	3.59	0.94	0 91
Parameter Set 8						
p-target	1.16	1.18	1.16	1.20	3.87	14.57
w-target	0.73	0.73	0.65	0.68	0.42	0.39
e-target	1.61	1.61	2.17	2.17	1 02	0.97
Parameter Set 9						
p-target	1 77	1.83	0.91	0.93	0.89*	6 87*
w-target	0.40	0.40	0.19	0.19	1.18	0 40
e-target	3.77	3.77	2.46	2.46	0.78	0.75

Table 5: Output Effects - Model 3 - Parameter Set 2-9.

Ongoing Demand Cycles - Amplitude of Cycles	Δ = 0	Δ = 0.5
Parameter set 2 - Baseline AD and High Wage Flexibility		
p-target	0.36	0 41
w-target	0.35	0.36
e-target	0.42	0 44
Parameter set 3 - Baseline AD and Low Wage Flexibility		
p-target	0.65	0.69
w-target	0.64	0.65
e-target	0.73	0 73
Parameter set 4 - Low AD and Baseline Wage Flexibility		
p-target	0.53	0.56
w-target	0.52	0.51
e-target	0.61	0 62
Parameter set 5 - High AD and Baseline Wage Flexibility		
p-target	0 44	0 51
w-target	0 43	0 47
e-target	0.52	0.53
Parameter set 6 - Low AD and Low Wage Flexibility		
p-target	0 68	0 70
w-target	0 67	0.66
e-target	0.75	0 76
Parameter set 7 - High AD and Low Wage Flexibility		
p-target	0.60	0.66
w-target	0.59	0.63
e-target	0.68	0.68
Parameter set 8 - Low AD and High Wage Flexibility		
p-target	0 39	0 42
w-target	0.38	0 37
e-target	0.46	0.48
Parameter set 9 - High AD and High Wage Flexibility		
p-target	0.31	0.38
w-target	0.30	0 34
e-target	0 37	0 38

Chapter 5

Conclusion

This thesis considers various fiscal and monetary policy regimes and evaluates them according to their ability to minimize fluctuations in the economy. It comprises of three essays. In the first essay, I examine the implications of two types of fiscal regimes on output volatility using a standard descriptive rational expectations closed economy framework and a related model which has more explicit micro foundations and which emphasizes forward looking behaviour on the part of agents. Three types of shocks are considered in this chapter, a demand, cost-push and a supply shock. Moreover, to make my comparison stark I investigate two polar cases: a flexible and a rigid fiscal regime. Under the flexible fiscal regime, the government uses fiscal policy in a countercyclical fashion, increasing the budget deficit when output falls whereas under the rigid fiscal regime, the government is assumed to balance the budget at each point in time by changing its expenditure.

My results for this chapter indicate that the two models yield different verdicts regarding which fiscal regime minimizes output volatility. I find that, at least for demand shocks and some common ways of specifying sticky prices, the rigid approach to fiscal policy is supported when I use the more forward looking version of the model (the "intertemporal IS" function). On the other hand, my analysis supports the flexible approach when the more descriptive version of the model is used ("textbook IS" function).

The model involves two features that make it possible for the rigid fiscal regime to minimize output fluctuations. Under the "Keynesian" or flexible approach to fiscal policy, the government finances its budget deficit by issuing more bonds and hence must accumulate debt. Thus while a flexible fiscal regime lessens the magnitude of any recession initially, it delays and weakens the eventual recovery. This is because, by issuing more bonds during downturns (to finance temporary deficits), a government with a fixed long-run debt-to-GDP ratio creates an obligation to work the debt ratio back down later on.

On the other hand, under the rigid fiscal regime, since the government has to balance the budget at each point in time, this impedes the automatic stabilizers. As a result, the impact effect of a negative shock is bigger under the rigid regime compared to the flexible regime. However, while the impact effect is larger, the speed at which the economy recovers is faster as this regime avoids the destabilizing part of a bond financed deficit. Depending on the magnitude of the impact effect and the speed at which the economy recovers from a recession, output volatility can be higher under a flexible regime.

