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The Inflation Bias, Central Bank Independence, and  
Monetary Conservatism

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# 1 Introduction

The implementation of an inflation targeting regime<sup>1</sup> in New Zealand in 1990 triggered a remarkable world wide surge of central bank reforms, that lasted well into the new millennium. Across the globe the purpose of all of these reforms was virtually the same: First, to increase the independence of central banks by drastically limiting the political influence on central bank executives, and secondly, to legally impose price stability as the only (or at least main) goal of monetary institutions. This wave of reforms was initially almost limited entirely to industrialized countries (profound central bank modifications took place for example in Canada (1991), the UK (1992), Sweden (1993) and Australia (1993))<sup>2</sup>. However, around the year 2000 it also spread to eastern European and other emerging economies, resulting in substantial central bank reforms in the Czech Republic (1998), Brazil (1999), South Africa (2000) and Hungary (2001).

Finally, also the European Central Bank (ECB), founded in 1998, strongly reflects this trend towards increased central bank independence and inflation awareness, as its institutional setup unifies high degrees of both political independence and inflation aversion.

Only few real world changes have been so significantly influenced by a series of new findings in theoretical research, like this wave of central bank reforms. The roots of this trend can be traced back to the influential result, that also benevolent and rational governments create upward biased inflation rates whenever they conduct

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<sup>1</sup>An inflation targeting regime is generally considered as an institutional central bank framework including the following points: Adoption of an explicit numerical inflation target, (operational) independence of central banks in executing their monetary policy, and high levels of policy transparency and accountability (Schmidt-Hebbel and Tapia, 2002).

<sup>2</sup>See Central Bank of Iceland (2007).

monetary policy on their own. This finding provided the basis for further research which concluded that this inflation bias can be reduced by delegating monetary policy to an independent, “monetary conservative” central bank.

In my thesis I want to provide a detailed insight into the concepts which motivated this observed trend of central bank reforms. For this purpose, I will first derive the underlying theoretical rationale for upward biased long run inflation rates. In the following, the most important proposals which aim at reducing this bias will be introduced. Here, my attention will focus in particular on the concept of the weight conservative central banker, since it was especially this notion which has significantly influenced the global reform wave (Romer, 2006, p. 517). Finally, I will present some recent theoretical results, which question the optimality of monetary conservatism. Since these models explicitly allow for monetary-fiscal interactions, especially in the light of the current European debt crisis their findings provide useful insights into the possible *indirect* effects of monetary conservatism on fiscal policy and public debt; an issue that has not been considered thus far.

My thesis will be organized as follows: Sections 2 and 3 provide some general facts related to inflation. Section 4 focuses on the formulation of the time inconsistency problem in monetary politics and the resulting inflation bias. Section 5 introduces the three most influential concepts for reducing this inflation bias, where attention will be focused on the concept of the weight conservative central banker. Section 6 presents the concept of the conservative central banker within modern micro based model frameworks with endogenous fiscal policy and public debt. Section 7 concludes.

## 2 Inflation: Basic concepts

### 2.1 Defining inflation

The term inflation in its contemporary understanding is generally defined as a continuous increase in the general level of prices<sup>3</sup> and thus as *price inflation*. However, considered within a historical context, the meaning of the word inflation has already been subject to notable changes.

The original definition of inflation, which dominated economic literature from the emergence of the term in the middle of the nineteenth century onwards until the early years of the twentieth century, was that inflation defines a change in the supply of paper money relative to the amount of circulating precious metal coins (Bryan, 1997). Thus its original meaning was completely uncoupled from any price considerations, since such a *monetary inflation* normally occurred in the absence of any changes in the general price level. However, as paper money gained more importance at the beginning of the last century, the clear distinction between currency (i.e. paper money) and traditional money (metal coins) became blurry and thus also this traditional definition of inflation lost its practical value. For that reason in the early years of the twentieth century economists started to redefine monetary inflation as *any* change in the supply of a circulating medium relative to some given “trade needs”. In order to measure this excess supply, it became common to use the average price level as a new reference value. Consequently inflation departed from defining a currency condition to describing a money and price condition. The final step, which then ultimately uncoupled inflation from any monetary component, was undertaken by John Maynard Keynes in his famous

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<sup>3</sup>See for example the prominent inflation definitions in Friedman (1963) or Laidler and Parkin (1975).

work “The General Theory of Employment, Interest and Money” (Keynes, 1936). Here Keynes argued that though money growth is an important determinant of inflation, it is by far not the only one. Also demand and supply issues, that is the real part of the economy, play an important role in the determination of the price level. Consequently he redefined inflation as *any* increase in the general price level and thus ultimately altered the perception of inflation from *monetary inflation* to *price inflation*.

## 2.2 Measuring inflation

Price-inflation in a given period is measured by the inflation rate. The inflation rate simply denotes the rate at which the general price level increases from one time period to the next period:

$$\pi_t = \frac{P_t - P_{t-1}}{P_{t-1}},$$

where  $P_t$  is the general price level at period  $t$  and  $\pi_t$  is the corresponding net rate of inflation.

Obviously the level of the inflation rate ultimately depends on how this price level is being determined. In practice there exist many different approaches of price measurement and thus also many types of inflation. However, the two most common measures to capture the general evolution of prices within an economy are the GDP Deflator and the Consumer Price Index (CPI), since both of them cover a fairly broad range of goods (Blanchard and Illing, 2004, p. 52) .

The GDP Deflator measures the average price level of all produced final goods in

an economy,  $P_t$ , by the ratio between the nominal GDP (the GDP measured in current prices) and the real GDP (the GDP measured in prices of a base year),

$$P_t = \frac{GDP_{nominal,t}}{GDP_{real,t}}.$$

The consumer price index, in turn, tries to capture the inflation burden of an average household by measuring the price development of consumption goods. Hereby the current costs of a representative consumer basket<sup>4</sup> are divided by the costs of the same basket in a given base year. In order to account for changes in tastes or in the range of offered products, the list of covered goods in the consumer basket is updated frequently.

### **2.3 The costs and benefits of inflation**

Though inflation has always been a big matter of concern throughout the last century until today, economists still struggle with providing reasonable explanations for the strong public dislike of inflation. As pointed out in Romer (2006) “[t]here is a wide gap between the popular view of inflation and the costs of inflation that economists can identify.” (Romer, 2006, p. 547)

In order to provide a structured overview of the most prominent positive and negative effects of inflation, I will differentiate between the costs of fully anticipated inflation and the costs and benefits of unanticipated inflation<sup>5</sup>.

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<sup>4</sup>The term “representative consumer basket” denotes a list of goods normally consumed by an average household within a certain time period, say a month (Mankiw, 2003, p. 36).

<sup>5</sup>The terms “costs” and “benefits” will refer to the positive and negative effects of inflation on social welfare. While unanticipated inflation features both positive and negative welfare effects, there can be hardly identified any benefits from anticipated inflation.

The meaning of anticipated and unanticipated inflation is straight forward: Anticipated inflation defines an actual inflation rate equal to inflation expectations, whereas unanticipated or surprise inflation denotes the difference between the actual and the expected inflation rate<sup>6</sup> (Abel and Bernanke, 2005, p. 456ff). It is generally assumed that anticipated inflation may occur both in the short and in the long run, whereas surprise inflation is just a short run phenomenon (since a repeatedly occurring surprise is clearly no longer a surprise).

### 2.3.1 The costs of anticipated inflation

The main effect of an inflation rate perfectly anticipated by economic agents is an equivalent increase in prices and consequently in all nominal variables. Some of the reasons why such anticipated changes in the general price level provoke costs for economic agents are: Higher transaction costs (“shoe leather costs”), costs of price adjustments (“menu costs”) and costs due to the general dislike of inflation (direct utility costs). The following brief description will deal with each of these cost factors in greater detail:

#### 1. Shoe leather costs

Shoe leather costs originate from the linkage between anticipated inflation and nominal interest rates. This relation is formalized in the Fisher principle, which states that any nominal interest rate  $i$  equals (approximately) the real interest rate  $r$  plus the rate of inflation expected over the interest period,  $\pi^e$ ,

$$i \approx r + \pi^e.$$

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<sup>6</sup>Note that the distinction between anticipated and unanticipated inflation is purely analytical and stands in no direct relation with actual historical inflation periods (Parklin, 2008).

Thus in the case of perfectly anticipated inflation  $\pi = \pi^e$  holds and nominal interest rates move simultaneously with inflation, leaving the real interest rate unchanged. However, an increase in nominal interest rates also implies rising opportunity costs of holding idle money for daily purchases. Since cash does not yield any interest, people will tend to economize their money holdings when inflation and consequently interest rates are rising, thus shifting more of their wealth into interest bearing assets. However, since transforming assets back into liquid cash involves costs, such a decrease in real money holdings will also make cash-based transactions more expensive where the resulting costs are defined as shoe leather costs<sup>7</sup> (Mankiw, 2003, p. 109ff).

## 2. Menu costs

Menu costs denote the costs of nominal price adjustments, which clearly also arise when price changes have been expected correctly. Such costs include for example reprinting catalogs or menu cards or rewriting nominal contracts (Abel and Bernanke, 2005, p. 457).

## 3. Direct utility costs

Some authors argue that anticipated inflation is socially costly simply because people dislike inflation (e.g. Shiller, 1997). Since agents relate to their economic environment in a nominal scale unit (e.g. Dollars or Euros), they may find large changes in this measuring unit as inconvenient or disturbing, even though the real value of their wealth has not changed (Romer, 2006,

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<sup>7</sup>This term shall figuratively emphasize how anticipated inflation increases transaction costs. Since in the presence of high interest rates economic agents will leave almost their entire money at their bank deposits, they will have to go more often to the bank for withdrawals, causing -amongst increasing time and energy costs- that their shoes get worn out more quickly.

p.549). Others relate this public dislike of inflation to the fact that people misconceive the actual effects of inflation. Katona (1976) for example argues that inflation is often just noticed as an increase in prices, whereas involved wage increases are generally overseen. This distorted public perception causes that people think that they are always “worse off” when there is inflation.

### 2.3.2 The costs of unanticipated inflation

There also exist several reasons why unanticipated inflation is socially costly. One of the main causes is the short run rigidity of almost any nominal variable. Since contracts are normally negotiated in nominal terms which cannot be altered instantaneously, an inflation rate higher than expected by the negotiating parties can lower the real value of these contracts ex post, involving unexpected gains or losses to the contracting parties (Mankiw, 2003, p. 119).

Another consequence of unexpected inflation is its alteration of the ex post real interest rate. A reformulation of the above presented Fisher equation shows that the ex ante real interest rate  $r$  is given by the agreed nominal interest rate  $i_t$  minus the expected inflation rate,  $\pi_t^e$ , that is  $r = i_t - \pi_t^e$ . However, the *actual* ex post real interest rate,  $r^{Post}$ , is given by the nominal interest rate minus the actually realized inflation rate,  $r^{Post} = i_t - \pi_t$ . Thus whenever there is surprise inflation, the ex post real interest rate  $r^{Post}$  will be lower than the desired real interest rate  $r$ , causing an unpredictable redistribution of wealth from lenders to borrowers (Mankiw, 2003). As a result, intertemporal decisions based on the ex ante real interest rate can turn out to be suboptimal in the light of the actual ex post real interest rate (McCallum, 2008).

Yet, from the viewpoint of the economy as a whole such unpredictable shifts of wealth caused by surprise inflation still do not represent social costs in its actual



sense, since overall wealth is not diminished but just redistributed. However, since economic agents are generally risk averse, they will spend a part of their resources on protecting themselves against surprise inflation which otherwise could have been used in a more effective way. It is this socially unproductive usage of resources which can be identified as welfare costs arising from unanticipated inflation (Abel and Bernanke, 2005, p. 457).

### **2.3.3 The benefits of unanticipated inflation**

However, from a (benevolent) policymaker's point of view there also exist various arguments in favor of creating surprise inflation (see, for example, Barro and Gordon, 1983a; Fischer and Modigliani, 1978; Fischer, 1995) . The most prominent argument for surprise inflation relates to the temporary trade off between unexpected inflation and short run growth, the so-called short run Phillips curve trade off. By actively creating unanticipated inflation, a policymaker can push both employment and output temporarily above their natural levels, which also leads to a temporary improvement in social welfare (when overall welfare is increasing in the output level, as is generally assumed).

The second advantage of surprise inflation refers to governmental revenues. Since economic agents use their inflation expectations in order to determine the level of their real cash holdings (see the previous section), governments can "tax away" the real value of these nominal holdings simply by creating surprise inflation. The advantage of such an inflation tax compared to other conventional taxes is that it is levied *ex post*, when decisions over nominal money holdings have already been undertaken. So in contrast to other forms of taxation, the inflation tax does *not* distort the microeconomic decision process of economic agents. Consequently, if a policymaker uses surprise inflation in order to raise money for financing public

spending needs, he can in exchange lower conventional tax rates and therefore reduce economic distortions.

A similar argument finally relates to the third advantage arising from unanticipated inflation. Since government liabilities are predominantly fixed in nominal terms, a policymaker can considerably reduce both the real value of its outstanding debt stock as well as the real value of interest payments simply by inflating beyond expectations. The consequently reduced real debt service then again allows the policymaker to lower the average tax level, with the resulting beneficial effects for overall society (Dwyer Jr., 1993).

### **3 A simple model of inflation**

Having reviewed the most important effects of inflation, in this section I will provide a brief overview of the main causes of inflation, both in the short as well as in the long run. For this purpose I will use a simple stochastic AS/AD model, in which -for the sake of brevity- I will restrict the analysis to the closed economy case.

The AS/AD model is a macroeconomic framework, which is used to model short run economic fluctuations as well as an economy's convergence to its long run equilibrium. The model consists of two parts: an aggregate demand block (AD equation), made up by a goods market equation (IS curve) and a money market equation (LM curve), and an aggregate supply part (AS equation). The economics literature describes different versions of AS/AD models, such as Keynesian, New Keynesian, Monetarist or Classical versions, which all exhibit notable differences in their theoretical setup. Since most of the theory on monetary conservatism bases on the Keynesian assumption of short run nominal rigidities, here I will also

use a standard Keynesian version of the AS-AD model. The employed log linear model equations will be of the following form<sup>8</sup>:

$$IS : y_t = \bar{d} - \alpha r_t + \epsilon_t, \quad (3.1)$$

$$LM : m_t - p_t = \gamma y_t - \beta(r_t + E_{t-1}(\pi_t)) + v_t, \quad (3.2)$$

$$AD : y_t = \frac{1}{\gamma + \beta/\alpha} (m_t - p_t + \beta(\bar{d}/\alpha + E_{t+1}(\pi_t) + \epsilon_t/\alpha) - v_t), \quad (3.3)$$

$$AS : y_t = \bar{y} + \delta(\pi_t - E_{t-1}(\pi_t)) + s_t, \quad (3.4)$$

where  $y_t$ ,  $m_t$  and  $p_t$  denote real GDP, the (exogenous) nominal money supply<sup>9</sup> and the average price level, respectively. Furthermore  $r_t$  defines the real interest rate prevailing in period  $t$ ,  $\pi_t = \Delta p_t = p_t - p_{t-1}$  is the period  $t$  inflation rate, and  $E_{t-1}(\pi_t)$  denotes rational period  $t$  inflation expectations formed in  $t - 1$ . The coefficients  $\alpha, \beta, \gamma$  and  $\delta$  are assumed to be positive, and  $\lambda$  will be bounded between zero and one. Finally  $\epsilon_t, v_t$  and  $s_t$  denote stochastic short run disturbance terms, which are assumed to be i.i.d. with  $x \sim N(0, \sigma_x^2)$  for  $x = \epsilon, v, s$ .

### 3.1 A brief model explanation

For the sake of clarity I will start with a brief explanation of the model equations (3.1) to (3.4).

