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Nominal Income as an Intermediate Target for Monetary Policy

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Abstract

This study has investigated the possibility of using nominal income targeting as a rule for monetary policy. First, the philosophy behind the rules and intermediate targets for monetary policy are explained. Second, theoretical models which compare nominal income targeting to money supply targeting and empirically studied models for nominal income targeting are viewed. And third, the empirical part of this study consists of a simulation exercise based on McCallum's rule combined with a single-equation atheoretic determination of nominal GDP.

According to theoretical models, there is no simple condition under which one rule is universally favoured over the other. Empirical studies suggest, however, that rules for nominal income targeting outperform rules which target, for example, the money supply or the exchange rate. A number of alternative rules for nominal income targeting have been proposed. However, there does not exist a rule which would dominate all others. Simulation exercise indicates that McCallum's rule with Finnish data does not induce the simulated values for nominal GDP to follow the target path, when monetary base or M1 are used as an instrument variable. With the monetary aggregate M2, the simulated nominal GDP follows the target path somewhat closely.

Tiivistelmä

Tutkielman tavoitteena on selvittää nimellisen kokonaistuotannon käyttöä rahapolitiikan välitavoitteena. Aluksi selvitetään rahapolitiikan sääntöjen ja välitavoitteiden logiikkaa. Sitten tarkastellaan teoreettisia tutkimuksia, jotka vertaavat raha-aggregaattien ja nimellisen BKT:n käyttöä rahapolitiikan välitavoitteena. Tämän jälkeen verrataan empiirisesti tutkittujen erilaisten nimellisen BKT:n sääntöjen ominaisuuksia. Empiirisessä osassa simuloidaan McCallumin sääntö, liitettynä yhden yhtälön mallilla nimellisen BKT:n laskemiseksi. McCallumin sääntö simuloidaan rahaperustan lisäksi raha-aggregaateilla M1 ja M2 sekä muutellen mallien parametrejä.

Teoreettisten tutkimusten mukaan ei voida yksinkertaistaa, että nimellisen BKT:n tai raha-aggregaatin sääntö olisi kaikissa tilanteissa aina parempi kuin toinen. Empiiristen tutkimusten mukaan nimellisen BKT:n säännöt toimivat kuitenkin paremmin kuin esimerkiksi raha-aggregaatti-säännöt. Monia erilaisia nimellisen BKT:n sääntöjä on esitetty kirjallisuudessa, jotka näyttäisivät toimivan suhteellisen hyvin mitattuna hintatason ja kokonaistuotannon stabiilisuudella. Yhtä ylivertaista sääntöä ei kuitenkaan voida nostaa esiin. Suomen aineistolla tehdyn simuloinnin mukaan McCallumin sääntö rahaperustaa tai M1:tä käyttäen ei aikaansaa simuloitua nimellistä BKT:tä seuraamaan asetettua tavoiteuraansa. M2:ta käyttäen tulokset jossakin määrin parantuvat.

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1 Introduction

The desire to provide normative guidance to public policy is a fundamental theme that has motivated much of monetary economics. As some macroeconomic outcomes are clearly preferable to others, e.g. stable prices rather than inflation and prosperity rather than unemployment, the question of which government actions are more likely to lead to more desirable outcomes is not just natural but inevitable. The literature on targets and instruments of monetary policy has evolved in response to the desire to bring monetary economics even closer to the actual operations of central banks. (Friedman 1990, p. 1186)

Traditionally, Finland has pegged the exchange rate of markka to a basket of currencies. Thus the exchange rate has served as an intermediate target for monetary policy. In September 1992 the markka was allowed to float which left the monetary policy without an explicit intermediate target. The Bank of Finland has instead set a direct target for inflation as have several other central banks. The aim is to stabilize inflation at about two percent, as measured by the indicator of the underlying rate of inflation[1], by 1995.

To achieve the ultimate goal of monetary policy, such as price stability, a central bank uses instruments to change the stance of monetary policy whenever indicators, operational targets or intermediate targets indicate that current instrument settings are apt to result in an undesirable outcome in terms of the goal. Nominal income is one potential intermediate target for monetary policy.