My findings indicate that the negative dimension of this dynamic trade-off is accentuated when I use the more forward looking version of the model and the supply function which involves more price stickiness (P-Bar supply function). The intuition behind this result is as follows. If the government is running a flexible fiscal policy, agents know that the accumulated debt must be subsequently paid down and hence they expect output to fall in the future. When the forward looking aggregate demand function is used, since current output is a function of expected future output (there is a unit coefficient term on the expected output term), as agents expect the latter to fall in the future, this will have a negative impact on current spending. Therefore, the flexible fiscal regime loses some of its ability to insulate the economy from shocks. My results indicate that when the insulating properties of a flexible fiscal policy is made less powerful, the stabilizing dimension of a rigid fiscal policy (less persistence) becomes the dominant consideration. In this case, it is the rigid fiscal regime and not the flexible fiscal policy that minimizes output fluctuations.

The second feature of my model that raises the probability that a rigid regime is more stabilizing for output involves the interaction of fiscal and monetary policy. In this chapter, the central bank's objective (assumed to be a future inflation rate of zero) is independent of changes in fiscal policy but its period-by-period decision rule is dependent on the type of fiscal regime in place. Since the rigid fiscal regime avoids the destabilizing features of a bond-financed deficit, the central bank finds it appropriate to react less aggressively to short-term fluctuations in the economy. Consequently, output volatility can be reduced under a rigid fiscal regime.

While my analysis in this chapter provides some support for the rigid approach when demand shocks are considered, on the other hand, when cost-push and supply shocks are simulated, I find that the flexible approach to fiscal policy is generally supported even when the more forward looking version of my model is used. Hence as it is often the case in macroeconomics, my verdict concerning which fiscal regime minimizes output volatility depends on the degree of forward lookingness of agents, the degree of price stickiness and the nature of shocks hitting the economy.

Chapter 3 of this thesis extends the analysis of the second chapter to a series of small open economy models. The same issues are analysed but this time using more complicated models. Besides extending the closed economy model to an open economy framework, several changes are introduced in this chapter. However, despite these changes, I show that most of my basic results from the closed economy models of chapter 2 can be carried over to the open economy framework. As in the second chapter, I find that conventional wisdom - that a flexible fiscal regime is more stabilizing - receives more support when the backward looking version of the model is involved and when supply and cost-push shocks are considered.

In this chapter, I again find that the rigid approach to fiscal policy receives more support when the more forward looking version of the model is involved and when a demand shock is simulated. However, contrary to chapter 2, this result is less dependent on which aggregate supply function is assumed. I find that even when the supply function which involves less price stickiness is used, the rigid approach to fiscal policy is supported.

Despite these small differences, my findings are robust, in the sense that my results from the closed economy model can be carried over to an open economy framework. My findings are thus similar to those of Clarida, Gali and Gertler (1999) who also find that many of the conclusions reached in a closed economy setting can be carried over to an open economy framework. However, as their results pertain only to monetary policy, this chapter has verified and proved that their findings can be extended to fiscal policy.

The analysis presented in this chapter also indicate that the presence of serially correlated shocks can affect the optimal behaviour of the central bank. When shocks are expected to persist for a long period of time, I find that it is optimal for the central bank to be more conservative. This finding not only confirms earlier results by Clarida, Galì and Gertler (1999) and Walsh (2000) who also show that the relative weight the central bank assigns to inflation in its objective function increases in the presence of serially correlated shocks, but also demonstrates that it is robust even when alternative fiscal regimes are modelled.

My results from these two chapters indicate that the rigid approach to fiscal policy should be given more consideration in policy circles. However, one should bear in mind that my analysis remains very stylized and possibly highly dependent on the types of models I have assumed. This is why more robustness checks are recommended in the future. Nevertheless, I find these results very informative for policymakers, particularly my result on the interaction between fiscal and monetary policy. It indicates that the systematic and rigid fiscal policy regime many countries have adopted in the last ten years may have indirectly contributed to the good economic performance we have witnessed during that period since it has made monetary policy-making easier.

The third essay of this thesis shifts the focus entirely to monetary policy. It compares the performance of three different monetary regimes - price level, exchange-rate and wage-rate targeting - using a series of small open economy macro models. I evaluate these three monetary regimes according to their ability to minimize output volatility by introducing temporary and on-going shocks to the models. I also assume in this chapter that the monetary authority can target any of these three regimes in a moderate or aggressive fashion.