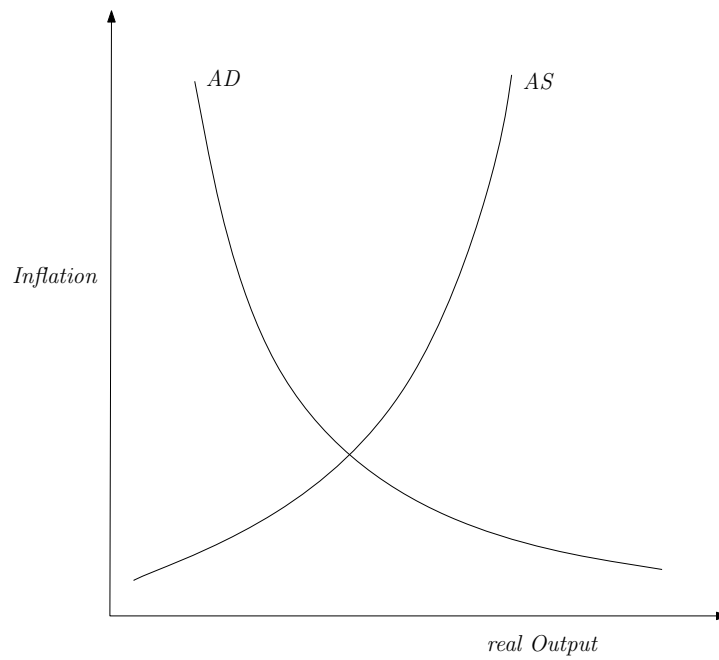
First, the IS equation (3.1) describes equilibrium on the goods market: Supply of goods, i.e. real GDP  $y_t$ , on the left hand side equals demand for goods on the right hand side. In this very simplified version, real goods demand just consists

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<sup>8</sup>The model is a slightly modified version of the Neoclassical/Keynesian Synthesis model presented in Minford and Peel, 2002, p. 21.

<sup>9</sup>In this context “money” may be interpreted as high powered money, i.e. currency and reserves, which do not yield any interest.

of a constant term  $\bar{d}$ , an interest elastic term  $\alpha r_t$  and a stochastic shock term  $\epsilon_t$ . Next, the LM curve (3.2) characterizes equilibrium on the money market. Supply of real money,  $m_t - p_t$ , equals demand for real money, which is increasing in real output  $y_t$  and decreasing in the nominal interest rate defined as  $r_t + E_{t-1}(\pi_t)$ . Additionally also real money demand includes a stochastic shock term,  $v_t$ . The AD curve (3.3) is simply the combination of the the IS equation (3.1) and the LM equation (3.2). It describes overall aggregate demand in the economy. Finally, the AS curve (3.4) captures the supply side of the economy. Actual period  $t$  production,  $y_t$ , fluctuates around some long run constant trend  $\bar{y}$ , where this so called natural rate of production is uniquely determined by real factors in the economy, such as the capital stock or the production technology. Fluctuations around this natural rate happen for two reasons: First, whenever actual period  $t$  inflation does not coincide with expected inflation but rather settles above or below these expectations, also actual production either lies above or below the long run natural rate. Second, also supply disturbances, such as unexpected changes in input prices, can cause actual output to departure from its long run trend. One big advantage of the AS-AD model is that it also permits for a graphical analysis of economic processes, in which both the AD and the AS curve are plotted in a  $(y, \pi)$  space. In such a diagram the AD curve is downwards sloping, since an increase in the price level leads *ceteris paribus* to a decrease in real output. The AS curve in turn has a positive slope, because an increase in inflation leads *ceteris paribus* to an increase in real output.



**Figure 3.1** The AS-AD model

## **3.2 Causes of inflation in the short and in the long run**

Using this model framework, the following two subsections will turn to the presentation of the roots of inflation in the long and in the short run.

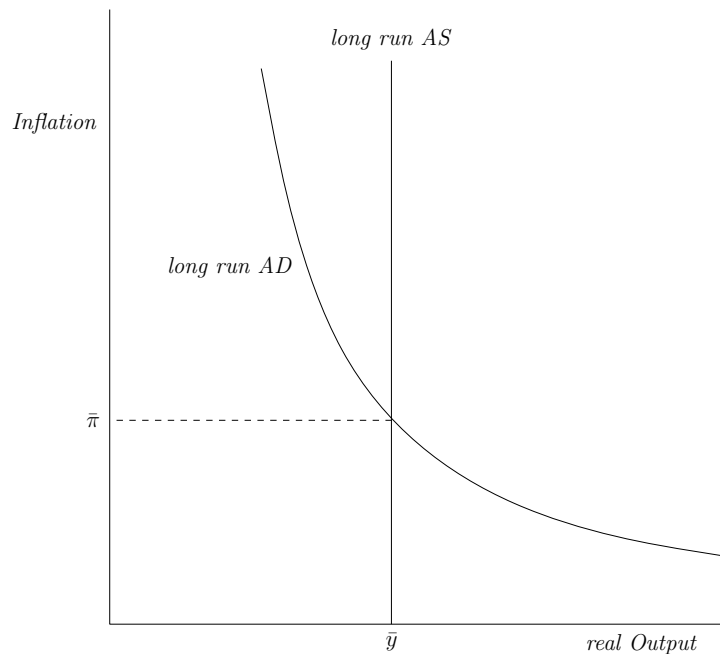
### **3.2.1 Causes of long run inflation**

First consider long run inflation. The long run is generally defined as the time horizon at which an economy settles at its steady state equilibrium. At this long run equilibrium prices are growing at a constant rate, called the long run or core inflation rate,  $\bar{\pi}$ . Furthermore, in the long run economic agents have gathered sufficient information about the nature of the economy, such that long run inflation

forecasts will always coincide with realized inflation rates. Combining these two issues implies that in the long run the following equality has to hold:

$$E(\pi) = \pi = \bar{\pi}. \quad (3.5)$$

Using (3.5) in (3.4) shows that in the long run real GDP equals its natural rate,  $\bar{y}$ , irrespectively of the *level* of the prevailing inflation rate (The long run AS curve thus is a vertical line in an  $(y, \pi)$  space.). The actual level of long run inflation thus has to be ultimately determined by the relative position of the long run AD curve (see Figure 3.2). In order to see what determines the position of the long



**Figure 3.2** The AS-AD model in the long run

run AD curve, first rewrite the AD equation (3.3) in a differentiated form, which gives:<sup>10</sup>

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<sup>10</sup>Since here aggregate demand in the long run is considered, clearly the short run disturbance terms  $\epsilon$  and  $v$  are both zero.

$$\Delta\bar{y} = \frac{1}{\gamma + \beta/\alpha} (\Delta m - \Delta p + \beta\Delta E(\pi)). \quad (3.6)$$

Next, substituting  $\bar{\pi}$  for  $\Delta p$  and rearranging yields:

$$\bar{\pi} = \Delta m - \Delta\bar{y}(\gamma + \beta/\alpha) + \beta\Delta E(\pi). \quad (3.7)$$

In two steps equation (3.7) can be further simplified. First, since in the long run real output equals its natural level,  $\Delta\bar{y}$  has to be zero and the second term in (3.7) cancels out entirely. Second, because of the equality in (3.5) also  $\Delta E(\pi)$  will be zero in the long run such that also the third term in (3.7) cancels out. This finally leaves the growth rate of the nominal money supply as the only factor determining long run inflation, meaning that in the long run monetary inflation is equivalent with price inflation.

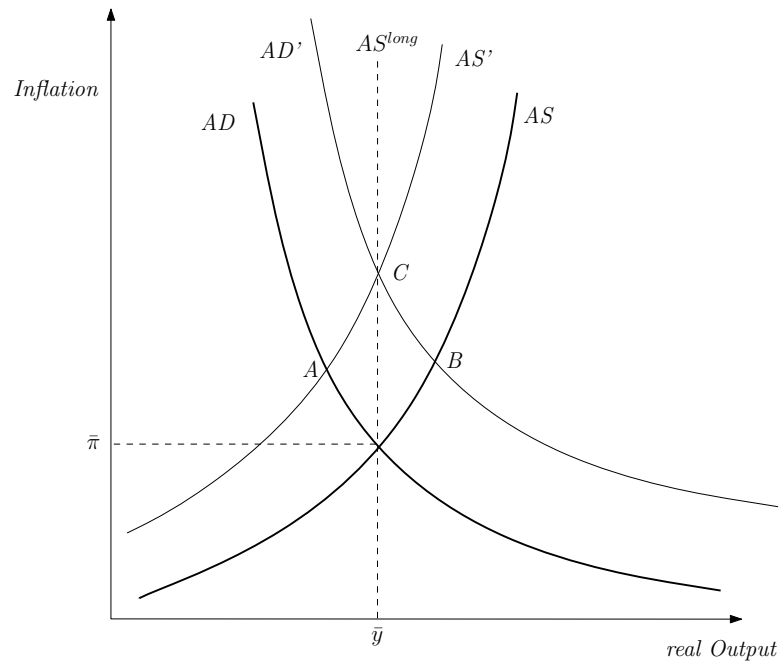
Assuming additionally long run economic growth does not substantially alter this proposition. In this case equation (3.7) would change to

$$\bar{\pi} = \Delta m - g(\gamma + \beta/\alpha), \quad (3.8)$$

where  $g = \Delta\bar{y}$  denotes trend growth of real GDP. Thus in the case of long run growth, any increase in the nominal money supply above  $g(\gamma + \beta/\alpha)$  would translate one to one into inflation. This is also intuitively plausible: Since demand for money is increasing in the real output level (if more goods are produced, more money is needed to buy them), in the presence of long run economic growth also the nominal money supply has to grow at a sufficiently high rate in order to satisfy steadily increasing money demand. In the above example this critical value of money growth equals  $g(\gamma + \beta/\alpha)$ : Any money growth rate above this level will trigger an increase in prices, i.e. inflation, whereas any growth rate below this critical value will trigger a *reduction* in the general price level, that is deflation.

### 3.2.2 Causes of short run inflation

In contrast to long run trend inflation, short run price inflation is not a purely monetary phenomenon. As Figure 3.3 illustrates, either an upwards shift of the AD or the (short run) AS curve causes short run inflation to rise above trend inflation (points A and B in Figure 3.3), whereas a converse movement of the curves depresses inflation below its trend. However, though an upwards movement of



**Figure 3.3** The AS-AD model in the short run

both of these curves leads to an increase in inflation, due to the respective behavior of real output these two cases are still diametrically different.

In the case of an upwards shift of the AD curve the economy moves along the short run AS curve. The resulting demand pressure pulls aggregate output above trend, but also leads to an increase in inflation. Because it is increased aggregate demand which causes the price level to rise, such a short run inflation is also called “demand-pull inflation”. In the case of an upwards shift of the short run AS



curve, however, there is a movement along the AD curve. Aggregate production declines and the resulting lack of aggregate supply at an unchanged level of aggregate demand leads to an increase in prices. Since negative supply shocks are often associated with unexpected increases in factor prices pushing up production costs, short run inflation of such a form is also called “cost-push inflation”. Thus in the case of demand pull inflation an economy experiences a boom with growth rates above trend, whereas in the case of cost push inflation the economy ends up in a situation of both high inflation and low economic activity, commonly denoted as stagflation.

Looking at equations (3.1) to (3.4) helps identifying the particular reasons for demand pull or cost push inflation. An inspection of equation (3.3) shows that demand pull inflation may have various sources, including an increase in the nominal money supply, a positive IS shock or a negative LM shock. Cost push inflation in turn is just triggered by one factor, that is the supply shock term  $s_t$ .

Finally equations (3.3) and (3.4) also demonstrate the output neutrality of anticipated inflation: If economic agents expect higher future inflation rates, both the AD and the short run AS curve will shift upwards (point C in Figure 3.3), thus causing an increase in the actual inflation rate, but no (substantial) changes in real output<sup>11</sup>.

After this brief summary of the most important inflation-related facts, the remaining sections of this thesis will now address the theoretical rationale for central bank independence and monetary conservatism, starting with a detailed explanation of what is generally understood as the “inflation bias”.

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<sup>11</sup>Note that in this model the net effect of an increase in expected inflation on real output is only zero if  $\frac{\alpha\beta}{\alpha\gamma+\beta} = \delta$  holds.

## 4 The Inflation Bias and monetary policy

The analysis so far suggests two findings: First, inflation is generally harmful to an economy (or at least strongly disliked by the general public) and second, the ultimate cause determining long run inflation is nominal money growth. In the light of these two results it would just seem logical to assume that governments and central banks around the world continuously monitor the growth rate of their nominal money supply in order to stabilize core inflation at a socially optimal low level. However, though the tight connection between nominal money growth and (long run) inflation is at least since the formulation of the quantity theory of money a well established fact, until the 1980s there could be observed inefficiently high growth rates of the nominal money supply which consequently also lead to excessive average inflation rates (Barro and Gordon, 1982b). Economists, confronted with this apparently illogical behavior of central bankers, were therefore searching for possible reasons which might justify this antagonism between theory and practice. One admittedly very tempting explanation was to simply consider politics as irrational (Barro and Gordon, 1983b, p. 590, Fn. 2). However, accepting such an explanation would obviously make any systematic examination of governmental behavior virtually impossible. If one therefore precludes irrationality as the reason for inefficiently high inflation rates, printing money for public finance purposes, that is seignorage, would serve as another potential explanation. However, though seignorage could be a reasonable explication for high average inflation rates or hyperinflation periods in developing countries, it was unable to justify excessive inflation rates in developed countries, where money creation did not constitute a (major) source of revenues (Romer, 2006, p. 506).

Therefore in the late 1970s and early 1980s several economists began to develop a new game-theoretic framework for modeling monetary policy, which aimed at reasoning the seemingly irrational behavior of real world monetary authorities.

The core result in this new framework was that even though committing to a low inflation rate principally constitutes the socially optimal strategy, in the absence of a strong enforcement mechanism such a commitment will turn out to be time-inconsistent, with the effect that even benevolent governments will be tempted to create “too much” inflation.

In the following I will present this game-theoretic framework in greater detail, basing my explanations on the seminal papers of Kydland and Prescott and Barro and Gordon (see Kydland and Prescott, 1977, and Barro and Gordon, 1983a,b). In order to fit my derivation into a well structured framework, I will first start with a brief explanation of the two main theoretical concepts of conducting monetary policy.

#### **4.1 The conduct of monetary policy: Rules versus discretion**

When deciding upon the nature of his monetary strategy, a policymaker faces two options: He can either reoptimize his monetary policy in every period anew, or he can commit himself *ex ante* to a certain monetary policy rule. In the first case one speaks of a discretionary strategy, whereas the second case corresponds to a policy strategy under commitment (Dwyer Jr., 1993).

The meaning of a discretionary strategy is quite straightforward. Under discretion a policymaker is completely free in the choice of his monetary policy and thus selects -conditional on his current information set- in every period that monetary policy which he views as most appropriate to reach his policy goals. Committing to a monetary policy rule in turn obviously means in the first place restricting this discretion of the policymaker. Such limitations can take various forms. One of the most prominent rules in economics literature is the money growth rate rule suggested by Classicals or Monetarists (see for example Friedman, 1960 or Lucas, 1980). Since inflation is ultimately a monetary phenomenon, this rule aims at

implementing low core inflation rates via a strict control of the growth rate of the nominal money supply. Other possible monetary rules which also ultimately aim at low inflation are for instance a commitment to a constant price level (e.g. Simons, 1936) or to a constant monetary base (Wallace, 1977).

However, since the long run relation between money growth and inflation is anyway conventional wisdom, the key question hence has to be why a policymaker should ever commit to a monetary rule, since such a commitment also clearly restricts his ability to counteract economic shocks. Until the mid 1970s a large group of economists thus supported the idea that a policy rule could never improve upon discretion (Turnovsky, 1977). The main argument against rules was that a benevolent policymaker acting under discretion could per definition execute any monetary strategy suggested by a policy rule, but would still dispose over the additional ability to react to unforeseeable economic disturbances (Dwyer Jr, 1993). However, supporters of monetary rules such as Milton Friedman opposed this view by arguing that an activist monetary policy entails long and variable lags in its effects, causing that an intended countercyclical monetary policy will most likely end up in a *procyclical* policy, thus amplifying economic distortions instead of smoothing them.