Two broad principles of monetary policy can be cited here. The first is that monetary policy should aim to stabilize some nominal quantity. The second is that a credible commitment to a fixed rule for monetary policy is preferable to unconstrained discretion. (Recently proposed policy rules attempt to deliver better performance measured by stability in output and prices). Since it appears unlikely that a central bank would abandon discretion altogether and adhere strictly to a rule, some of the advocates of these rules stress that rules might also be used as a baseline path around which discretionary policy decisions could be oriented. One frequently advocated rule is nominal income targeting. Several procedures for targeting nominal income have been proposed.

The aim of this study is to examine the usefulness of nominal income as an intermediate target for monetary policy, with the ultimate policy objective of price stability.

This study consists of three parts. The first part is an introduction to relevant concepts of monetary policy, explaining briefly terms such as instrument variables, indicators, operational targets, intermediate targets and goals of monetary policy. A brief overview of the strategy of monetary policy in certain central banks is presented in order to connect the theory of nominal income targeting to the actual operations of central banks. The philosophy behind the rules for monetary policy and the characteristics of a good rule are presented followed by an explanation of nominal income targeting. The second part is a survey of the literature on nominal income targeting, from the early proposals to some of the latest articles. The

[1]The indicator of underlying inflation is calculated by removing the effect of subsidies and indirect taxes as well as house prices and mortgage interest payments from the consumer price index

proposed rules for nominal income targeting presented in this paper are subdivided into lagged adjustment rules and forecast adjustment rules. Finally, the third part reports on the testing of a simple simulation model based on McCallum's rule.

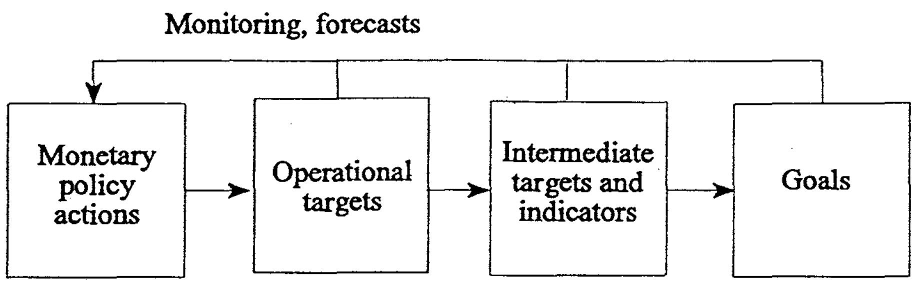
2 Introduction to monetary policy

The overriding objective of economic policy, as well as of monetary policy, is to ensure the stable development of the economy and a maximal standard of living. However, the central bank cannot directly influence its ultimate targets by means of the instruments at its disposal. Therefore, central banks set different-level objectives for their operations. (Aaltonen et al. 1994)

2.1 Targets of monetary policy

Different-level objectives for monetary policy can be divided for example into goals, intermediate targets and indicators, and operational targets. These are illustrated in figure 1.

Figure 1 **Targets of monetary policy**



Source: Aaltonen et al. 1994, p. 44

2.1.1 Goals

A goal variable represents the ultimate objectives of monetary policy. A common goal among different countries is inflation prevention or price level stability (JP Morgan 1994). It is typically assumed that a second goal, which may also be considered as a result of the first goal, involves some measure of real cyclical conditions, such as unemployment or real GDP, measured relative to their capacity or normal level (McCallum 1990, pp. 3-4).

2.1.2 Operational targets and intermediate targets

Since the central bank cannot directly influence on goals, it sets targets for its monetary policy. Monetary policy targets can be subdivided into operational targets and intermediate targets. Operational targets are aimed at in the short term and intermediate targets in the medium term. Operational targets are explained briefly in section 2.1.4.

An intermediate target serves as an operational guide for policy when the latter is conducted according to a two-stage process. First the central bank determines the value and a time path for the intermediate target (e.g. a year) which would be consistent with the desired ultimate policy objective. Then the central bank's efforts are focused on trying to achieve the designated path for the intermediate target variable, as if doing so were the objective governing policy (Friedman 1990, 1202). An ideal intermediate target has a high correlation with the goal but is much easier to control. An example would be a scheme whereby efforts are devoted to achieving a target path for some specific monetary aggregate (e.g. monetary base, M1, M2, M3)[2], in the belief that this path will lead to a desirable combination of inflation and output realizations. Other potential target variables include nominal income and the foreign exchange rate (in a fixed exchange rate regime) (McCallum 1990, pp. 4-5). Intermediate targets are often called indicators, if the central bank has not set precise numerical targets for them.