The results from this chapter are easily summarized. I find that price level or wage-rate can do as well as or better than exchange-rate targeting. However, exchange-rate targeting is frequently the second best policy regime while price level and wage-rate targeting regimes switch between the first and third place. Hence, exchange-rate targeting appears to be more robust to model uncertainty compared to the other two targeting regimes and thus emerges as an appealing compromise approach especially when my analysis focuses on on-going shocks. My results thus provides some support for Europe's decision to embrace the strongest form of exchange-rate targeting.

Moreover, I find that aggressive targeting usually leads to more volatility in the economy, especially if on-going shocks are present. Another important finding has also emerged from this chapter. According to Goodfriend and King (1997), the appropriate policy response when nominal rigidities are present is to make the current value of that sticky nominal variable the target of monetary policy. In my models, this involves targeting the wage-rate. Despite the fact that my models respects their "New NeoClassical Synthesis" framework and despite the intuitive appeal of their argument, I find that contrary to what they predict, targeting the most sticky variable in my model (the wage-rate) is by no means the best policy response.

References

Ahn, C-M. "The Monetary Policy Rule in Australia: Inflation Targeting and Policy Reaction", *Australian National University*, Working Paper in Trade and Development #00/07, 2000.

Alesina, A. and G. Tabellini. "A Positive Theory of Fiscal Deficits and Government Debt", *Review of Economic Studies*, Vol. 57, No. 3 (1990), 403-414.

Alesina, A. and T. Bayoumi. "The Costs and Benefits of Fiscal Rules: Evidence from U.S States", NBER Working Paper No. 5614, 1996.

Alesina, A. and R. Perotti. "Budget Deficits and Budgets Institutions", IMF Working Paper 96/52, 1996.

Amato, J.D. and T. Laubach. "Implications of Habit Formation for Optimal Monetary Policy", Federal Reserve Board *Finance and Economics Discussion Series* No. 58, 2001.

Backus, D.B. and J. Driffill. "The Consistency of Optimal Policy in Stochastic Rational Expectations Models", CEPR Discussion Paper No. 124, 1986.

Ball, L. "Efficient Rules for Monetary Policy", NBER Working Paper No. 5952, 1997.

Ball, L. "Policy Rules for Open Economies", in John B. Taylor (ed.), *Monetary Policy Rules*, University of Chicago Press, 1999.

Barro, R.J. "On the Determination of the Public Debt", *Journal of Political Economy*, Vol. 87, No. 5 Part 1 (1979), 940-947.

Barro, R.J. and D.B. Gordon. "Rules, Discretion and Reputation in a Model of Monetary Policy", *Journal of Monetary Economics*, Vol. 12, No. 1 (1983), 101-122.

Batini, N. and A. Haldane. "Forward-Looking Rules for Monetary Policy", in John B. Taylor (ed.), *Monetary Policy Rules*, University of Chicago Press, 1999.

Batini, N. and E. Nelson. "Optimal Horizons for Inflation Targeting", Bank of England Working Paper No. 119, 2000.

Bayoumi, T. and B. Eichengreen. "The Political Economy of Fiscal Restrictions: Implications for Europe and the United States", *European Economic Review*, Vol. 38, No. 3-4 (1994), 783-791.

Bayoumi, T. and B. Eichengreen. "Restraining Yourself: The Implications of Fiscal Rules for Economic Stabilization", *IMF Staff Papers*, Vol. 42, No. 1 (1995), 32-48.

Bayoumi, T., M. Goldstein and G. Woglom. "Do Credit Markets Discipline Sovereign Borrowers? Evidence from the US States", *Centre for Economic Policy Research*, Working Paper No. 1088, 1995.

Beetsma, R. and H. Jensen. "Optimal Inflation Targets, "Conservative" Central Banks, and Linear Inflation Contracts: Comment", *American Economic Review*, Vol. 89, No. 1 (1999), 342-347.

Beestma, R. and H. Uhlig. "An Analysis of the Stability and Growth Pact", *Economic Journal*, Vol. 109, No. 458 (1999), 546-571.

Bernanke, B.S. and I. Mihov. "Measuring Monetary Policy", *Quarterly Journal of Economics*, CXII (1998), 869-902.

Blinder, A.S. and R.M. Solow. "Does Fiscal Policy Matter?", *Journal of Public Economics*, Vol. 2, No. 4 (1973), 319-337.