The new game theoretic approach of modeling monetary policy based on Kydland and Prescott (1977) and Barro and Gordon (1983b) substantially altered this ongoing discussion. Though also in these models rules dominate discretion, the underlying arguments are quite different from the ones used by Friedman, as the following two sections will show.

## **4.2 Monetary Policy as a non-cooperative game**

Until the late 1970s proponents of a monetary rule mainly used natural rate AS/AD models with rational expectations for the determination of optimal monetary pol-

icy (see for example Sargent and Wallace, 1975). The choice of the optimal strategy was made over a range of *prespecified* monetary rules, where research focused upon the question which of these rules yielded the lowest long run inflation rate. Clearly such a setup triggered that discretion as a policy strategy had been excluded *ex ante*, with crucial implications on the formation of policy expectations. Since in these models agents had no reason to assume a deviation of the monetary authority once the policy strategy had been implemented, *any* chosen monetary strategy also automatically constituted a rational expectations equilibrium. In these models equality between private expectations and the policymaker's strategy had thus been imposed as a *prior constraint*.

Kydland and Prescott (1977) were the first to argue that such a framework is inappropriate to describe real world monetary policy. In reality monetary policy is not chosen once and for all (as the above framework implies), but rather on an ongoing basis. Consequently they suggested that also theoretical models should permit for sequential policy choices. However, allowing the policymaker to re-optimize in every period clearly implies that (unexpected) monetary policy *does* have real implications, which thus would justify discretionary acting as a plausible policy strategy. Using a simple model with sequentially chosen policy, Kydland and Prescott (1977) proofed that monetary commitment does dominate discretion *in principle*, since by following a predefined monetary rule a policymaker also actively influences expectations of future inflation rates. However, whenever there exist temptations for the policymaker to create surprise inflation, in the absence of an exogenous mechanism enforcing the monetary rule, such a commitment will not be time consistent and can therefore not constitute a stable rational expectations equilibrium.

Barro and Gordon (1983b) adapted and refined these ideas of Kydland and Prescott within a Phillips curve model. In their influential paper the process of executing

monetary policy is described as a non-cooperative game played between the policymaker and rational economic agents. Any equilibrium in this game has to include the following features (see Barro and Gordon, 1983b, p. 591):

- 1) a decision rule for private agents which determines their actions as a function of their current information set,
- 2) an expectations function which determines the expectations of private agents as a function of their current information set, and
- 3) a policy rule which specifies the behavior of policy instruments as a function of the policymaker's current information set.

For an equilibrium to further constitute a rational expectations Nash equilibrium, additionally both of the following two conditions have to be met:

- First, the decision rule outlined in 1) has to be optimal for agents given their expectations as formulated in 2) and
- Second, for the policymaker described in 3) it has to be optimal to perform in accordance with the agents' expectations function 2), given that he knows about the decision rule of private agents specified under 1).

Conditional on monetary policy being chosen sequentially, equality of policy expectations and actual chosen policy in this setup is then a characteristic of the equilibrium, and no longer a prior constraint.

Using this framework, Barro and Gordon showed that governmental-conducted monetary policy is likely to cause an inflation bias, such that trend inflation at the long run equilibrium will be inefficiently high. Since understanding the evolution of this inflation bias is crucial for the topic of this thesis, the remaining part of Section 4 will thus focus on its detailed explanation, where Section 4.3 will first provide a verbal intuitive explication, and Sections 4.4 to 4.6.1 a formal derivation within a simple macro model.

### **4.3 Time inconsistency and the inflation bias**

The line of argumentation which Barro and Gordon used to justify the existence of an inflation bias may be best understood within the context of a simple example: Assume an economy governed by a benevolent rational policymaker, whose aim is to maximize social welfare in every period via an adequate choice of monetary policy. As pointed out in Section 4.1, this policymaker can either act in a discretionary way, or he can commit himself to a preannounced monetary rule. However, since the policymaker will not be subject to any higher control instance, it will ultimately depend upon himself whether he sticks to any self-imposed rule or whether he decides to deviate.

Now suppose that in some period  $t$  the policymaker commits to a monetary policy rule, which aims at establishing the socially optimal inflation rate from period  $t$  onwards via an appropriate use of monetary instruments. Further assume that private agents believe this commitment and thus set current economic decisions in accordance with expecting this socially optimal (low) inflation rate in the future. Since monetary policy is chosen sequentially, in period  $t + 1$  the benevolent policymaker principally faces two options: He can either follow the preannounced policy rule and thus implement the socially optimal inflation rate, or he can deviate from his rule and implement a different inflation rate. Relying on the argumentation in

Kydland and Prescott (1977), Barro and Gordon proved that, given that private agents expect the monetary rule, it will always be optimal for the policymaker to deviate from his preannounced rule and create an inflation rate higher than expected. The reason is the following: Since in period  $t + 1$  period  $t$  prices as well as period  $t$  expectations are history, the policymaker will also treat them as exogenous when solving his period  $t + 1$  optimization problem. Given that private agents expect the socially optimal inflation rate, a policymaker will thus be confronted with the temptation to create surprise inflation (for the reasons outlined in Section 2.3.3). Since in the case of low inflation expectations the marginal social costs of creating surprise inflation are approximately zero, whereas the marginal gains are clearly positive, the policymaker will exploit this situation and will inflate beyond expectations.

However, this implies that any rational, forward looking economic agent will certainly not expect the policymaker to follow an optimal monetary rule, meaning that such a monetary policy rule can never constitute a stable rational expectations equilibrium. Policy commitment is thus a time inconsistent strategy. Furthermore, in the long run (when agents have gathered sufficient information to understand the policymaker's optimization problem) rational agents will rather expect the policymaker to create unexpected inflation up to that level at which the marginal gains of creating additional inflation are exactly outweighed by the marginal costs. Accordingly they will anticipate such a high level of core inflation already in advance. Since a benevolent policymaker, faced with such high inflation expectations, can not do any better than actually inflating up to the expected level, under sequentially chosen monetary policy the only stable rational expectations equilibrium is characterized by an upwards biased core inflation rate, or put differently, by a long run inflation rate which includes an inflation bias.



## 4.4 A simple model of the inflation bias

The approach of verifying this intuitive explanation also in a formal way will be the following: First the model economy will be sketched, which will be geared to the simple stochastic AS/AD model in Rogoff (1985). As a second step the optimal monetary rule under commitment will be derived. This derivation will be made subject to the condition that there exists an exogenous enforcement mechanism which prevents the policymaker from deviating. Next relaxing this condition will demonstrate that without such a mechanism committing to a monetary rule constitutes a time inconsistent strategy. Consequently, since the implementation of a monetary rule is infeasible, finally equilibrium under discretion will be derived, where it will be shown that the prevailing core inflation rate will be biased upwards.

Following the approach laid out in Barro and Gordon (1983b), the model setup will assume two players: A benevolent policymaker, who wants to maximize social utility by choosing the best possible monetary strategy, and a large group of workers, who -engaging in wage negotiations- seek to prevent themselves from real wage reductions caused by surprise inflation. Concerning notation, target values of the policymaker will be marked with a tilde, whereas the optimal values of the workers will wear a bar. Additionally, lower case letters will denote natural logarithms and all appearing coefficients will be assumed to be positive.

### 4.4.1 The private sector

There exists a large number of identical firms in the economy, which produce only one single good,  $y$ , using a Cobb-Douglas production function. Aggregate production in period  $t$  thus is:

$$y_t = c_0 + \alpha \hat{k} + (1 - \alpha)n_t + z_t, \quad (4.1)$$

where  $c_0$  is a constant term,  $\hat{k}$  is a fixed capital stock,  $n$  is labor and  $z$  is a stochastic productivity shock, with  $z \sim N(0, \sigma_z^2)$ .

Supply of labor  $n_t^s$  is given by a function increasing in the real wage

$$n_t^s = \bar{n} + \omega(w_t - p_t), \quad (4.2)$$

with  $w_t$  being the nominal wage rate,  $p_t$  the price level and  $\omega$  the marginal reaction of labor supply to changes in the real wage<sup>12</sup>.

Wage negotiations over the nominal wage rate  $w_t$  will be conducted on a firm-by-firm basis at the end of period  $t - 1$ , which will create a short run rigidity in nominal wages. It will furthermore be assumed that workers contractually agree to provide whatever amount of labor is being demanded by the firms, given that the negotiated nominal remuneration  $\bar{w}_t$  is being paid. Obviously this causes that actual period  $t$  employment is uniquely demand side determined.

Next, firms in this economy will hire additional workers until the marginal product of labor equals the (logarithmic) real wage, denoted as  $\bar{w}_t - p_t$ . Labor demand, and consequently actual employment in period  $t$  then is

$$n_t^d = n_t = \bar{n} + \frac{(p_t - \bar{w}_t)}{\alpha} + \frac{z_t}{\alpha}. \quad (4.3)$$

At wage negotiations, the wage setters<sup>13</sup> will choose a base wage rate,  $\bar{w}_t$ , which minimizes  $E_{t-1}(n_t - \bar{n}'_t)^2$ , where  $E_{t-1}$  is the rational expectations operator based on period  $t - 1$  information,  $n_t$  is the actual employment rate as formulated in equation (4.3) and  $\bar{n}'_t$  describes the employment level which would arise if base wage rates could be negotiated after observing all relevant period  $t$  information,

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<sup>12</sup>In order to simplify algebra  $\bar{n} = \hat{k} + \frac{1}{\alpha}[\log(1 - \alpha) + c_0]$  will be assumed (at no loss of generality).

<sup>13</sup>That is employers and workers' representatives involved into a firm's wage negotiation process.

especially the monetary policy of the policymaker and the productivity shock  $z_t$ . The expression  $\bar{n}'_t$  can be found by combining (4.2) with the marginal product of labor:

$$\bar{n}'_t = \bar{n} + \frac{\omega z_t}{1 + \alpha\omega}. \quad (4.4)$$

Next,  $n_t - \bar{n}'_t$  equals

$$n_t - \bar{n}'_t = \frac{z_t}{\eta} + \frac{(p_t - \bar{w}_t)}{\alpha}, \quad (4.5)$$

with  $\eta \equiv \alpha(1 + \omega\alpha)$ .

Using (4.5) in order to minimize  $E_{t-1}(n_t - \bar{n}'_t)^2$  with respect to  $\bar{w}_t$  finally gives the general decision rule for the base wage rate in period  $t$ :

$$\bar{w}_t^A = E_{t-1}(p_t), \quad (4.6)$$

where the superscript  $A$  indicates that equation (4.6) defines the decision rule of the wage setters under any arbitrary policy regime<sup>14</sup>.

#### 4.4.2 The policymaker

The benevolent rational policymaker will have perfect information in every period and will try to implement a monetary policy which maximizes social welfare by minimizing deviations of both employment and inflation from their respective socially optimal values.

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<sup>14</sup>The result that wage setters target a logarithmic real wage of zero is due to the specification of  $\bar{n}$ .

This goal will be formalized in a quadratic period social loss function of the following form<sup>15</sup>:

$$L_t(\pi_t, n_t, \tilde{\pi}, \tilde{n}'_t, \chi) = (n_t - \tilde{n}'_t)^2 + \chi(\pi_t - \tilde{\pi})^2 \quad (4.7)$$

with  $\pi_t = p_t - p_{t-1}$ .

Here  $\tilde{n}'_t$  is the socially optimal employment rate (that is the employment rate which the policymaker actually targets after obtaining all relevant period  $t$  information, including the realization of the shock variables),  $\tilde{\pi}$  is the socially optimal inflation rate<sup>16</sup> and  $\chi$  describes the weight which society, and consequently also the policymaker, attaches to employment stabilization versus inflation stabilization. The quadratic form of the social loss function does not only facilitate computations considerably, but also illustrates that social costs of inflation and employment fluctuations are said to be increasing in their amplitude. In order to create activist monetary policy, the period  $t$  labor market equilibrium,  $\tilde{n}'_t$ , will just be of a second best form (due to labor market distortions), meaning that the socially optimal (that is the first best) level of employment,  $\tilde{n}'_t$ , is located *above* this distorted natural rate<sup>17</sup>. Arguments justifying the assumption of a distorted labor market are for example high income taxation, excessive unemployment benefits or high legal minimum wages. The removal of all of these labor market distortions, which would consequently also eliminate the inflation bias and implement a first best equilibrium, does not constitute a feasible strategy in this model, which means that at

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<sup>15</sup>The main results would also hold if one assumes a multiperiod loss function (Rogoff, 1985).

<sup>16</sup>The determination of the optimal level of inflation in an economy is not a subject of this thesis. However, current research suggests that this rate should be both a low single digit number and well above zero (see for example Fischer, 1996).

<sup>17</sup>To simplify calculations, it is assumed that the difference between the first and the second best employment level remains constant over time and equals  $\tilde{n} - \bar{n}$ .

most a second best equilibrium can be reached<sup>18</sup>. However, since the policymaker targets the first best employment rate, he will exploit the short run rigidity in nominal wages and will create surprise inflation in order to temporary lower *real* wages. Since these real wage reductions will also decrease real labor costs, such an activist monetary policy pushes employment temporary closer to the first best level and thus improves social welfare.

Turning back to the policymaker's loss function, it will for simplicity be assumed that the government conducts monetary policy via directly choosing the current price level  $p_t$ . Accordingly, for the derivation of the equilibrium strategies under any monetary regime, one first has to express the policymaker's loss function (4.7) in terms of the decision variable of the policymaker,  $p_t$ :

$$L_t^A = \left( \frac{z_t}{\eta} + \frac{(p_t - \bar{w}_t)}{\alpha} - (\tilde{n} - \bar{n}) \right)^2 + \chi (p_t - p_{t-1} - \tilde{\pi})^2, \quad (4.8)$$

where (4.8) is obtained by plugging (4.5) into (4.7) and using the fact that  $\tilde{n}'_t - \bar{n}'_t = \tilde{n} - \bar{n}$ . The superscript  $A$  again indicates that (4.8) defines the policymaker's loss function under any arbitrary policy regime. Equation (4.8) is one of the central equations in this formal part of my thesis, since all derivations of monetary policy regimes as well as their welfare evaluations will basically departure from this expression.

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<sup>18</sup>For arguments justifying the infeasibility of the first best equilibrium see Section A.1 in the appendix.

## 4.5 Equilibrium under commitment

The first regime under consideration is commitment to an optimal monetary rule, where I assume that only simple rules are feasible<sup>19</sup>. As already mentioned, this derivation will suppose the existence of an exogenous enforcement mechanism which will prevent the policymaker from deviating. The process of choosing the optimal policy under commitment can thus be viewed as equivalent to the once-and-for-all selection of the optimal monetary rule in natural rate models such as in Sargent and Wallace (1975). Like in these models, the ex-ante exclusion of discretion causes that the independence of policy expectations and policy realizations is broken up and therefore any chosen monetary strategy constitutes a stable rational expectations equilibrium. In the context of the presented model setup this implies that due to the commitment mechanism expectations over the period  $t$  price level,  $E_{t-1}p_t$ , always have to coincide with the actual realized price level,  $p_t$  (Barro and Gordon, 1983b, p. 597). Substituting the general decision rule of the wage setters (4.6) into the policymaker's loss function (4.8), the optimization problem under commitment, indicated with a superscripted  $R$  for rule, then is:

$$\min_{p_t} L_t^R = \left( \frac{z_t}{\eta} + \frac{(p_t - E_{t-1}p_t)}{\alpha} - (\tilde{n} - \bar{n}) \right)^2 + \chi (p_t - p_{t-1} - \tilde{\pi})^2. \quad (4.9)$$

s.t.  $E_{t-1}p_t = p_t$ .