2.1.3 Indicators

The role of an indicator variable (also called as an information variable) is not to serve as a stand-in to be aimed at like a target, but rather to provide information to the policymaker regarding the recent or current state of the economy or the stance of monetary policy. The observation that an indicator variable currently has an unusually high (or low) value might mean that instrument settings should be reconsidered because they are apt to result in an undesirable outcome in terms of goals (or in terms of an intermediate target). Potential indicators may be e.g. different price indices, interest rates, foreign exchange rates, monetary aggregates and credit expansion. (McCallum 1990, p. 15)

Regardless of whether the central bank uses a variable as an intermediate target or as an indicator, there are two basic requirements. The variable (quantity or price) must be observable, and its movements must provide information about subsequent movements in the economic activity that monetary policy ultimately seeks to affect. (Friedman 1993, p. 12) Furthermore, such a variable should be observable with as short a lag as possible.

[2]Definitions of monetary aggregates in Finland since 1991 (Jokinen 1991) are:

Monetary base = Cash held by public + banks' reserves

M1 (narrow money)= Cash held by public + check and savings accounts in banks + other transfer accounts in banks

M2 (broad money) = M1 + other FIM deposits in banks (e.g. time deposits)

M3 = M2 + The Certificates of Deposits held by public

2.1.4 Instrument variables

An instrument variable[3] is one that can be directly controlled by the relevant policy authority. The variable used may be either a quantity or a price. A quantity variable may be e.g total reserves, nonborrowed reserves, the monetary base or either reserves or the monetary base adjusted for changes in reserve requirements. The list of potential price variables includes various short-term interest rates. (Friedman pp. 1990, 1188-1189)

2.2 Practice of some central banks[4]

As mentioned earlier the ultimate objective of monetary policy in Finland is price stability without an explicit intermediate target. Instead, the Bank of Finland uses a variety of indicators to guide its monetary policy. These include monetary aggregates, credit expansion, interest rates, exchange rates and several price indices (Pikkarainen 1993, pp. 532-533). The main operational target is the level of short-term interest rates, as is the case for most central banks, and the main instruments are minimum reserves, standing facilities and open market operations.

The goal of price stability[5] can also be seen as the goal of previous fixed exchange rate regimes, since one purpose of the fixed exchange rate was ultimately to force domestic inflation to conform with inflation in the major trading partners. Specific inflation targets also exist, for instance, in Britain, Sweden, Canada, and New Zealand. (Svensson 1994, pp. 3-4)

The use of indicators has also been adopted today by most central banks. However, two types of commonly used intermediate targets are monetary aggregates and exchange rates. A specific monetary aggregate target exists e.g. in Switzerland and Germany. (JP Morgan 1994, pp. 4-5). Although nominal income targeting is frequently advocated, no country has yet adopted a strict nominal income rule. However, Canada has been using nominal income as an unofficial intermediate target ("intermediate guide").

Certain variables can thus be used consequently either in the application of rules which are followed fairly rigidly or as general indicators which provide useful information to central banks, which may then use a considerable degree of discretion in the eventual setting of policy. Over time, there have been periods when views have tended to prefere rule-based monetary policy only to be followed by periods when preferences leaned clearly toward discretionary monetary policy (Guitián, 1994). In recent years, there has been a shift away from rules to discretion. This may be seen in two ways. First, the number of countries applying

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[3] It is worth noting that an instrument variable according to this definition is also treated in literature as an operational target, and open market operations, reserve requirements and standing facilities are treated as instruments.

[4] See, for example Bernanke & Mishkin (1992)

[5] See also e.g Lahdenperä 1994

formal intermediate targets has decreased. Second, countries have missed their explicit targets with a greater degree of impunity than before. (JP Morgan 1994, pp. 4-5). Yet, the use of rules has not been altogether discarded. Instead, as seen earlier, the rules have been formulated in terms of ultimate policy objectives. The issue of rules versus discretion will be discussed briefly in section 3.1.