Blinder, A.S. and R.M. Solow. "Does Fiscal Policy Still Matter? A Reply", *Journal of Monetary Economics*, Vol. 2, No. 4 (1976), 501-510.

Bohn, H. and R.P. Inman. "Balanced-Budget Rules and Public Deficits: Evidence from the U.S States", *Carnegie-Rochester Conference Series on Public Policy*, Vol. 45, No. 0 (1996), 13-76.

Buiter, W.H. and M. Miller. "Monetary Policy and International Competitiveness: The problem of Adjustment", *Oxford Economic Papers*, Vol. 33, No. 0 (Supplement July 1981), 143-175.

Buiter, W.H. and M. Miller. "Real Exchange Rate Overshooting and the Output Cost of Bringing Down Inflation: Some Further Results", in J. A. Frenkel (ed.), *Exchange Rates and International Macroeconomics*, NBER, Chicago, University of Chicago Press, 317-358, 1983.

Calvo, G.A. "Staggered Contracts in a Utility-Maximizing Framework", *Journal of Mone-*

tary Economics, Vol. 12, No. 3 (1983), 383-398.

Canzeroni, M.B. and B. Diba. "Fiscal Constraints on Central Bank Independence and Price Stability", Centre for Economic Policy and Research Discussion Paper No. 1463, 1996.

Chang, R. and A. Velasco. "Liquidity Crises in Emerging Markets: Theory and Policy", NBER Working Paper 7272, 1999.

Chari, V.V. and P. J. Kehoe. "Optimal Fiscal and Monetary Policy", *Research Department Staff Report* No. 251, Federal Reserve Bank of Minneapolis, 1998.

Chiang, A.C. *Fundamental Methods of Mathematical Economics*, Third Edition. New York: McGraw-Hill, 1984.

Christiano, L.J. "A Reexamination of the Theory of Automatic Stabilizers", *Carnegie-Rochester Conference Series on Public Policy*, Vol. 20, No. 0 (1984), 147-206.

Christiano, L.J. M. Eichenbaum and C. Evans. "The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds", *Review of Economics and Statistics*, Vol. 78, No. 1 (1984), 16-34.

Christiano, L.J. M. Eichenbaum and C. Evans. "Monetary Policy Shocks: What Have We Learned and to What End?", NBER Working Paper No. 6400, 1998.

Christiano, L.J. and T.J. Fitzgerald. "Understanding the Fiscal Theory of the Price Level", NBER Working Paper No. 7668, 2000.

Clarida, R., J. Gali and M. Gertler. "The Science of Monetary Policy: A New Keynesian Perspective", *Journal of Economic Literature*, Vol. 37, No. 4 (1999), 1661- 1707.

Clarida, R., J. Gali and M. Gertler. "Optimal Monetary Policy in Open Versus Closed Economies: An Integrated Approach", *American Economic Review*, Vol. 91, No. 2 (2001), 248-252.

Cohen, D.S. and G.R. Folette. "The Automatic Stabilizers: Quietly Doing their Thing", Federal Reserve Board, *Finance and Economics Discussion Series* No. 64, 1999.

Côté, D., J. Kuszczak., J.P Lam., Y. Liu., and P. St-Amant. "The Performance of Simple Rules in Canadian Macroeconomic Models", Mimeo, Bank of Canada, 2002.

Cooper, R. and H. Kempf. "Designing Stabilization Policy in a Monetary Union", Working Paper 00-01, Federal Reserve Bank of Cleveland, 2000.

Currie, D. and P. Levine. *Rules, Reputation and Macroeconomic Policy Coordination*. Cambridge, Cambridge University Press, 1993.

DeLong, J.B. and L.H. Summers, "Is Increased Price Flexibility Stabilizing?", *American Economic Review*, Vol. 76, No. 5 (1986), 1031-1044.

Devereux, M.B. and C. Engle. "Fixed vs Floating Exchange Rates: How Price Setting Affect the Optimal Choice of Exchange Rate Regime", NBER Working Paper No. 6867, 2000.

Devereux, M.B. "Monetary Policy, Exchange Rate Flexibility and Exchange Rate Pass-through", Mimeo, University of British Columbia, 2000.

Devereux, M.B and P. Lane. "Exchange Rate Regime and Monetary Policy Rules for Emerging Markets", Mimeo, University of British Columbia, 2001.