Next using the prior constraint  $E_{t-1}p_t = p_t$  in (4.9) shows that the second term in

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<sup>19</sup>This assumption follows the argumentation in Rogoff (1985) or Lohmann (1992) who point out that the formulation of a *state-contingent* rule (a rule which would also account for economic shocks) involves serious problems both in its formulation and its legislation. However, other authors, such as Lockwood et al. (1995) or Svensson (1995) also view state contingent feedback rules as feasible.

the first bracket cancels out entirely and the actual minimization problem of the policymaker reduces to

$$\min_{p_t} L_t^R = \left(\frac{z_t}{\eta} - (\tilde{n} - \bar{n})\right)^2 + \chi(p_t - p_{t-1} - \tilde{\pi})^2. \quad (4.10)$$

As equation (4.10) shows, the exogenous commitment mechanism prevents the policymaker from exploiting the short run Phillips curve trade-off and restricts him to consider only the direct welfare implications of inflation in his optimization problem.

In order to get the optimal rule under policy commitment, first differentiate (4.10) with respect to  $p_t$  which gives

$$\frac{\partial L_t^R}{\partial p_t} = 2\chi(p_t - p_{t-1} - \tilde{\pi}). \quad (4.11)$$

Setting this first order condition equal to zero and solving for  $p_t$  yields the optimal monetary rule under commitment<sup>20</sup> :

$$p_t^R = p_{t-1} + \tilde{\pi}. \quad (4.12)$$

The intuition behind equation (4.12) is straight forward: Since the policymaker disposes over perfect control of the price level, in order to implement the socially optimal inflation rate he will simply increase this price level in every period at a rate equal to  $\tilde{\pi}$ . Since policy deviation is an infeasible strategy, wage setters will

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<sup>20</sup>The second order condition for a minimum is fulfilled, that is  $\frac{\partial^2 L_t^R}{\partial^2 p_t} > 0$ .

believe the commitment of the policymaker and will accordingly set their nominal base wage claims equal to

$$\bar{w}_t^R = E_{t-1}(p_t^R) = p_{t-1} + \tilde{\pi}. \quad (4.13)$$

Note that the three necessary equilibrium conditions as imposed in Section 4.2 are already fulfilled: We have a policyrule for the policymaker, (4.12), and a decision rule for wage setters, (4.13), which -due to the model specifications- coincides with the private expectations function. Furthermore since the enforcement mechanism precludes deviations of the policymaker, this set of strategies also has to constitute a stable rational expectations equilibrium.

As a result, condition on the existence of a credible commitment mechanism, the optimal monetary rule manages to implement a second best equilibrium, at which labor markets are still distorted but inflation rates always equal their socially optimal level.

#### 4.5.1 Evaluating the social costs under commitment

Since the different monetary policy regimes, which will be considered later in this thesis, can hardly be compared in a direct way, I will thus use the expected social losses at each of these regimes as a common reference value for their performance<sup>21</sup>. These expected social losses will be calculated by plugging the respective equilibrium strategies of the players as well as the equilibrium inflation rate into the generalized social loss function (4.8) and taking  $t - 1$  expectations over this function.

Applying this method to calculate the expected social losses under commitment, I

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<sup>21</sup>I will use the expected rather than the actual social losses for comparisons, since the actual period  $t$  losses also depend upon the stochastic supply shock term  $z_t$ .



thus plug the policy rule (4.12), the decision rule (4.13) and the realized long run inflation rate (which equals the socially optimal inflation rate  $\tilde{\pi}$ ) into the general social loss function (4.8), which gives an expression for the actual period  $t$  social losses:

$$L_t^R = \left( \frac{z_t}{\eta} + \frac{(p_{t-1} + \tilde{\pi} - p_{t-1} - \tilde{\pi})}{\alpha} - (\tilde{n} - \bar{n}) \right)^2 + \chi (\tilde{\pi} - \tilde{\pi})^2. \quad (4.14)$$

Taking  $t - 1$  expectations over (4.14) and additionally simplifying the expression gives the expected social losses under commitment<sup>22</sup>:

$$E_{t-1}(L_t^R) = (\tilde{n} - \bar{n})^2 + \frac{\sigma_z^2}{\eta^2}. \quad (4.15)$$

Equation (4.15) shows that these expected social losses basically depend on two factors: First, on the degree of labor market inefficiencies (the difference between the distorted labor market equilibrium  $\bar{n}$  and the first best equilibrium  $\tilde{n}$ ), and second on the variance of the supply shock term,  $\sigma_z^2$ . Since losses due to labor market inefficiencies are regime-independent, the actual, regime-dependent losses of commitment boil down to the obvious inability of the policymaker to counteract economic disturbances. For the sake of stable inflation the monetary authority will accept socially costly fluctuations in employment, as the second term in (4.15) illustrates.

## 4.5.2 The issue of time inconsistency

However, if one precludes the existence of an exogenous enforcement mechanism, commitment to an optimal monetary rule does no longer constitute a stable ra-

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<sup>22</sup>Note that  $E_{t-1}(z_t^2) = \sigma_z^2$ .

tional expectations equilibrium. The following calculations shall now demonstrate this issue also formally.

According to its definition, in a Nash equilibrium the strategies chosen by every player have to constitute a best response, given the strategies of the respective other players. In order to check whether the commitment strategies (4.12) and (4.13) still form a stable Nash equilibrium, one therefore has to verify whether these strategies are still mutual best responses. In the case of the wage setters the answer is straight forward: Since their general decision rule (4.6) always incorporates the policy rule of the policymaker, (4.13) still has to constitute a best response to the policy rule (4.12). Next, in order to test whether also the policy rule of the policymaker still constitutes a best response to the decision rule of the wage setters, rewrite the optimization problem of the policymaker and substitute the wage setters' decision rule (4.13) into the loss function of the policymaker (4.8),

$$\min_{p_t} L_t^{Dev} = \left( \frac{z_t}{\eta} + \frac{p_t - (p_{t-1} + \tilde{\pi})}{\alpha} - (\tilde{n} - \bar{n}) \right)^2 + \chi (p_t - p_{t-1} - \tilde{\pi})^2. \quad (4.16)$$

The policymaker, who is now no longer constrained to implement an inflation rate equal to expected inflation, will solve the above minimization problem and will select a price level equal to

$$p_t^{Dev} = p_{t-1} + \tilde{\pi} + \frac{\alpha}{1 + \alpha^2 \chi} \left( (\tilde{n} - \bar{n}) - \frac{z_t}{\eta} \right). \quad (4.17)$$

Obviously (4.17) differs from the preannounced optimal rule (4.12). Having a closer look at (4.17) shows that the reasons for this deviation are twofold: First, given that wage setters have expected a low inflation rate, the benevolent policymaker will be tempted to exploit these expectations and stimulate the economy via surprise inflation; second, since the policymaker is no longer bounded to create the socially optimal inflation rate at all costs, he will choose to partly accommo-

date supply shocks in order to reduce large employment fluctuations at the costs of some fluctuations in inflation.

Thus, the commitment policy rule (4.12) no longer constitutes a best response to the commitment wage setters rule (4.13) and consequently, in the absence of an exogenous enforcement mechanism, these commitment strategies cannot form a stable rational expectations equilibrium.

#### 4.6 Equilibrium under discretion

Since policy commitment is a time inconsistent strategy, this section will now turn to the second way of executing monetary policy, i.e. discretion. In order to derive the equilibrium strategies under discretion I will first determine the optimal monetary strategy of the discretionary policymaker for *any* given strategy of the wage setters, that is for any value of  $\bar{w}_t$ . Since discretionary policy per definition corresponds with sequential optimization, the policymaker will -after observing the productivity shock  $z_t$ - determine his optimal monetary strategy in every period by differentiating (4.8) with respect to  $p_t$ , which gives

$$\frac{\partial L^D}{\partial p_t} = \frac{2}{\alpha} \left( \frac{z_t}{\eta} + \frac{(p_t - \bar{w}_t)}{\alpha} - (\tilde{n} - \bar{n}) \right) \frac{2}{\alpha} \chi(p_t - p_{t-1} - \tilde{\pi}). \quad (4.18)$$

Setting (4.18) equal to zero and rearranging yields a best response function of the policymaker for any arbitrary realization of  $\bar{w}_t$ <sup>23</sup>:

$$p_t^D = \frac{1}{1 + \alpha^2 \chi} \left( \alpha^2 \chi(p_{t-1} + \tilde{\pi}) + \bar{w}_t + \alpha(\tilde{n} - \bar{n} - \frac{z_t}{\eta}) \right). \quad (4.19)$$

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<sup>23</sup>Again the necessary second order conditions for a minimum are fulfilled.

Wage setters in turn will understand the policymaker's optimization problem in the long run and will consequently choose a nominal base wage rate at a sufficiently high level, such that in the absence of economic shocks the policymaker has no incentive to further inflate beyond expectations<sup>24</sup>. In order to get this decision rule of the wage setters first take  $t - 1$  expectations across (4.19):

$$E_{t-1}(p_t^D) = \frac{1}{1 + \alpha^2\chi} (\alpha^2\chi(p_{t-1} + \tilde{\pi}) + \bar{w}_t + \alpha(\tilde{n} - \bar{n})). \quad (4.20)$$

In a second step substitute the general decision rule (4.6) for  $\bar{w}_t$  in (4.20) and solve the expression for  $\bar{w}_t$ . The decision rule of the wage setters under discretion is:

$$\bar{w}_t^D = E_{t-1}(p_t^D) = p_{t-1} + \tilde{\pi} + \frac{(\tilde{n} - \bar{n})}{\chi\alpha}. \quad (4.21)$$

Finally plugging (4.21) back into (4.19) gives the equilibrium policy rule of the discretionary policymaker:

$$p_t^D = p_{t-1} + \tilde{\pi} + \frac{(\tilde{n} - \bar{n})}{\chi\alpha} - \frac{\alpha}{1 + \alpha^2\chi} \frac{z_t}{\eta}. \quad (4.22)$$

As in the commitment case also here equation (4.22) and (4.21) already constitute the three equations necessary for the existence of an equilibrium. In order to check whether (4.22) and (4.21) also constitute a rational expectations Nash equilibrium, once again both strategies have to constitute best responses to each other. Since the policymaker incorporates the decision rule of private agents into his optimization problem ( $\bar{w}_t$  forms part of equation (4.8)), the resulting policy rule (4.22) has to be a best response to (4.21). Also the decision rule of private agents is a best

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<sup>24</sup>Note that though also individual wage setters dislike inflation, they do not have any incentive to change their equilibrium behavior, since their individual labor contract has only a marginal impact on the aggregate inflation rate.

response, since by employing their general decision rule (4.6), they also incorporate the policy rule of the policymaker into their decision process. Accordingly equations (4.22) and (4.21) together also form a stable rational expectations Nash equilibrium.

Finally in order to show that long run inflation under discretion is biased upwards, subtract  $p_{t-1}$  from equation (4.21), which gives the expected inflation rate under discretion (which in equilibrium equals trend inflation, see equation (3.5) in Section 3.2.1):

$$\bar{\pi}^D = \tilde{\pi} + \frac{(\tilde{n} - \bar{n})}{\chi\alpha}. \quad (4.23)$$

As equation (4.23) shows, at the discretionary equilibrium trend inflation will be systematically too high. A more detailed inspection of (4.23) displays that long run inflation under discretion equals the socially optimal inflation rate,  $\tilde{\pi}$ , plus an inflation bias  $\frac{(\tilde{n} - \bar{n})}{\chi\alpha}$ . This bias is caused by the short run attempts of the policymaker to improve social welfare via activist monetary policy and is increasing in the degree of labor market inefficiencies, measured by  $(\tilde{n} - \bar{n})$ . tion of (4.23) displays that long run inflation under discretion equals the socially optimal inflation rate,  $\tilde{\pi}$ , plus an inflation bias  $\frac{(\tilde{n} - \bar{n})}{\chi\alpha}$ . This bias is caused by the short run attempts of the policymaker to improve social welfare via activist monetary policy and is increasing in the degree of labor market inefficiencies, measured by  $(\tilde{n} - \bar{n})$ .

#### 4.6.1 Evaluation of the social costs under discretion

Following the structure of Section 4.5, also here I will conclude the derivation of the discretionary outcome with the evaluation of the expected social costs under discretion. However, contrast to Section 4.5.1 here I will not directly calculate the expected social costs, but I will rather follow the approach in Rogoff (1985) and first develop a general notation for expected social losses under any arbitrary

monetary policy regime. This generalized notation decomposes the expected social losses according to their respective origins, which will turn out to be helpful later on, when possible improvements upon the discretionary outcome will be considered. Defining  $\Lambda_t^A$  as  $E_{t-1}(L_t^A)$  this “general” expected social loss function is of the following form,

$$\Lambda_t^A = (\tilde{n} - \bar{n})^2 + \chi\Pi^A + \Gamma^A, \quad (4.24)$$

with  $\Pi^A \equiv (\bar{\pi}^A - \tilde{\pi})^2$  and  $\Gamma^A \equiv E_{t-1} \left\{ \left[ \frac{z_t}{\eta} + \frac{(p_t^A - E_{t-1}(p_t^A))}{\alpha} \right]^2 + \chi [p_t^A - E_{t-1}(p_t^A)]^2 \right\}$ . Here  $p_t^A$  defines the policymaker’s decision rule under an arbitrary monetary regime and  $\bar{\pi}^A$  marks the long run inflation rate occurring under that regime<sup>25</sup>.

A more detailed look at  $\Lambda_t^A$  discloses the different roots of social costs: The first term for example shows the dead weight loss caused by labor market imperfections. This term is both non stochastic and invariant across any chosen policy regime. The second term measures the difference between the long run inflation rate and the socially optimal target rate. It is thus also non-stochastic, but does depend on the chosen regime. The last term finally defines the stabilization part. It measures up to which degree the policymaker manages to offset short run inflation caused by economic disturbances. Importantly note that stabilization here refers to minimizing fluctuation of employment and inflation around their long run *market determined* values, and not around their socially optimal values.

Since the long run trend inflation under discretion has already been determined (see equation (4.23)),  $\Pi^D$  can already be calculated and there remains only  $\Gamma^D$  left for determination. In order to calculate the stabilization costs of standard discretionary policy, one first has to derive the price level forecast error which the discretionary policymaker permits to occur in order to stabilize employment. This

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<sup>25</sup>The exact formal derivation of (4.24) can be looked up in Section A.2 in the appendix.

prediction error equals the actual minus the expected period  $t$  price level and can hence be calculated using equations (4.21) and (4.22):

$$p_t^D - E_{t-1}(p_t^D) = -\frac{z_t}{\eta} \left( \frac{\alpha}{1 + \alpha^2 \chi} \right). \quad (4.25)$$

Since in the case of cost push inflation employment and inflation move into opposite directions, a stabilization conflict arises and the policymaker therefore permits for some fluctuations in inflation for the sake of employment stabilization<sup>26</sup>.

By using (4.25) in  $\Gamma^A$  as well as (4.23) in  $\Pi^A$  finally the overall expected social losses under discretion are obtained

$$\Lambda_t^D = E_{t-1} L_t^D = (\tilde{n} - \bar{n})^2 + \underbrace{\frac{(\tilde{n} - \bar{n})^2}{\alpha^2 \chi}}_{\Pi^D} + \underbrace{\frac{\sigma_z^2}{\eta^2} \frac{\alpha^2 \chi}{(1 + \alpha^2 \chi)}}_{\Gamma^D}. \quad (4.26)$$

Comparing these expected social losses under discretion (equation (4.26)) with the expected social losses under commitment (equation (4.15)) shows that in a predominant number of cases discretion will cause a larger decrease of social welfare than a regime with policy commitment<sup>27</sup>. Thus, though there exists a stable equilibrium under discretion, the resulting outcome is certainly not socially optimal, such that the logical next step clearly is to consider ways out of this “bad equilibrium” under discretion and search for methods to bring social welfare closer to its second best value under commitment.

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<sup>26</sup>The reason why demand shocks do not play any role throughout this thesis is simple. Since in the case of an aggregate demand shock output and employment stabilization is consistent with inflation stabilization, the perfectly informed policymaker will thus offset any demand shock with a corresponding monetary policy and consequently demand pull inflation can be eliminated entirely.

<sup>27</sup>Section A.3 in the appendix derives the exact parameter conditions necessary for the dominance of policy commitment over discretion.