3 Rules for monetary policy

Hall & Mankiew (1993) present two broad principles of monetary policy which, according to them, have reached increasing agreement among economists. Because there is evidence that in the medium- and long-term monetary policy can systematically affect only nominal variables and not real ones (Svensson 1994, p. 3)[6], the first principle is that monetary policy should aim to stabilize some nominal quantity. In practice, many countries have attempted to stabilize the growth of the nominal money stock. A famous rule is Milton Friedman's proposed policy of constant growth of the money supply: Setting the constant growth rate of money equal to the expected growth of potential GDP minus the expected rate of increase of velocity implies a zero expected rate of inflation (according to the quantity theory of money). The problem[7] in nominal money stock targeting is the difficulty in defining which definition of money has the most reliable relationship to income or prices and thus which monetary aggregate to apply. There is a conflict involved here: although more narrow monetary aggregates are easier to control, they may be very weakly correlated with the goal, whereas broader aggregates correlate more closely with the goal but are more difficult to control. For example, it has been argued by Friedman (1993, p. 3) that in the U.S. the Federal Reserve knows neither the magnitude nor even the sign of the response of M2 to open market operations, although in recent years M2 seems to have attracted more support as a target for U.S. monetary policy than any other such variable. There exists an extensive literature on the link from financial variables to output and prices and some of the results seem to be at odds with each other.

The second principle is the desirability of a credible commitment to a fixed rule for monetary policy. It has been suggested that there may be a substantial gain if the central bank is committed in advance to a set policy, rather than being free to exercise unconstrained discretion. Discretionary policymaking is regarded as period-by-period choice of instrument settings that appear to be optimal with respect to goal variables (McCallum 1990, p. 6). Policymaking according to a rule exists when the authority chooses not to attempt optimizing choices on a period-by-period basis but chooses to implement in each period a formula for setting its instrument that has been designed to apply at all times, and not just to the current period (McCallum 1987, p. 10). Kydland and Prescot (1977) developed a formal model of rules versus discretion, which Barro and Gordon (1983) elaborated on. Kydland and Prescot brought the concept of dynamic inconsistency to macroeconomics in this context. Before that it appeared that discretion dominated rules. "Dynamic inconsistency occurs when a future policy decision that forms part of an optimal plan formulated at an initial date is no longer optimal from the viewpoint of a later date, even though no new information has appeared in the meantime" (Fischer 1990, p. 1169). In the next section a simple Phillips-curve example (closed-sector model) of dynamic inconsistency by Fisher (1990, pp.

[6]Monetary policy do effect on real variables, output and employment, in the short run.

[7] This problem is depending on the stability and predictability of the velocity.

1169-1176) is presented to illustrate the possible superiority of rules over discretion.

3.1 Rules versus discretion

In the context of rational expectations, the rules-versus-discretion debate arises from the claim that policy will be dynamically consistent if determined by rules. By contrast, a policy with discretion may be expected to make the short-run optimal decision every time it is possible and therefore gains nothing from opportunism. On average, discretion produces a worse outcome than does a rule.

Suppose that the policy-maker has a single period loss function quadratic in the rate of inflation (π) and in the deviation of real output (y) from a target level (y*):

$$L() = a\pi^2 + (y - ky^*)^2, \quad a > 0, \ k > 1. \tag{3.1}$$

The target level for output exceeds the natural rate. The assumption k > 1 is crucial. The most plausible justification is that tax distortions cause the natural rate of employment to be too low, which allows the loss function L( ) to be consistent with the single period utility function of private agents. An alternative view is that the government tastes differ from those of the private sector. However, dynamic inconsistency may occur whether or not they have the same tastes. The intertemporal loss function, a discounted sum of the form

$$M_t() = \sum_{0}^{\infty} (1 + \delta)^{-i} L_{t+i}(), \tag{3.2}$$

may more plausibly differ between private sector and government. An expectational Phillips curve describes the relationship between output and inflation in each period, where π^e is the expected rate of inflation:

$$y = y^* + b(\pi - \pi^e). \tag{3.3}$$

In a one-period game, the policymaker first sets the inflation rate. Under discretion the expected inflation rate is taken as given, implying

$$\pi = (a + b^2)^{-1} b[(k - 1)y^* + b\pi^e]. \tag{3.4}$$

If expectations are correct, the inflation rate will be positive at the level

$$\pi_d = a^{-1}b(k-1)y^*. \tag{3.5}$$

Subscript (d) represents discretion. The inflation rate is higher the larger the value of (b), and thus the greater the output gain from unanticipated inflation, the greater is the distortion (k-1)y*, and the smaller the value of (a) (the less costly is inflation). The implied value of the loss function under discretion is

$$L_d = (k-1)^2 y^{*2}(1 + a^{-1}b^2). \tag{3.6}$$

This equilibrium is worse for the government (and, with the same utility function, for the private sector) than a zero inflation equilibrium. The zero inflation equilibrium, the precommitment solution, gives a value of the loss function