Dittmar, R., W.T. Gavin and F.E. Kydland. "The Inflation-Output Variability Trade-off and Price - Level Targets", Federal Reserve Bank of St. Louis Review, January 1999.

Dixit, A. and L. Lambertini. "Fiscal Discretion Destroys Monetary Commitment", Working Paper, Princeton University, 2001.

Dornbusch, R. "Expectations and Exchange Rate Dynamics", *Journal of Political Economy*, Vol. 84, No. 6 (1976), 1161-1176.

Duguay, P. "Empirical Evidence on the Strength of the Monetary Transmission Mechanism in Canada: An Aggregate Approach", *Journal of Monetary Economics*, Vol 33, No. 1. (1994), 39-61.

Fatas, A. and I. Mihov "Government Size and Automatic Stabilizers", *Journal of International Economics*, 2002, Forthcoming.

Fisher, I. *100% Money*, City Printing Company, 1945.

Fleming, J. M. "Domestic Financial Policies Under Fixed and Floating Exchange Rates", *IMF Staff Papers*, Vol. 9 (1962), 369-379.

Fortin, P. "Low Inflation and the Canadian Economy: A Comment", in David E. W. Laidler (ed), *Where We Go from Here*, Toronto: C.D. Howe Institute, 1997.

Freedman, C. and T. Macklem. "A Comment on 'The Great Canadian Slump'", *Canadian Journal of Economics*, Vol. 31, No. 3 (1998), 646-665.

Friedman, M. *A Program for Monetary Stability*, New York: Fordham University Press, 1959.

Friedman, B.M. "Changing Effects of Monetary Policy on Real Economic Activity", NBER Working Paper No. 3278, 1990.

Fuhrer, J.C. and G.R. Moore. "Inflation Persistence", *Quarterly Journal of Economics*, Vol. 110, No. 1 (1995), 127-59.

Fuhrer, J.C. "An Optimization Model for Monetary Policy Analysis: Can Habit Formation Help?", Federal Reserve Bank of Boston Working Paper No. 98-1, 1998.

Fuhrer, J.C. "Habit Formation in Consumption and its Implications for Monetary-Policy Models", *American Economic Review*, Vol. 90, No. 3 (2000), 367-390.

Galì, J. and M. Gertler. "Inflation Dynamics: A Structural Econometric Analysis", *Journal of Monetary Economics*, Vol. 45, No. (1999), 195-222.

Galì, J. and T. Monacelli. "Optimal Monetary Policy and Exchange Rate Volatility in a Small Open Economy", Manuscript, Boston College, 2000.

Galì, J., M. Gertler and J.D. López-Salido. "European Inflation Dynamics", *European Economic Review*, Vol. 45, No. 7 (2001), 1237-1270.

Gerlach, S. and G. Schnabel. "The Taylor Rule and Interest Rates in the EMU Area: A Note", BIS Working Paper No. 73, 1999.

Gerlach, S. and F. Smets. "MCIs and Monetary Policy in Small Open Economies Under Floating Exchange Rates", *European Economic Review*, 2002, Forthcoming.

Ghironi, F. "Alternative Policy Rules for a Small Open Economy: The Case of Canada", Department of Economics, Boston College, Working Paper, 2000.

Goldstein, M. and G. Woglom. "Market-Based Fiscal Discipline in Monetary Unions: Evidence from the U.S Municipal Bond Market", in M.Canzeroni, V. Grilli and P. Masson (eds.), *Fiscal Institutions and Fiscal Performance*, The University of Chicago Press, 1992, 209-232.

Goodfriend, M. and R. King. "The New Neoclassical Synthesis and the Role of Monetary Policy", NBER *Macroeconomics Annual*, Vol. 12, (1997), 321-383.

Gorbett, F. and J.F. Helliwell. "Assessing the Dynamic Efficiency of Automatic Stabilizers", *Journal of Political Economy*, Vol. 79, No. 4 (1971), 826-845.

Hairault, J-O., P-Y. Henin and F. Portier. *Business Cycles and Macroeconomic Stability. Should We Rebuild Built-in Stabilizers?*, Dordrecht and London: Kluwer Academic Publishers.

Jensen, H. "Targeting Nominal Income Growth or Inflation?", *American Economic Review*, 2002, Forthcoming.