## 5 Monetary conservatism as a solution to improve upon discretion

The publication of the Barro-Gordon model in 1983 clearly helped to better understand the inefficient behavior of monetary authorities, since it provided a theoretical explanation why governments and central banks fail to implement low, stable inflation rates. However, the contribution of this model mainly was to formalize an existing problem. Apart from suggesting trigger strategies in order to improve upon discretion (which though do only work out in an infinite horizon model) the publications of Barro and Gordon on this topic did not suggest any concept to overcome or at least reduce the inflation bias (see Barro and Gordon, 1983a,b). Therefore shortly after the publication of the Barro-Gordon model several researchers started to focus upon theoretical methods to reduce the inflation bias. Since policy commitment constitutes an infeasible strategy, these attempts concentrated on methods to bring down long run inflation *without* impeding discretionary acting of the policymaker as such.

Since it is the activist monetary policy of the policymaker which at the end of the day causes excessive high average inflation rates, all of the theoretical proposals first suggested to delegate monetary policy away from the government to an independent central banker. However, such a delegation would remain without any effect if this central banker would still share the policymaker's preferences. Therefore in all of the proposed solutions this independent central banker has been attached with the task of minimizing a slightly different social loss function, where these modifications all aimed at making the central bank more inflation averse than the government, i.e. monetary conservative.

In this section I will present the three most prominent theoretical proposals in this area. The first suggestion has been made by Rogoff (1985), who has shown that



the implementation of a weight conservative central banker, who puts a higher weight on inflation stabilization than society does, can considerably reduce the inflation bias. As already announced in the introduction, this theoretical concept probably had the highest practical significance for the observed wave of central bank reforms, which is why also this thesis will mainly focus upon that theoretical proposal. However, there still exist two other prominent theoretical suggestions to combat the inflation bias, which are a target conservative central banker proposed in Svensson (1995) and an independent central banker attached with a linear inflation contract, suggested in Walsh (1995)<sup>28</sup>. These two concept manage to eliminate not just a part, but the entire inflation bias and are thus able to implement a second best equilibrium. However, despite of their theoretical attractiveness they both feature considerable drawbacks related to their practical implementability.

## 5.1 Weight conservatism: A conservative central banker

As already pointed out, the political changes which Rogoff proposed are twofold: First, monetary policy should be executed by an independent central banker and not by the policymaker himself, and second, this independent central banker should put more, but not infinitely more weight on inflation stabilization than average society does.

The following formal derivation will illustrate why such a setup is able to reduce the inflation bias and improve social welfare.

Suppose that in period  $t - 1$  an agent is selected to head the central bank, who has the reputation of being more inflation averse than society. Further assume that

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<sup>28</sup>Strictly speaking the linear inflation contract does not fall into the category of monetary conservatism, since in this concept the loss function as such does not change. Nevertheless, for the sake of clarity it will also be presented within this section.

this central banker will choose his optimal monetary policy strategy by minimizing a slightly different social loss function of the form

$$L_t^B = (n_t - \tilde{n}_t')^2 + (\chi + \epsilon)(\pi_t - \tilde{\pi})^2, \quad (5.1)$$

with  $\epsilon > 0$ .

Since the substitution of  $\chi$  by  $(\chi + \epsilon)$  constitutes the only change compared to the discretionary case, also the algorithm for calculating the policy rule and the decision rule is equivalent to Section 4.6. Therefore for the sake of brevity only the results will be provided here:

$$p_t^D = p_{t-1} + \tilde{\pi} + \frac{(\tilde{n} - \bar{n})}{(\chi + \epsilon)\alpha} - \frac{\alpha}{1 + \alpha^2(\chi + \epsilon)} \frac{z_t}{\eta}, \quad (5.2)$$

$$\bar{w}_t^B = E_{t-1}(p_t^D) = p_{t-1} + \tilde{\pi} + \frac{\tilde{n} - \bar{n}}{\alpha(\chi + \epsilon)}. \quad (5.3)$$

Note that equations (5.2) and (5.3) also form a rational expectations equilibrium according to the Barro-Gordon definition<sup>29</sup>, where the long run inflation established at this equilibrium equals

$$\bar{\pi}^B = \frac{(\tilde{n} - \bar{n})}{\alpha(\chi + \epsilon)} + \tilde{\pi}. \quad (5.4)$$

A comparison of equations (4.23) and (5.4) shows that for an  $\epsilon > 0$  trend inflation can really be reduced compared to the discretionary case.

However, showing that weight conservatism reduces the average inflation bias alone does not yet verify that the introduction of a conservative central banker also improves social welfare. The reason therefore is the stabilization performance of the

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<sup>29</sup>The proof is equivalent to the discretionary case and will therefore be omitted here.

conservative central banker: Under discretion the policymaker offsets economic shocks in accordance with social preferences, that is in the best possible way. However, comparing (4.22) with (5.2) shows that under a conservative central banker monetary responses to supply shocks are less pronounced than under discretion, which implies that socially costly employment fluctuations will increase. In order to see this impact of weight conservatism on social welfare, calculate the expected social loss function under an independent central banker, following again the same procedure as derived in Section 4.6,

$$\Lambda_t^B = (\tilde{n} - \bar{n})^2 + \underbrace{\left( \frac{(\tilde{n} - \bar{n})}{\alpha(\chi + \epsilon)} \right)^2}_{\Pi^B} + \frac{\sigma_z^2 (\chi + \epsilon)^2 + \frac{\chi}{\alpha^2}}{\underbrace{\eta^2 \left( \frac{1}{\alpha^2} + \chi + \epsilon \right)^2}_{\Gamma^B}}. \quad (5.5)$$

Comparing (5.5) with the expected social loss function under discretion, (4.26), shows that in the case of a conservative central banker, that is for  $\epsilon > 0$ , the loss term capturing trend inflation,  $\Pi^B$ , has decreased, whereas the stabilization term  $\Gamma^B$  has increased. If a conservative central banker can really improve overall social welfare, there thus has to exist an  $\epsilon^*$ , with  $0 < \epsilon^* < \infty$ , which minimizes  $\Lambda_t^B$  and thus also reduces social losses compared to the discretionary case<sup>30</sup>. In order to verify this condition, I will follow the proof in Rogoff (1985)<sup>31</sup> and will first differentiate  $\Lambda^B$  with respect to  $\epsilon$ :

$$\frac{\partial \Lambda_t^B}{\partial \epsilon} = \chi \frac{\partial \Pi^B}{\partial \epsilon} + \frac{\partial \Gamma^B}{\partial \epsilon}, \quad (5.6a)$$

$$\frac{\partial \Pi^B}{\partial \epsilon} = -2 \frac{[(\tilde{n} - \bar{n})/\alpha]^2}{(\chi + \epsilon)^3}, \quad (5.6b)$$

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<sup>30</sup>Since the derivation of a closed form solution turns out to be highly complicated, in the following just the *existence* of such an  $\epsilon^*$  will be proven.

<sup>31</sup>Rogoff, 1985, p. 1178.

$$\frac{\partial \Gamma^B}{\partial \epsilon} = 2 \frac{\sigma_z^2}{\eta^2} \frac{\epsilon/\alpha^2}{((1/\alpha)^2 + \chi + \epsilon)^3}. \quad (5.6c)$$

Next note that, since  $\epsilon > 0$  holds by assumption, (5.6b) shows that  $\frac{\partial \Pi^B}{\partial \epsilon}$  is strictly negative for every possible value of  $\epsilon$ . Furthermore, an inspection of (5.6c) shows that  $\frac{\partial \Gamma^B}{\partial \epsilon}$  is zero for  $\epsilon = 0$  and positive for  $\epsilon > 0$ . Hence, as a first result  $\frac{\partial \Lambda_t^B}{\partial \epsilon}$  has to be negative at  $\epsilon = 0$ . However, for a sufficiently large value of  $\epsilon$   $\frac{\partial \Lambda_t^B}{\partial \epsilon}$  must change to positive, since as  $\epsilon$  approaches positive infinity,  $\frac{\partial \Gamma_t^B}{\partial \epsilon}$  will converge to zero at a rate  $\epsilon^{-2}$ , whereas  $\frac{\partial \Pi_t^B}{\partial \epsilon}$  will converge to zero at rate  $\epsilon^{-3}$ . So there has to exist some positive finite value of  $\epsilon^*$ , at which  $\frac{\partial \Lambda_t^B}{\partial \epsilon^*} = 0$  holds and hence overall social losses are minimized<sup>32</sup>.

The intuitive conclusion of this proof is the following: Raising  $\epsilon$  from 0 causes that the central banker attaches more weight to inflation stabilization than society does, which thus drives down the inflation bias (see equation (5.4)). However reducing this bias comes at the costs of less flexibility in reacting to unanticipated economic shocks, which then triggers an increase in  $\Gamma^B$ . In the neighborhood of  $\epsilon = 0$  the gains from inflation stabilization more than outweigh the costs due to higher employment fluctuations. Equivalently as  $\epsilon$  becomes very large, the marginal costs from reducing  $\epsilon$  a bit and accepting a slightly higher trend inflation rate are more than outweighed by the resulting stabilization gains. Finally, at some value  $\epsilon^*$ ,  $\frac{\partial \Lambda_t^B}{\partial \epsilon^*} = 0$  holds and the difference between social gains due to reduced trend inflation and social losses caused by an increased stabilization bias reaches its maximum.

As a result, the introduction of a conservative central banker does constitute both a stable rational expectations equilibrium *and* an improvement compared to the

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<sup>32</sup>Clearly this proof just shows that there is an extreme value at  $\epsilon^*$ . However, Rogoff points out that via some additional calculations it can be proven that at  $\epsilon^*$  also the second order condition for a minimum is fulfilled.

discretionary case. Though weight conservatism can not eliminate the entire inflation bias, its implementation still means a reduction in average inflation and an overall improvement in social welfare<sup>33</sup>.

## 5.2 Theoretical proposals to eliminate the entire inflation bias

Having reviewed the concept of weight conservatism in greater detail, the next two subsections will provide a brief summary of the two other prominent suggestions of reducing the inflation bias under discretion. As already mentioned, though both of these concepts manage to eliminate the entire inflation bias in theory, they do face some notable drawbacks referring to their practical implementability.

### 5.2.1 Target conservatism: A conservative inflation target

The basic idea presented in Svensson (1995) is of striking simplicity. First, as in Rogoff (1985) also Svensson proposes that monetary policy should be delegated to an independent central banker, who is attached with a modified social loss function. However, in contrast to Rogoff, Svensson does not change the relative weight in this loss function, but rather alters the inflation target itself in order to eliminate the inflation bias.

The proposed solution then works as follows: Since an inflation target equal to the socially optimal rate yields a long run inflation equal to this rate plus an

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<sup>33</sup>Since the reduction of the inflation bias under the conservative central banker comes at the cost of higher employment volatility, some authors have argued that this concept might not be optimal in the case of very large supply shocks. A suggestion to overcome this problem has been made in Lohmann (1992), who proposes that the conservative central banker should only be *partly* independent, such that in the presence of large shocks he can be overridden by a discretionary government. In her setup this central banker will then choose a linear combination of the conservative and the discretionary inflation rate whenever shocks exceed a certain threshold, causing that the undesirable negative welfare implications of sharp changes in the employment rate can be reduced.

inflation bias, a more conservative target, which equals the socially optimal rate *minus* this inflation bias should exactly produce the socially optimal inflation rate. Implementing this inflation targeting concept of Svensson within the above model setup means that the new conservative inflation target has to equal  $\pi^T = \tilde{\pi} - \frac{(\tilde{n} - \bar{n})}{\chi\alpha}$ . Next note that since the model setup as such has not changed, the policymaker is still following a discretionary policy. Consequently the formal derivation of the decision- and the policy rule, as well as the proof for the existence of a rational expectations equilibrium are equivalent to section 4.6. Therefore one can directly see the effect of a conservative inflation target by substituting  $\pi^T$  for  $\tilde{\pi}$  in the expression for the long run inflation rate under discretion, equation (4.23):

$$\bar{\pi}^{Target} = \tilde{\pi}. \quad (5.7)$$

Equation (5.7) shows that with a conservative inflation target equal to  $\pi^T$  the entire inflationary bias can be offset. Additionally, since the only change compared to discretion is a lower target inflation rate, stabilization behavior is not affected and thus the discretionary policymaker still offsets economic shocks in a socially optimal way.

So at first sight the proposed conservative inflation target seems to be an elegant way to overcome the inflation bias and implement a second best equilibrium. However, despite of this theoretical attractiveness Svensson's approach unfortunately does feature some problematic issues concerning its practical implementation. First note that, since the actual target of the central bank is not the socially optimal inflation rate but rather the more conservative inflation target  $\pi^T$ , the central bank *still* systematically misses its target. Svensson points out that this issue should not be much of a problem, since also under discretion average inflation systematically exceeds the socially optimal level. However, inflation targeting

and discretionary monetary policy differ in one crucial point: If one understands inflation targeting in its general perception, such a concept implies that the central bank publicly announces to commit to a certain inflation target, whereas discretion lacks of such a clear-cut commitment. Thus under an inflation targeting regime public expectations of the central bank hitting its target are much more pronounced than under discretion. If the central bank systematically misses this target, it will suffer from a constant loss in credibility in the eyes of the general public, which might lead to a point where people start to question the effectiveness of the targeting regime. The conclusion of Svensson (1995) also acknowledges this issue, but counters that the general fail to reach the announced target then has to be explained to the public as a necessary condition in order to offset the inflation bias. However, whether this issue could really be communicated to the general public in a convincing way, has to be put into question.

### 5.2.2 A linear inflation contract

The second prominent suggestion to overcome excessive average inflation has been put up in Walsh (1995). Also this theoretical concept manages to completely eliminate the inflation bias, but like inflation targeting also this approach does involve some practical drawbacks.

Again the first step is to delegate monetary policy to an independent central banker. Next, in order to prevent this central banker from creating an inflation bias, Walsh adds an additional linear cost term (a linear inflation contract) to the loss function in order to stronger penalize any *positive* deviation of inflation from its socially optimal rate. The modified loss function of the central banker consequently is

$$L(\pi_t, n_t, \tilde{\pi}, \tilde{n}'_t, \chi) = (n_t - \tilde{n}'_t)^2 + \chi(\pi_t - \tilde{\pi})^2 + \rho(\pi_t - \tilde{\pi}). \quad (5.8)$$

In Walsh (1995) it is demonstrated that via an appropriate choice of  $\rho$  the inflation bias arising under discretion can be eliminated entirely.

To show this concept again within the model setup employed so far,  $\rho$  has to be chosen according to  $\rho = \frac{\tilde{n} - \bar{n}}{\alpha}$ , which results in a social loss function (in terms of  $p_t$ ) of the form

$$L_t = \left( \frac{z_t}{\eta} + \frac{(p_t - \bar{w}_t)}{\alpha} - (\tilde{n} - \bar{n}) \right)^2 + \chi (p_t - p_{t-1} - \tilde{\pi})^2 + \frac{\tilde{n} - \bar{n}}{\alpha} (p_t - p_{t-1} - \tilde{\pi}). \quad (5.9)$$

Calculating the policy rule and the decision rule of the trade union again according to the theoretical scheme outlined in section 4.6, it can be shown that the entire inflation bias disappears in equilibrium and average inflation equals its socially optimal level<sup>34</sup>. Thus, also the first impression of a linear inflation contract is that it constitutes an even better concept than the conservative central banker. However, a more detailed look reveals also here some practical and political problems concerning the implementation (Svensson, 1995, p.14).

The practical problem is that the costs implied by the inflation contract are most likely of a monetary nature, whereas the rest of the loss function describes costs in utility terms. Thus monetary revenues of the central banker have to be translated into utility terms before optimization can be carried out. The involved political problems might even be of a more serious nature. Note that the formulation of the linear inflation contract implies a negative remuneration, i.e. costs, to the central banker whenever inflation lies above the socially optimal rate, but positive monetary gains whenever actual inflation lies *below* this rate. Such a formulation hence has the perverse effect that in the case of a negative demand shock, at which both inflation and economic activity are low, the wage of the central banker

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<sup>34</sup>The proof for the existence of a rational expectations equilibrium is again equivalent to the discretionary case above.



would *increase*, an issue which would be hard to justify toward the general public. Therefore also the practical relevance of this theoretical concept is questionable.