Judd, J.P. and G.D. Rudebusch. "Taylor Rule and the Fed: 1970-1997", *Federal Reserve Bank of San Francisco Economic Review*, Vol. 3, (1998), 3-16.

Julius, D., Fry, M., Mahadeva, L., Roger, S. and G. Sterne, "Monetary Policy Frameworks in a Global Context", Manuscript, Bank of England, October 2000.

Kerr, W. and R.G. King. "Limits on Interest Rate Rules in the IS Model", *Federal Reserve Bank of Richmond Economic Quarterly*, Vol. 82, No. 2 (1996), 47-75.

King, R.G. "The New IS-LM Model: Language, Logic and Limits", *Federal Reserve Bank of Richmond Economic Quarterly*, Vol. 86, No. 3 (2000), 45-103.

Kiley, M. "Monetary Policy Under Neoclassical and New-Keynesian Phillips Curves, with an Application to Price Level and Inflation Targeting", Federal Reserve Board, *Finance and Economics Discussion Series* No. 27, 1998.

Kozicki, S. "How Useful are Taylor Rules for Monetary Policy", *Federal Reserve Bank of Kansas City Economic Review*, Second Quarter, 1999.

Kydland, F.E., and E.C. Prescott. "Rules Rather Than Discretion: The Inconsistency of Optimal Plan", *Journal of Political Economy*, Vol. 85, No. 3 (1977), 473-491.

Laubach, T., F.S. Mishkin. and A. Posen. *Inflation Targeting*, Princeton University Press, Princeton, New Jersey, 2000.

Lebow, D.E., J.M. Roberts and D.J. Stockton. "Economic Performance under Price Stability", Federal Reserve Board, *Division of Research and Statistics Working Paper* No. 125, 1992.

Leeper, E.M., C. Sims and T. Zha. "What Does Monetary Policy Do?", *Brookings Papers on Economic Activity*, Vol. 0, No. 2 (1996), 1-63.

Leitemo, K. and U. Söderström. "Simple Monetary Policy Rules and Exchange Rate Uncertainty", Sveriges Riksbank Working Paper No. 122, 2001.

Levin, A., V. Wieland and J.C. Williams. "Robustness of Simple Policy Rules under Model Uncertainty", in John B. Taylor (ed.), *Monetary Policy Rules*, University of Chicago Press, 1999.

Levinson, A. "Balanced Budgets and Business Cycles: Evidence from the States", *National Tax Journal*, Vol. 51, No. 4 (1998), 715-732.

Lockwood, B., M. Miller and L. Zhang. "Designing Monetary Policy When Unemployment Persists", *Economica*, Vol. 65, No. 259 (1998), 327-345.

Mankiw, N.G and W.M. Scarth, *Macroeconomics: Canadian Edition*, New York, Worth Publishers, 1995.

Mattina, T. and F. Delorme. "The Impact of Fiscal Policy on the Risk Premium of Government Long-Term Debt: Some Canadian Evidence", Working Paper, Department of Finance (Canada) 97-01, 1996.

McCallum, B.T. "Rational Expectations and Macroeconomic Stabilization Policy: An Overview", *Journal of Money, Credit and Banking*, Vol. 12, No. 4, Part 2 (1980), 716-746.

McCallum, B.T. "A Semi-Classical Model of Price Level Adjustment", *Carnegie-Rochester Conference Series on Public Policy*, Vol. 41, No. 0 (1994), 251-284.

McCallum, B.T. "Topics in Monetary Theory and Policy", Lectures at the Institute for Advanced Studies, Vienna, Austria, May 1995.

McCallum, B.T. "The Alleged Instability of Nominal Income Targeting", NBER Working Paper, No. 6291, 1997.

McCallum, B.T. "Should Monetary Policy Respond Strongly to Output Gaps?", *American Economic Review (Papers and Proceedings)*, Vol. 91, No. 2 (2001), 258-262.

McCallum, B.T. and E. Nelson. "Nominal Income Targeting in an Open-economy Optimizing Model", *Journal of Monetary Economics*, Vol. 43, No. 3 (1999a), 553-578.

McCallum, B.T. and E. Nelson. "An Optimizing IS-LM Specification for Monetary Policy and Business Cycle Analysis", *Journal of Money, Credit and Banking*, Vol. 31, No. 3 (1999b), 296-316.

McCallum, B.T. and E. Nelson. "Monetary Policy for an Open Economy: An Alternative Framework with Optimizing Agents and Sticky Prices", *Oxford Review of Economic Policy*, Vol. 16, No. 4 (2000), 74-91.

McCallum, B.T. and E. Nelson. "Timeless Perspective vs. Discretionary Monetary Policy in Forward-Looking Models", Mimeo, 2001.

McCallum, B.T. and J.K Whitaker. "The Effectiveness of Fiscal Feedback Rules and Automatic Stabilizers under Rational Expectations", *Journal of Monetary Economics*, Vol. 5, No. 2 (1979), 171-186.

Monacelli, T. "Open Economy Policy Rules under Imperfect Pass-Through", Mimeo, Department of Economics, Boston College, 1999.

Mundell, R.A. "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates", *Canadian Journal of Economics and Political Science*, Vol. 29, (1963), 475-485.

Mussa, M. "Sticky Prices and Disequilibrium Adjustment in a Rational Model of the Inflationary Process", *American Economic Review*, Vol. 71, No. 5 (1981), 1020-1027.

Myers, G. and W.M. Scarth. "Is Price Flexibility Destabilizing? Evidence for the Open Economy", *Journal of International Economics*, Vol. 28, No.3, (1990), 349-363.

Nelson, E. "UK Monetary Policy 1972-1997: A Guide using Taylor's Rule", Mimeo, Bank of England, 2000.

Nordhaus, W. "The Political Business Cycle", *Review of Economic Studies*, Vol. 42, No.2, (1975), 169-90.

Obstfeld, M. and K. Rogoff. "New Directions for Stochastic Open Economy Models", *Journal of International Economics*, Vol. 50, No. 1 (2000), 117-153.

Persson, T. and G. Tabellini. "Designing Institutions for Monetary Stability", *Carnegie-Rochester Conference Series on Public Policy*, Vol. 39, No. 0 (1993), 53-89.

Persson, T. and G. Tabellini. *Monetary and Fiscal Policy*, Cambridge: MIT Press.

Poole, W. "Optimal Choice for Monetary Policy Instrument in a Simple Stochastic Macro Model", *Quarterly Journal of Economics*, Vol. 84, No. 2 (1970), 197-216.

Poterba, J.M. "Do Budget Rules Work?", in A. Auerbach (ed.), *Fiscal Policy: Lessons From Empirical Research*, MIT Press, 1997, 53-86.

Ramsey, F.P. "A Mathematical Theory of Saving", *Economic Journal*, Vol. 38, (1928), 543-559.

Roberts, J.M. "New Keynesian Economics and the Phillips Curve", *Journal of Money, Credit and Banking*, Vol. 27, No. 4, Part 1 (1995), 975-984.

Roberts, J.M. "How Well Does the New-Keynesian Sticky-Price Model Fit the Data?", Federal Reserve Board, *Finance and Economics Discussion Series*, No. 13, 2001.

Rogoff, K. "The Optimal Degree of Commitment to an Intermediate Monetary Target", *Quarterly Journal of Economics*, Vol. 100, No. 4 (1985), 1169-1189.

Rotemberg, J.J. "The New Keynesian Microfoundations", NBER *Macroeconomics Annual*, 1987, 69-104.

Rotemberg, J.J. and M. Woodford. "Interest Rate Rules in an Estimated Sticky Price Model", in J.B Taylor (ed.), *Monetary Policy Rules*, Chicago: University of Chicago Press, 1999

Rotemberg, J.J. and M. Woodford. "An Optimization-Based Econometric Framework for the Evaluation of Monetary Policy", NBER Technical Working Paper No. 233, 1998.

Rudd, J. and K. Whelan. "New Tests of the New-Keynesian Phillips Curve", Federal Reserve Board, *Finance and Economics Discussion Series*, No. 30, 2001.

Rudebusch, G. and L.E.O Svensson. "Policy Rules for Inflation Targeting", in John B. Taylor (ed.), *Monetary Policy Rules*, University of Chicago Press, 1999.

Rudebusch, G. "Assessing National Income Rules for Monetary Policy with Model and Data Uncertainty", Federal Reserve Board of San Francisco Working Paper 2000-03, 2000.