### **5.3 Theoretical limitations of the presented approaches**

The above discussion has shown that there exist various theoretical approaches to reduce or even eliminate the inflation bias, where the weight conservative central banker by Rogoff is probably the most influential suggestion among the three introduced concepts<sup>35</sup>. However, though all of the presented proposals have certainly contributed to the observed changes in central bank institutions, their theoretical and practical significance is still limited. These limitations take various forms: One remarkable drawback constitutes the high degree of simplification inherent in these models. For example fiscal policy or public debt do not play any role in the optimization process of the policymaker, though Section 2.3.3 has clearly shown that also fiscal considerations can constitute a remarkable temptation for a monetary authority to create surprise inflation. Furthermore, also the assumptions concerning monetary instruments are a large abstraction of reality. In the frameworks considered above the monetary authority disposes over perfect control of the current price level, where changes in this price level in turn have an immediate and well defined impact on the model economy. In reality, however, central banks are far from perfectly controlling the price level and also the impacts of monetary policy are neither direct nor immediate. Finally, since all of the above concepts have been elaborated within a standard Keynesian framework, they additionally face the general disadvantages of all Keynesian models, most importantly the general lack of micro-foundation.

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<sup>35</sup>Section A.4 in the appendix once again summarizes in a graphical way the time-inconsistency problem of the policymaker and the reduction of trend inflation via the introduction of a conservative central banker.

Because of these drawbacks, in the last section of my thesis I will sketch possible implications of monetary conservatism within modern micro-founded models, which manage to overcome most of the previously mentioned disadvantages. More precisely, I will introduce two recently published papers, which investigate the implications of a Rogoff weight conservative central banker in a model framework with endogenous fiscal policy and public debt.

## **6 The conservative central banker in modern, micro based model setups**

Due to the previously mentioned drawbacks of traditional Keynesian setups, contemporary research increasingly considers time inconsistency problems in public policies within modern general equilibrium frameworks. Ireland (1997) for example basically replicates the results of the Barro-Gordon model within a dynamic general equilibrium model with utility maximizing households, sticky prices and monopolistic competition. However, though this approach accounts for the lack of micro foundation, it still faces the drawback of completely abstracting from fiscal policy. Another branch of literature has focused on time consistent *fiscal* policy in dynamic general equilibrium models (Chari and Kehoe, 1990 or Klein et. al., 2008). However, since these papers consider only time inconsistency problems of fiscal policy, money in general does not play any role. Additionally, these models also abstract from public debt. Then there exists yet another strand of literature, which investigates optimal monetary *and* fiscal policy, but which considers commitment as feasible such that time inconsistency is excluded ex ante (e.g. Schmitt-Grohé and Uribe, 2007 or Ferrero, 2005).

Only recently several papers have focused on the quite obvious problem of finding optimal time consistent fiscal *and* monetary policy strategies in setups where

policy commitment is precluded, though such an arrangement seems to be a quite realistic reflection from real world institutional setups. Díaz-Giménez et al. (2008) and Martin (2009), for example, consider models, in which there is a dynamic interaction between debt accumulation and inflation and where time inconsistency evolves because of the policymaker's temptation to use surprise inflation in order to reduce the real stock of public debt. However, nowhere in the above presented literature the impacts of implementing some form of monetary conservatism have been considered<sup>36</sup>.

In this context Adam and Billi (2008) and Niemann (2009) constitute a remarkable exception. Both of these papers consider the most prominent version of monetary conservatism -that is the weight conservative central banker- within a modern macroeconomic setup, where Adam and Billi (2008) focus on the interaction between weight conservatism and endogenous fiscal policy, whereas Niemann (2009) investigates the effects of weight conservatism on endogenous public debt. The key research question in both these papers is the same: Does a conservative central banker still remain desirable within a micro-founded model framework, augmented with endogenous fiscal policy and public debt?

In order to answer this question, in the following two subsections I will briefly summarize the model setups as well as the main results of both papers, where I will put the main focus on the work by Niemann, since his model challenges the the general result of a welfare-improving conservative central banker.

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<sup>36</sup>One though may point out the paper by Lippi (2003), where a conservative central banker in a micro-founded environment with non-atomistic wage setters is considered. However, Lippi (2003) focuses entirely on the *real* implications of monetary conservatism and abstracts from any costs of inflation.

## 6.1 Weight conservatism and fiscal policy

### 6.1.1 The model setup

The employed model structure in Adam and Billi (2008) is a stochastic New-Keynesian framework with monopolistic competition and sticky prices. The model economy is populated by a continuum of infinitely lived households which gain utility from three sources: consumption of an aggregate consumption good, consumption of a public good provided by the government, and leisure. Two distortive factors enter the economy: First, aggregate production of the consumption good is stochastic due to technology shocks, and second, also the degree of monopolistic competition is subject to random shocks.

Households earn income in the form of profits and wages and can use this income either for consumption or for the purchase of one period government bonds, which pay a gross nominal interest rate  $R_t$  in the next period. If firms want to change the prices of their products, they face menu-costs in the form of a Rotemberg-type quadratic resource cost term (see Rotemberg, 1982). Prices in the economy are thus sticky and monetary policy has short run real effects.

The government consists of two authorities: A fiscal policymaker and a monetary policymaker. The fiscal policymaker's aim is to choose an optimal level of public goods provision and finance this supply either via lump sum taxes or via the issuance of government bonds. Due to the availability of lump sum taxes the government budget is balanced in every period, such that debt does not play any role in the model. The monetary policymaker in turn sets in every period the optimal level of the nominal interest rate paid on government bonds<sup>37</sup>. The goal of both

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<sup>37</sup>Since the model abstracts from cash holdings, an Euler equation will ensure a direct mechanical connection between the interest rate and inflation at the equilibrium.

policymakers is to maximize social welfare, which in this case means to choose that level of  $g_t$  and  $R_t$  which maximizes household utility.

### 6.1.2 Equilibrium under sequential policies

Assuming lack of intertemporal commitment, equilibrium strategies have to be sequentially optimal in order to constitute a stable Nash equilibrium. In their analysis Adam and Billi restrict the set of feasible policy functions to Markov-perfect strategies<sup>38</sup>. At the sequential policies equilibrium (SP equilibrium) the strategies of both policymakers will dictate an activist policy, which at the end of the day will result in having no real effects. More precisely, the reaction functions will indicate the selection of a level of government spending which is too high, and a nominal interest rate which is too low compared to an optimal Ramsey outcome under commitment. Since in this model the optimal inflation rate under policy commitment is zero, these deviations will result in an inflationary pressure, leading to an inefficiently high steady state inflation rate. The reasons for this seemingly irrational behavior of public authorities are identical to the above presented Barro-Gordon model. Since due to monopolistic competition aggregate output will be inefficiently low, both policymakers will try to bring output at least temporary closer to its first best level, either via public spending (fiscal policymaker) or via a reduction of the nominal interest rate (monetary policymaker). However, as in the standard Barro-Gordon model, such a behavior will be anticipated by rational, forward-looking households, such that this activist policy will have no real long run effects.

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<sup>38</sup>Markov strategies are defined as history-independent, time-invariant strategies, which determine current acting just as a function of current economic conditions.

### 6.1.3 Welfare implications of a conservative central banker

In a next step Adam and Billi investigate equilibrium policy strategies under a conservative central banker. Under monetary conservatism the fiscal policymaker will still aim at maximizing household utility, whereas the monetary authority's new objective will consist in maximizing a weighted sum of household utility and a quadratic inflation loss term<sup>39</sup>. Since now the policy goals of both authorities differ, the timing of policy acting does become crucial. Therefore Adam and Billi include both the Nash equilibrium as well as Stackelberg leadership equilibria in their analysis. Their main results are the following:

In the case of simultaneous decision making (Nash equilibrium) and monetary leadership the equilibrium inflation rate will decrease as the relative weight on inflation stabilization increases and will ultimately converge to its optimal value under monetary commitment. However, though the inflation bias can thus be brought, the fiscal spending bias in turn will increase compared to the case without a conservative central banker. The reason is that lower inflation rates reduce the inflationary pressure and hence make fiscal overspending more attractive. Nevertheless, Adam and Billi find that the net welfare effects of weight conservatism are still positive, since the welfare gains due to reduced trend inflation more than outweigh the welfare losses caused by an increased fiscal spending bias<sup>40</sup>.

In the case of fiscal leadership the achieved welfare gains are even more pronounced, since there the fiscal policymaker internalizes the within-period effects of his policy choices on the monetary authority's reaction function. This causes that in the

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<sup>39</sup>This loss term is similar to the inflation loss term employed in Section 4 and will punish both positive and negative deviations of inflation from its Ramsey optimal value of zero.

<sup>40</sup>The drawback of this result is that it clearly hinges on the availability of lump sum taxes.

extreme case of a fully conservative central banker<sup>41</sup> both the inflation- and the fiscal spending bias can be eliminated, which will result in the implementation of a second best equilibrium.

In a nutshell, Adam and Billi (2008) conclude that also in an environment with endogenous fiscal policy the introduction of a conservative central banker still remains desirable<sup>42</sup>. In one very special case, that is with fiscal leadership and a fully conservative monetary authority, overall welfare even reaches a second best equilibrium level. However, though Adam and Billi show that this result is quite robust to parameter changes, it still hinges to a large degree on the assumption of lump-sum taxation. At least in the case of monetary leadership and simultaneous policy choices the exclusion of lump sum taxation might significantly alter the results. Since lump-sum taxes are hardly observed in reality, this issue can be pointed out as one drawback of the paper. However, the result under fiscal leadership (which the authors view as the most realistic timing) is less vulnerable to the assumption of lump sum taxation, such that the overall conclusion of a welfare-improving conservative central banker is still valid.

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<sup>41</sup>That is a monetary policymaker, who attaches zero weight on the households' utility maximization.

<sup>42</sup>This explanation has obviously abstracted from any stabilization costs of increased conservatism. However, Adam and Billi also show that the increases in stabilization costs are of a negligible magnitude compared to the optimal state-contingent stabilization response under policy commitment.

## 6.2 Weight conservatism and public debt

### 6.2.1 The model setup

The model setup in Niemann (2009) differs from the framework used by Adam and Billi (2008) in various aspects. While the above model is clearly of a New-Keynesian form, Niemann assumes a dynamic flexible price economy with money and nominal debt, which -in contrast to Adam and Billi (2008)- abstracts from stochastic economic disturbances. Also Niemann assumes a continuum of infinitely lived households, whose preferences are given by

$$\sum_{t=0}^{\infty} \beta^t \{\log(c_t) - \alpha n_t\}, \quad (6.1)$$

where  $c_t$  again denotes period  $t$  consumption of some consumption good,  $n_t$  defines the period  $t$  labor effort and  $0 < \beta < 1$  the discount factor. In contrast to Adam and Billi (2008), public goods provision  $g$  will be both constant and *exogenously* determined, and will *not* yield any utility for households.

In every period households face the following budget constraint:

$$M_{t+1} + B_{t+1} \leq M_t - P_t(1 + \tau_t^c)c_t + B_t(1 + R_t) + W_t n_t, \quad (6.2)$$

where the amount of nominal balances carried over to the next period (cash,  $M_{t+1}$ , plus bonds,  $B_{t+1}$ ) on the left hand side has to be smaller or equal than the nominal stock of wealth held in the current period, consisting of current cash holdings,  $M_t$ , minus expenditures for consumption goods,  $P_t(1 + \tau_t^c)c_t$ , (with  $\tau_t^c$  being a consumption tax rate), plus repayments of last period's bond purchases,  $B_t(1 + R_t)$  (principal plus interest gains) and nominal wage earnings,  $W_t n_t$ . The timing in the economy will be such that the asset market opens only after the goods market has closed. Thus households are constrained to use only their nominal cash holdings



carried over from the previous period for the purchase of consumption goods. This leads to the following cash-in-advance constraint

$$M_t \geq P_t(1 + \tau_t^c)c_t. \quad (6.3)$$

Inflation in this economy has two effects: First, anticipated inflation triggers a corresponding increase in the nominal interest rate and second, surprise inflation acts as a lump-sum tax on the nominal cash holdings of households (see equation (6.3)).

Concerning political authorities, there will be again a monetary and a fiscal policymaker, who will undertake their decisions independently in a non-cooperative fashion. The period  $t$  policy instrument of the monetary policymaker will be the overall nominal money supply  $M_{t+1}^a$ <sup>43</sup>, where the superscript  $a$  shall distinguish individual from aggregate variables. The fiscal policymaker's instruments, in turn, are the consumption tax rate  $\tau_t^c$  and the stock of government bonds issued in period  $t$ ,  $B_{t+1}^a$ . Using these three instruments both policymakers have to fulfill the following intertemporal budget constraint<sup>44</sup>:

$$M_{t+1}^a + B_{t+1}^a + P_t\tau_t^c \geq M_t^a + B_t^a(1 + R_t) + P_tg. \quad (6.4)$$

I turn next to the objective function of both policymakers. In a first instance, the fiscal policymaker will again try to maximize the household utility in every period. However, this fiscal policymaker will be more "impatient" than the private sector, meaning that his discount factor will be biased downwards compared to

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<sup>43</sup>The monetary authority will determine  $M_{t+1}^a$  only *after* households have chosen their stock of cash holdings for the next period.

<sup>44</sup>Note that the role of the monetary authority in this model is being restricted to a public finance function.

household's discount factor<sup>45</sup>. The objective function of the fiscal authority thus is

$$\sum_{t=0}^{\infty} \delta^t \{ \log(c_t) - \alpha n_t \}, \quad (6.5)$$

with  $\delta < \beta$ .

The monetary policymaker's goal in turn will be to maximize a weighted sum of the households utility and an inflation loss term:

$$\sum_{t=0}^{\infty} \beta^t \left\{ -\gamma \left( \frac{1 + \pi_t}{1 + \pi_t^e} \right)^2 + (1 - \gamma) [\log(c_t) - \alpha n_t] \right\}, \quad (6.6)$$

with  $\pi_t = \frac{P_t}{P_{t-1}} - 1$  the period  $t$  inflation rate and  $\pi_t^e$  the expected inflation rate. The parameter  $\gamma \in (0, 1)$  measures the relative weight which the monetary authorities attaches to utility maximizations versus inflation losses minimization.

Due to the intertemporal budget constraint there will be a dynamic interplay between the fiscal and the monetary policymaker, in which the real stock of government liabilities will take the role of an endogenous state variable. A time inconsistency problem arises since the impatient fiscal policymaker will seek to postpone tax-caused distortions into the future which will lead to an excessive accumulation of public debt, whereas the monetary policymaker in turn will be tempted to use surprise inflation in order to reduce the real value of this outstanding debt stock<sup>46</sup>.

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<sup>45</sup>Such fiscal impatience may have various reasons, for example electoral concerns of political representatives (Niemann, 2009, p. 2).

<sup>46</sup>Importantly note that since public debt ultimately has to be financed via distortionary activity (i.e. either via consumption taxes or via money creation, see again equation (6.4)), the outstanding stock of public debt has negative welfare implications.

### 6.2.2 Equilibrium in the “undistorted” economy

Since both policymakers lack intertemporal commitment, equilibrium strategies once again have to be sequentially optimal. Like in Adam and Billi (2008) also Niemann restricts his attention to Markov-perfect equilibria of the dynamic game<sup>47</sup>. These Markov-perfect equilibrium strategies can be described by two generalized Euler equations (GEEs); one for the fiscal and one for the monetary policymaker. Both Euler equations equate the marginal welfare gains from increasing consumption today (via lowering the consumption tax or a reduction of the inflation tax) to the marginal costs of facing a higher level of real debt in the next period. A steady state is thus reached when the marginal incentives for accumulating and decumulating real debt just balance in both Euler equations.

In order to create a benchmark case, Niemann first considers the case where  $\delta = \beta$  and  $\gamma = 0$  holds (no fiscal impatience, no conservative central banker). The objective of both policymakers thus reduces to maximize household utility in every period. In this benchmark setup Niemann identifies two possible steady states, where it is the initial level of real debt which ultimately pins down to which of these two steady states the economy will converge. If the initial stock of real public assets is sufficiently high, the economy will stabilize at a completely undistorted equilibrium, at which the entire flow of public expenditures can be financed via interest earnings such that both the consumption and the inflation tax will be zero. However, for lower real values of initial assets or for any real level of initial public debt this undistorted equilibrium will be infeasible and the economy will converge to a second, distorted equilibrium. At this equilibrium the debt stock will be zero, but the equilibrium level of consumption will be smaller than in the previous case,

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<sup>47</sup>Due to their very definition, Markov strategies are always time consistent.

since now public expenditure has to be financed via distortionary activities of the policymakers.

### 6.2.3 Equilibrium with fiscal impatience and monetary conservatism

Yet, just additionally introducing fiscal impatience is sufficient to trigger a collapse of both of the above equilibria. The reason is that since fiscal impatience causes the fiscal authority to discount future utility at a higher rate than the monetary policymaker or the households, his preferences will consequently shift from tax financing to debt financing, thus leading to positive values of real debt. The interesting key finding of Niemann is that additionally introducing a conservative central banker *increases* the incentives of the policymaker to accumulate debt. This unexpected outcome results out of the interplay of several factors in this model:

First Niemann proves that for any degree of fiscal impatience the elasticity of money growth around the steady state level of real debt has to be positive. This issue is also intuitively plausible: Since the monetary policymaker tries to prevent the impatient fiscal policymaker from running into excessive debt, he will punish every deviation from the steady state level of real debt with increased money growth, that is an increase in inflation. Importantly, the “strength” of this response, that is the elasticity of money growth, will be *increasing* in the degree of fiscal impatience; the more the fiscal policymaker edges to the lax side and seeks to accumulate debt, the stronger has to be the marginal inflation response in order to prevent him from doing so. As a first result, the steady state level of real debt (and also of *any* other steady state variable, such as consumption, inflation or the consumption tax) will be *independent* of the degree of fiscal impatience. The degree of fiscal impatience only affects the steady state elasticity of money growth. If one further introduces a weight conservative central banker, additionally a direct and an indirect effect kick in. First, the direct effect of weight conservatism is that

the monetary authority will be less willing to use inflation in order to prevent the policymaker from accumulating debt. Accordingly at any given level of real debt, the elasticity of money growth and thus the “strength” of the inflation response around the steady state will *decrease*. However, and this is the crucial point in this paper, this behavior will be internalized by the fiscal policymaker. The indirect effect of monetary conservatism then is that the fiscal policymaker, which will now be less disciplined by the monetary authority for steady state deviations, will be tempted to accumulate more debt, up to a new higher steady state level of real debt. At this higher steady state level the money growth elasticity has reached again its original level and thus the fiscal authority will again refrain from further accumulating debt. However, at this new steady state also the other model variables will have changed, especially consumption will be lower and inflation will be higher compared to the case without weight conservatism.

The surprising effect of the conservative central banker in this model thus is that instead of lowering long run inflation he will *increase* long run inflation. The elasticity of money growth around the steady state however stays unaffected from monetary conservatism. Using numerical simulations in order to measure the welfare effects of a conservative central banker, Niemann finally shows that the direct welfare gains during transition (lower degree of surprise inflation) are more than outweighed by the long run costs of increased real debt and the end result thus is that the introduction of a conservative central banker has negative welfare implications.

Via considering also the indirect effects of lower long run inflation on public debt accumulation, Niemann adopts a broader perspective on monetary conservatism which has not yet been considered in the theoretical literature. By showing that under the assumption of fiscal impatience a weight conservative central banker will

cause higher equilibrium levels of both real debt and inflation he challenges the main theoretical results on the desirability of a conservative central banker presented thus far. Note though that Niemann (2009) does not question the ability of a conservative central banker to bring down trend inflation *as such*, but he rather points out that these low inflation rates can have adverse effects on fiscal policy behavior, whose welfare effects might be more pronounced than the initial positive effects of reduced inflation.

Finally, in the light of the current European debt crisis this theoretical result might be of particular interest, since it provides an explanation why several south European countries have accumulated such high levels of public debt since their accession to the EMU. Additionally it strengthens the theoretical support for combining monetary conservative regimes with legal fiscal deficit limits and debt ceilings, such as the European stability and growth pact.

## **7 Summary and Conclusion**

The aim of my thesis was to give a detailed overview of the theoretical concepts which underlie the series of pronounced central bank reforms observed over the last twenty to thirty years. After a brief summary of some general inflation-related facts I turned to the presentation of the time-inconsistency problem in monetary policy and the resulting inflation bias, where I used a simple Keynesian model in order to illustrate the problem also formally. I further proceeded with introducing several concepts which aim at reducing this socially costly inflation bias, where I put the main focus on the idea of the independent, weight conservative central banker. In the final section I reviewed two micro-based model frameworks, in which the implications of such a weight conservative central banker within an environment

with endogenous fiscal policy and public debt are considered.

The literature on time-consistent monetary policies has shown that even rational, benevolent governments may create excessive inflation. The entire society is thus better off when monetary policy is delegated to an independent, conservative central banker. This famous theoretical result derived by Rogoff has contributed an important part to the world-wide trend of central bank reforms. After several years of experience with independent conservative monetary authorities, numerous studies also empirically verified the negative effect of monetary conservatism on average inflation rates<sup>48</sup>. However, as some recently published papers indicate, the view on monetary conservatism adapted thus far in theoretical research might have been too narrow in order to capture the entire welfare effects of a conservative central banker. Model frameworks with endogenous fiscal policy and public debt show that the effects of weight conservatism are less clear-cut than most of the literature suggests. These findings do not challenge the concept of independent, conservative central banks as such, but rather indicate that more attention should be attached to the interaction between monetary conservatism and fiscal policy.

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<sup>48</sup>For a summary of this literature see for example Berger et al. (2001).





## Appendix A

### A.1 The first best solution and its infeasibility

The social loss function presented in Section 4.4.2 assumes that due to labor market imperfections the natural rate of employment is too low to be socially efficient, meaning that welfare can be improved by pushing employment temporary above its natural level using activist monetary policy. The obvious questions linked to that assumption clearly are from where such imperfections actually originate and whether they can be reduced or even eliminated.

The possible sources of distortions in labor markets are numerous (see for example the derivations of aggregate supply in Sørensen and Whitta-Jacobsen (2005) or Blanchard and Illing (2004)). First, excessive real wages can make the implementation of a socially optimal natural employment rate infeasible. Such high real wages can arise due to imperfect competition and monopoly power, or because of inefficiently high unemployment benefits<sup>49</sup> (see Sørensen and Whitta-Jacobsen, 2005, pages 524ff). Furthermore, also powerful trade unions can prevent the real wage from falling to its socially optimal level. Finally it can be possible that also firms prefer to pay higher real wages, for example in order to motivate their employees<sup>50</sup>.

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<sup>49</sup>Since these benefits constitute one component of the opportunity costs of working.

<sup>50</sup>For a positive theory on equilibrium wages above the market clearing level see the literature on efficiency wage models, for example Akerlof and Yellen (1986) or Romer (2006), pages 438ff.

Another source of labor market inefficiencies are high income taxes. Since such taxes breach the gap between the gross wage which the employer has to bear and the net wage which the worker receives at the end of the day, in the presence of high income taxation labor supply at any given gross wage might be inefficiently low.

Since this list of possible labor market distortions could be continued almost arbitrarily, the removal of *all* of these distortive factors will most likely be infeasible in reality<sup>51</sup> (see for example Rogoff, 1985; Lohmann, 1992 or Svensson, 1995), which thus makes also the implementation of a first best labor market equilibrium impossible. Additionally note that even if one would consider the removal of all labor market distortions as practicable, there would still remain other incentives for creating unanticipated inflation, as the discussion in Section 2.3.3 has shown. The consequence thus is, no matter whether one believes that all labor market distortions can be eliminated or not, it is highly unrealistic or even impossible to remove all possible temptations for the policymaker to create surprise inflation. However, since it is exactly these temptations which will result in an inflationary bias, it is commonly assumed that the first best solution is infeasible in reality.

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<sup>51</sup>For example consider that though income taxation or unemployment benefits might distort the labor supply, they also constitute important means of redistribution and help maintaining social peace. Thus their complete removal would encounter serious public resistance.

## A.2 Mathematical derivation of the general expected social loss function

The general expected social loss function under any arbitrary policy regime (equation (4.24)) is obtained via several modifications of the policymaker's general loss function (A.1):

$$L_t^A = \left( \frac{z_t}{\eta} + \frac{(p_t - \bar{w}_t)}{\alpha} - (\tilde{n} - \bar{n}) \right)^2 + \chi (p_t - p_{t-1} - \tilde{\pi})^2. \quad (\text{A.1})$$

First, a decomposition of (A.1) gives

$$(\tilde{n} - \bar{n})^2 + \left( \frac{z_t}{\eta} + \frac{(p_t - \bar{w}_t)}{\alpha} \right)^2 - 2 \frac{z_t}{\eta} (\tilde{n} - \bar{n}) - 2 \frac{(p_t - \bar{w}_t)}{\alpha} (\tilde{n} - \bar{n}) + \chi (p_t - p_{t-1} - \tilde{\pi})^2. \quad (\text{A.2})$$

Next, substituting  $\bar{w}_t^D - \bar{\pi}^D$  for  $p_{t-1}$  in equation (A.2)<sup>52</sup> yields

$$(\tilde{n} - \bar{n})^2 + \left( \frac{z_t}{\eta} + \frac{(p_t^A - \bar{w}_t^A)}{\alpha} \right)^2 - 2 \frac{z_t}{\eta} (\tilde{n} - \bar{n}) - 2 \frac{(p_t^A - \bar{w}_t^A)}{\alpha} (\tilde{n} - \bar{n}) + \chi (p_t^A - \bar{w}_t^A + \bar{\pi}^A - \tilde{\pi})^2, \quad (\text{A.3})$$

where the superscripts have been changed from  $D$  to  $A$  in order to emphasize that here the expected social losses under any arbitrary policy regime are considered.

Once again rearranging the different terms gives

$$\begin{aligned} & (\tilde{n} - \bar{n})^2 + \left( \frac{z_t}{\eta} + \frac{(p_t^A - \bar{w}_t^A)}{\alpha} \right)^2 + \chi (\bar{\pi}^A - \tilde{\pi})^2 - \\ & - 2\chi \frac{(p_t^A - \bar{w}_t^A)}{\alpha\chi} (\tilde{n} - \bar{n}) + \chi (p_t^A - \bar{w}_t^A)^2 + 2\chi (p_t^A - \bar{w}_t^A) (\bar{\pi}^A - \tilde{\pi}). \end{aligned}$$

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<sup>52</sup>One can use  $p_t^D$  and  $\bar{w}_t^D$  (and thus also  $\bar{\pi}^D$ ) for the derivation of the general expected social loss function, since these strategies are actually general expressions, describing optimal behavior of the policymaker and the wage setters whenever decisions are made sequentially and none of the players faces additional constraints.

Using  $\bar{\pi}^D - \tilde{\pi} = \bar{\pi}^A - \tilde{\pi} = \frac{(\tilde{n} - \bar{n})}{\chi\alpha}$  and employing the fact that  $\bar{w}_t^A = E_{t-1}p_t$  simplifies the above expression considerably to

$$(\tilde{n} - \bar{n})^2 + \left( \frac{z_t}{\eta} + \frac{(p_t^A - \bar{w}_t^A)}{\alpha} \right)^2 + \chi (\bar{\pi}^A - \tilde{\pi})^2 + \chi (p_t^A - \bar{w}_t^A)^2. \quad (\text{A.4})$$

Finally taking  $t - 1$  expectations over the entire expression yields the expected social loss function under any arbitrary policy regime as presented in Section 4.6.1:

$$(\tilde{n} - \bar{n})^2 + \chi (\bar{\pi}^A - \tilde{\pi})^2 + E_{t-1} \left\{ \left( \frac{z_t}{\eta} + \frac{(p_t^A - E_{t-1}(p_t^A))}{\alpha} \right)^2 + \chi (p_t^A - E_{t-1}(p_t^A))^2 \right\}. \quad (\text{A.5})$$

### A.3 Necessary parameter conditions for the dominance of the rule outcome

In order to identify the exact parameter conditions under which commitment yields a socially better result than discretion, I first rewrite the expected social losses under both regimes:

$$E_{t-1}L_t^R = (\tilde{n} - \bar{n})^2 + \frac{\sigma_z^2}{\eta^2}, \quad (\text{A.6})$$

$$E_{t-1}L_t^D = (\tilde{n} - \bar{n})^2 + \underbrace{\frac{(\tilde{n} - \bar{n})^2}{\alpha^2\chi}}_{\Pi^D} + \underbrace{\frac{\sigma_z^2}{\eta^2} \frac{\alpha^2\chi}{(1 + \alpha^2\chi)}}_{\Gamma^D}. \quad (\text{A.7})$$

Not surprisingly, a first inspection of both expressions shows that the regime independent dead weight loss term  $(\tilde{n} - \bar{n})^2$  is identical across both policy regimes. However, further comparisons illustrate that additional welfare losses under commitment just result out of the policymaker's inability to counteract economic shocks, whereas under discretion there arise both stabilization *and* inflation costs, though

expected stabilization costs are smaller than under commitment<sup>53</sup>. The condition under which commitment dominates discretion is thus straight forward: Commitment to a policy rule yields a socially better result than discretion whenever the expected social losses due to increased employment volatility are smaller than the expected social gains from bringing down long run inflation, that is whenever

$$\frac{\sigma_z^2}{\eta^2} < \frac{(\tilde{n} - \bar{n})^2}{\alpha^2 \chi} + \frac{\sigma_z^2}{\eta^2} \frac{\alpha^2 \chi}{1 + \alpha^2 \chi} \quad (\text{A.8})$$

holds. Employing the fact that  $\eta \equiv \alpha(1 + \omega\alpha)$ , this inequality can be further simplified to

$$\sigma_z^2 \underbrace{\frac{\chi}{(1 + \alpha^2 \chi)(1 + \alpha\omega)^2}}_{<1} < (\tilde{n} - \bar{n})^2. \quad (\text{A.9})$$

As equation (A.9) shows, the condition for the dominance of the commitment regime finally boils down to a relation between the supply shock variance and the degree of labor market imperfections: Whenever the variance of the stochastic supply shock times an expression smaller than one is smaller than the squared difference between the first and the second best labor market equilibrium, then commitment yields a socially better result than discretion. Thus there can only be identified two very rare cases at which a discretionary regime should be preferred over policy commitment: Either when the difference between the first best employment rate and the distorted second best employment rate is *very* small, or when the variance of the supply shock term  $z$  is *very* large.

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<sup>53</sup>Note that the stabilization cost term  $\frac{\sigma_z^2}{\eta^2}$  is multiplied by  $\frac{\alpha^2 \chi}{(1 + \alpha^2 \chi)} < 1$ .

## A.4 Monetary conservatism and the inflation bias: A graphical interpretation

Conducting a graphical analysis of the time inconsistency problem demonstrates the dilemma in which a policymaker finds himself in an illustrative, clear-cut way. For that reason here I will once again summarize the main results of Sections 4 and 5 in a graphical way. These results are the time inconsistency of policy commitment, the existence of a discretionary inflation bias and the improvement upon discretion via the introduction of a weight conservative central banker.