Sack, B. and V. Wieland. "Interest Rate Smoothing and Optimal Monetary Policy: A Review of Recent Empirical Evidence", *Journal of Economics and Business*, Vol. 52, No. 1-2 (2000), 205-228.

Scarth, W.M. "Debt and Deficits in an Open Economy", *Journal of International Money* *and Finance*, Vol. 7, No. 3 (1988), 351-358.

Scarth, W.M. *Macroeconomics: An Introduction to Advanced Methods*, second edition, Toronto: The Dryden Press, 1996.

Schmitt-Grohe, S. and M. Uribe. "Price-Level Determinancy and Monetary Policy Under a Balanced-Budget Requirement", *Journal of Monetary Economics*, Vol. 45, No. 1 (2000), 211-231.

Smets, F. "What Horizon for Price Stability?", ECB Working Paper No 24, 2000.

Smyth, D.J. "Built-in Flexibility of Taxation and Stability in a Simple Dynamic IS-LM Model", *Public Finance*, Vol. 29, No. 1 (1974), 111-113.

Soderlind, P., "Solution and Estimation of RE Macromodels with Optimal Policy", *European Economic Review*, Vol. 43, No. 4-6 (1999), 813-823.

Söderström, U. "Targeting Inflation with a prominent role for money," Sveriges Riksbank, Working Paper, 2001.

Svensson, L.E.O. "Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets", *European Economic Review*, Vol. 41, No. 6 (1997), 111-146.

Svensson, L.E.O. "Inflation Targeting as a Monetary Policy rule", *Journal of Monetary Economics*, Vol. 43, No. 3 (1999a), 607-654.

Svensson, L.E.O. "Price-Level Targeting vs. Inflation Targeting: A Free Lunch?", *Journal of Money, Credit and Banking*, Vol. 31, No. 3 (1999b), 277-295.

Svensson, L.E.O. "Open Economy Inflation Targeting", *Journal of International Economics*, Vol. 50, No. 1 (2000), 155-183.

Taylor, J.B. "Discretion Versus Policy Rules in Practice", *Carnegie-Rochester Conference Series on Public Policy*, Vol. 39, No. 0 (1993), 195-214.

Taylor, J.B. "Introduction" in J.B Taylor (ed.), *Monetary Policy Rules*, Chicago: University of Chicago Press, 1999.

Taylor, J.B. "Reassessing Discretionary Fiscal Policy", Unpublished manuscript, 2000.

Tobin, J. "A Proposal for International Monetary Reform", *Eastern Economic Journal*, Vol. 4, No. 1 (1978), 153-159.

Turnovsky, S.J. *Methods of Macroeconomic Dynamics*, Cambridge: MIT Press, 1995.

van der Noord, P. "The Size and Role of Automatic Fiscal Stabilizers in the 1990s and Beyond", OECD Working Paper, 2000.

Vestin, D. "Price Level Targeting Versus Inflation Targeting in a Forward-Looking Model", IIES Stockholm University Working Paper, 2000.

Walsh, C.E. "Optimal Contracts for Independent Central Bankers", *American Economic Review*, Vol. 85, No. 1 (1995), 150-67.

Walsh, C. E. *Monetary Theory and Policy*, Cambridge: MIT Press, 1999a.

Walsh, C. E. "Monetary Policy Trade-Offs in the Open Economy", Mimeo, UCSC, 1999b.

Walsh, C. E. "Speed Limit Policies: The Output Gap and Optimal Monetary Policy", Mimeo, UCSC, 2001.

Weise, C.L. "Severity of Economic Fluctuations under a Balanced Budget Amendment", *Contemporary Economic Policy*, Vol. 14, No. 2 (1996), 26-40.

Wicksell, K. *Interest and Prices*, New York, Augustus M. Kelley, 1965.

Williams, J. "Simple Rules for Monetary Policy", Federal Reserve Board, *Finance and Economic Discussions Papers Series*, 1999.

Woodford, M. "Optimal Monetary Policy Inertia", NBER Working Paper No. 7261, 1999.

Woodford, M. "Pitfalls of Forward-Looking Monetary Policy", *American Economic Review*, Vol. 90, No. 2 (2000), 100-104.

Yun, T. "Nominal Price Rigidity, Money Supply Endogeneity, and Business Cycles", *Journal of Monetary Economics*, Vol. 37, No. 2 (1996), 345-370.