For this purpose I first conduct a simple modification of the discretionary policy rule (4.19) in order to obtain a best response function of the policymaker to already established inflation expectations<sup>54</sup>,

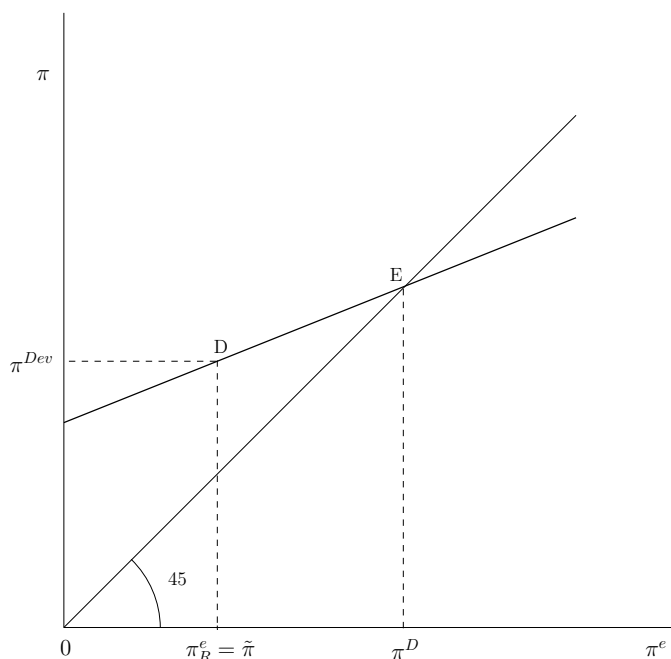
$$F(\pi^e) = \pi_t = \frac{\chi\alpha^2\tilde{\pi} + \alpha(\tilde{n} - \bar{n})}{1 + \alpha^2\chi} + \frac{\pi_t^e}{1 + \alpha^2\chi}, \quad (\text{A.10})$$

where I once again used the fact that  $E - t - 1(p_t) = \bar{w}_t$ .

Next this best response function  $F$  is plotted together with the 45 degree line in a  $(\pi^e, \pi)$  space: Since at any stable rational expectations equilibrium policy expectations have to coincide with policy realizations, clearly any equilibrium has to be located on the 45 degree line. As figure A.1 shows, if people expect zero inflation there is a large benefit from creating surprise inflation and thus the best response function  $F(\pi^e)$  has a positive intercept (which equals the first term in equation (A.10)). However, also at the expected inflation rate implied by the policy rule,  $\pi_R^e$ , the optimal response function of the policymaker lies *above* the 45 degree line. Accordingly also at  $\pi_R^e$  the policymaker will deviate from his preannounced strat-

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<sup>54</sup>Here I will abstract from economic disturbances, such that  $z_t = 0$ .



**Figure A.1** Graphical interpretation of the time inconsistency problem

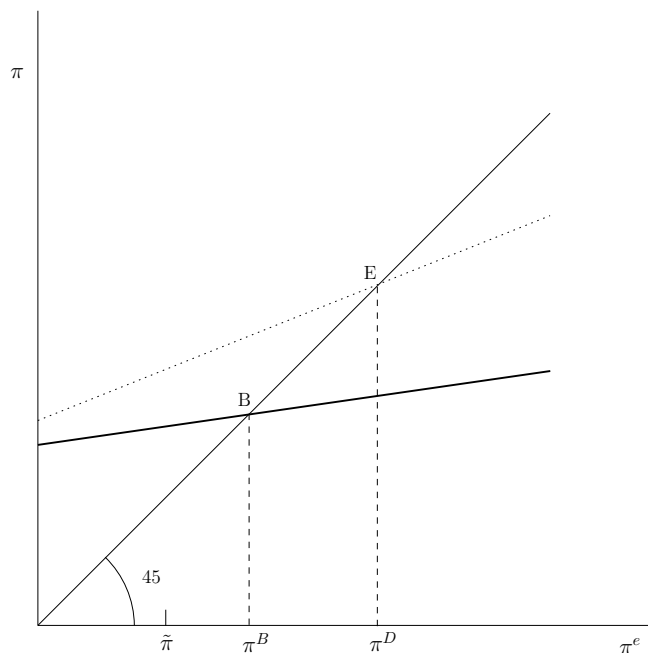
egy and will create surprise inflation equal to  $\pi^{Dev} - \pi^R$ . Policy commitment is thus a time inconsistent strategy and can therefore not constitute a stable rational expectations equilibrium. Wage setters, internalizing this issue, will therefore adjust their inflation expectations upwards, which will reduce the policymaker's incentives to create surprise inflation, until inflation expectations finally reach point E. At this point the best response function of the policymaker intersects with the 45 degree line, meaning that further inflating beyond expectations no longer pays off for the policymaker and therefore a stable equilibrium establishes. However, since the equilibrium inflation rate at point E,  $\pi^D$ , is situated well above the socially optimal inflation rate  $\tilde{\pi}$ , the equilibrium is subject to an inflation bias.

As Section 5 has shown, this unsatisfactory outcome can be improved via the introduction of an independent weight conservative central banker. In order to illustrate this also graphically, one needs again the best response function of such a conservative central banker to already established inflation expectations. Since

the algorithm for calculating this best response function is identical to the standard discretionary case, one obtains this function simply by substituting  $(\chi + \epsilon)$  for  $\chi$  in (A.10).

$$F^B(\pi^e) = \pi_t^B = \frac{(\chi + \epsilon)\alpha^2\tilde{\pi} + \alpha(\tilde{n} - \bar{n})}{1 + \alpha^2(\chi + \epsilon)} + \frac{\pi_t^e}{1 + \alpha^2(\chi + \epsilon)}. \quad (\text{A.11})$$

Next I plot this best response function  $F^B(\pi^e)$  together with the original best response function (the dotted line in Figure A.2) and the 45 degree line again into a  $(\pi^e, \pi)$  space. As figure A.2 demonstrates, both the intercept and the slope of



**Figure A.2** The reduction of trend inflation by a conservative central banker

the conservative central banker's best response function are now smaller compared to the previously considered case<sup>55</sup>, since at any level of expected inflation the conservative central banker is less willing to use surprise inflation in order to stim-

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<sup>55</sup>For the intercept to be smaller than under discretion additionally the condition  $\tilde{\pi} < \alpha(\tilde{n} - \bar{n})$  has to hold.



ulate the economy. Consequently at point B, where  $F^B(\pi^e)$  intersect with the 45 degree line, the established long run inflation rate is lower than under discretion, which shows that the implementation of a conservative central banker helps to bring down average inflation. However, as the formal derivation above already indicated, weight conservatism just manages to reduce, but not to eliminate the inflation bias. Therefore also under a conservative central banker equilibrium inflation is still located above the socially optimal level, as Figure A.2 illustrates.



## Appendix B

### B.1 Abstract

This thesis examines the theoretical concepts which have contributed to the world wide trend of central bank reforms. Since governments can not credibly commit to a non-activist monetary policy, long run inflation rates are inefficiently high, which causes a reduction in social welfare. This inflation bias can be diminished by delegating monetary policy to an independent central bank, which additionally has to be more inflation averse than the government. The economics literature has suggested various concepts for the setup of such independent central banks, where the “conservative central banker” has probably been the most influential among them. This conservative central banker reduces average inflation rates and improves social welfare by attaching a relatively higher weight to inflation stabilization than society would. Many political authorities around the world followed this proposal and created independent central banks, which were charged with the main goal of implementing low and stable inflation. However, current research which investigates monetary conservatism from a broader perspective suggests that the welfare effects of a conservative central banker are less clear-cut than the existing literature would indicate. Especially if the interactions between monetary conservatism and public debt are considered, the implementation of a conservative central banker might even have adverse welfare effects.

## B.2 Abstract (German)

Diese Diplomarbeit behandelt jene theoretischen Konzepte, welche den weltweiten Trend an Zentralbank-Reformen mit auslösten. Die Tatsache, dass Regierungen sich nicht glaubhaft auf eine passive Geldpolitik festlegen können, bewirkt in der Folge systematisch hohe Inflationsraten, die eine Reduktion des sozialen Wohlstands implizieren. Dieser Inflations-Bias kann verringert werden, indem die Geldpolitik einer unabhängigen Zentralbank übertragen wird, welche darüber hinaus inflationären Tendenzen mehr abgeneigt ist als die Regierung. Die ökonomische Literatur brachte diverse Vorschläge für die Ausgestaltung einer solchen Zentralbank hervor, wobei der "conservative central banker" wahrscheinlich den größten Einfluss auf praktische Reformentwicklungen hatte. Dieser Zentralbanker reduziert die durchschnittliche Inflation und erhöht den sozialen Wohlstand, indem er Inflationsschwankungen eine relativ höhere Wertigkeit beimisst als dies in der Gesellschaft geschieht. Diesem Vorschlag folgten weltweit viele Regierungen, indem sie unabhängige Zentralbanken schufen und eine niedrige stabile Inflation als deren Hauptziel festlegten. Aktuelle Forschungsarbeiten, welche dieses Konzept aus einer breiteren Perspektive betrachten, deuten jedoch darauf hin, dass die Wohlstandseffekte einer konservativen Zentralbank weit weniger eindeutig sind als in der bisherigen Literatur angenommen wird. Speziell unter Miteinbeziehung der Wechselwirkungen zwischen konservativer Geldpolitik und Staatsschulden kann die Einrichtung einer konservativen Zentralbank sogar den sozialen Wohlstand reduzieren.

## **B.3 Curriculum Vitae**

### **Personal Information**

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### **Education**

03/2008 - present: Studies of Law and Economics  
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### **Working Experience**

08-09/2010: Trainee  
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## Bibliography

- Andrew B. Abel and Ben Bernanke. *Macroeconomics*. Pearson Addison Wesley, 5 edition, 2005.
- Klaus Adam and Roberto M. Billi. Monetary conservatism and fiscal policy. *Journal of Monetary Economics*, 55:1376–88, 2008.
- George A. Akerlof and Janet L. Yellen. *Efficiency wage models of the labor market*. University of Cambridge, 1986.
- Robert Barro and David Gordon. Rules, discretion and reputation in a model of monetary policy. *Journal of Monetary Economics*, 1983a.
- Robert Barro and David Gordon. A positive theory of monetary policy in a natural rate model. *The Journal of Political Economy*, 91(4):589–610, 1983b.
- Helge Berger, Jakob de Haan, and Sylvester Eijffinger. Central bank independence: An update of theory and evidence. *Journal of Economic Surveys*, 15, 2001.
- Olivier Blanchard and Gerhard Illing. *Makroökonomie*. Pearson Studium, 3 edition, 2004.
- Michael F. Bryan. On the origin and evolution of the word inflation. Federal Reserve Bank of Cleveland, 1997.
- V.V. Chari and Patrick J. Kehoe. Sustainable plans. *Journal of Political Economy*, 98:783–802, 1990.

- Javier Díaz-Giménez, Giorgia Giovannetti, Ramon Marimon, and Pedro Teles. Nominal debt as a burden on monetary policy. *Review of Economic Dynamics*, 2008.
- Gerald P. Dwyer Jr. Rules and discretion in monetary policy. *Journal of the Federal Reserve Bank of St. Louis*, pages 3–13, 1993.
- Andrea Ferrero. Fiscal and monetary rules for a currency union. ECB working paper No. 502, 2005.
- Stanley Fischer. Modern approaches to central banking. NBER working paper series, 1995.
- Stanley Fischer. Why are central banks pursuing long-run price stability? *Journal of the Reserve Bank of Kansas City*, pages 7–34, 1996.
- Stanley Fischer and Franco Modigliani. Towards an understanding of the real effects and costs of inflation. NBER working paper series, 1978.
- Milton Friedman. *A Program for Monetary Stability*. Fordham University Press, 1960.
- Milton Friedman. *Inflation. Causes and Consequences*. Proquest Info & Learning, 1963.
- Peter N. Ireland. Sustainable monetary policies. *Journal of Economic Dynamics and Control*, 1997.
- George Katona. The psychology of inflation. In Richard D. Curtin, editor, *Surveys of Costumers, 1974-75*, pages 9–19. Institute for Social Research, University of Michigan, 1976.



- John Maynard Keynes. *The General Theory of Employment, Interest and Money*. Palgrave Mcmillian, 1936.
- Paul Klein, Per Krusell, and José-Víctor Ríos-Rull. Time-consistent public policy. *Review of Economic Studies*, 75:789–808, 2008.
- Finn Kydland and Edward Prescott. Rules rather than discretion: The inconsistency of optimal plans. *Journal of Political Economy*, 85(3):473–490, 1977.
- David E. W. Laidler and Michael Parkin. Inflation: A survey. *Economic Journal*, 85:741–809, 1975.
- Francesco Lippi. Strategic monetary policy with non-atomistic wage setters. *Review of Economic Studies*, 70:909–919, 2003.
- Ben Lockwood, Marcus Miller, and Lei Zhang. Designing monetary policy when unemployment persists. Technical report, University of Exeter, 1995.
- Susanne Lohmann. The optimal degree of commitment. credibility and flexibility. *American Economic Review*, 82(1):273–286, 1992.
- Robert E. Lucas Jr. Rules, discretion and the role of the economic advisor. In Stanley Fischer, editor, *Rational Expectations and Economic Policy*, pages 199–210. University Chicag Press, 1980.
- N. Gregory Mankiw. *Makroökonomik*. Schäffer-Poeschel Verlag Stuttgart, 5 edition, 2003.
- Fernando M. Martin. A positive theory of government debt. *Review of Economic Dynamics*, 2009.

- Bennett T. McCallum. Inflation expectations. In Steven N. Durlauf and Lawrence E. Blume, editors, *The New Palgrave Dictionary of Economics Online*. Palgrave Macmillian, 2008. Online version, access: November 3rd 2010.
- Patrick Minford and David Peel. *Advanced Macroeconomics. A Primer*. Edward Elgar Publishing, 2002.
- Stefan Niemann. Dynamic monetary-fiscal interactions and the role of monetary conservatism. Discussion Papers, University of Essex, 2009.
- Central Bank of Iceland. Monetary bulletin 2007-2. Technical report, 2007. URL: <http://www.sedlabanki.is/lisalib/getfile.aspx?itemid=5325>.
- Michael Parkin. inflation. In Steven N. Durlauf and Lawrence E. Blume, editors, *The New Palgrave Dictionary of Economics Online*. Palgrave Macmillian, 2008. Online version, access: November 11th 2010.
- Kenneth Rogoff. The optimal degree of commitment to an intermediate monetary target. *Quarterly Journal of Economics*, pages 1169–1190, 1985.
- David Romer. *Advanced Macroeconomics*. McGraw-Hill, 3 edition, 2006.
- Julio Rotemberg. Sticky prices in the united states. *The Journal of Political Economy*, 90:1187–1211, 1982.
- Thomas J. Sargent and Neil Wallace. “rational” expectations, the optimal monetary instrument, and the optimal monetary rule. *The Journal of Political Economy*, 83(2):241–54, 1975.
- Klaus Schmidt-Hebbel and Matias Tapia. Monetary policy implementation and results in twenty inflation-targeting countries. Technical Report working paper no 166, Central Bank of Chile, 2002.

- Stephanie Schmitt-Grohé and Martin Uribe. Optimal simple and implementable monetary and fiscal rules. *Journal of Monetary Economics*, 54:1702–1725, 2007.
- Robert J. Shiller. Why do people dislike inflation? In Christina D. Romer and David H. Romer, editors, *Reducing Inflation: Motivation and Strategy*. University of Chicago Press, 1997.
- Henry Simons. Rules versus authorities in monetary policy. *Journal of Political Economy*, pages 1–30, 1936.
- Peter B. Sørensen and Hans J. Whitta-Jacobsen. *Introducing advanced Macroeconomics*. McGraw-Hill, 2005.
- Lars E.O. Svensson. Optimal inflation targets, 'conservative' central banks, and linear inflation contracts. *The American Economic Review*, 1995.
- Stephen J. Turnovsky. *Macroeconomic Analysis and Stabilization Policies*. Cambridge University Press, 1977.
- Neil Wallace. Why the fed should consider holding  $m_0$  constant. *Federal Reserve of Minneapolis Quarterly Review*, pages 2–10, 1977.
- Carl Walsh. Optimal contracts for independent central bankers. *American Economic Review*, 85(2):150–167, 1995.