$$L_p = (k-1)^2 y^{*2}\ , < L_d. \tag{3.7}$$

Why does the policymaker not choose an inflation rate of zero, thereby attaining L_p rather than L_d? Under the rules of game, in which the private sector commits itself first to a given π^e, $\pi = \pi^e = 0$ is not a Nash equilibrium. If the private sector has committed itself to $\pi^e = 0$, the policymaker will choose the positive rate of inflation given by (3.4). The inflation rate in (3.5) is the Nash equilibrium which, if expected by the private sector, will be implemented by the government. If the policymaker could somehow commit herself to choosing $\pi = 0$, she could obtain L_p.

Furthermore, the inflation rate and the value of the utility function in the case where individuals are fooled into expecting the policymaker to obtain zero inflation but where she instead acts opportunistically, are as follows. With $\pi^e = 0$, the optimal discretionary inflation, from (3.4), is

$$\pi_f = (a + b^2)^{-1}[b(k-1)y^*], \tag{3.8}$$

and the corresponding value of loss function is

$$L_f = (1 + a^{-1}b^2)^{-1}(k-1)^2 y^{*2}. \tag{3.9}$$

Thus

$$L_f = (1 + a^{-1}b^2)^{-1}L_p = (1 + \theta)^{-1}L_p, \qquad (3.10)$$

and

$$L_d = (1 + a^{-1}b^2)L_p = (1 + \theta)L_p. \qquad (3.11)$$

$\theta = b^2/a$ is, loosely, a measure of the utility gain from unexpected inflation: (b) gives the increase in output and (a) the utility loss from higher inflation. Thus we have the fundamental set of inequalities that demonstrates the benefits of precommitment

$$L_f < L_p < L_d. \qquad (3.12)$$

The discretionary solution produces the largest loss, with a positive rate of inflation and no output gain. The policymaker is supposed to want to choose a zero inflation rate to attain L_p. But the government is tempted to violate expectations if the private sector is lulled into expecting zero inflation, because the loss function is lower when the government succeeds in fooling the private sector than when it acts consistently ($L_f < L_p$). But in striving to obtain output gains by fooling the private sector, the government succeeds only in raising the inflation rate and producing the worst of the three outcomes in (3.12).

Hence, according to Kydland and Prescott, policymakers should be constrained by a rule. That would enable them to achieve the precommitted solution, which is not the best possible but is better than the discretionary alternative. Therefore by committing itself in advance not to try to create monetary surprises, the government can lower expected inflation and achieve better performance.

Although there may be agreement among economists that some kind of a rule is desirable as it reduces uncertainty about monetary policy and can increase its credibility, (since it has been recognized that expectations about future economic developments exert an important influence on current economic behaviour), the issue is not closed, as the above brief survey of the practice of central banks illustrates. One argument for discretionary policy is that it leaves the policymaker the flexibility to respond rapidly to unanticipated changes that are not foreseen or are not describable in the potential rule (Fisher 1990, p. 1179). Furthermore, criticism of Friedman (1993, p. 2) asserts that these unanticipated changes in financial markets, and for the foreseeable future, will be ever-present and ongoing to a sufficient extent as to spoil any attempt to achieve a successful monetary policy by following a rule based on a predetermined intermediate target. The underlying idea of the proponents of discretion is, therefore, that variations in monetary conditions reflect shifts in the demand and supply of money due to a variety of factors. These shifts and factors can be ascertained and estimated by the policymakers. Therefore, since the effects of monetary policy will depend on the nature of the disturbance, the policy response is best determined discretionally.

(Guitián 1994, p. 4)

The effects of deregulation and liberalization of capital and financial markets are not considered in the simple model of rules vs discretion above. However, in conducting monetary policy an international perspective has to be taken into consideration. Monetary policies, to be effective, whether based on rules or discretion should not run counter to fundamental market forces nor accommodate market developments that are not in accordance with those fundamental forces. Policy adaptations in these circumstances is the moral hazard created by such policy responses. Markets internalize the freedom they are thus granted from their own discipline and, as a result, governments assume the costs and risks of developments that do not reflect fundamental trends. In this context, Guitián (1994, p. 20) proposed that rule-based regimes may have an advantage over discretionary policy if their design and implementation are consistent with the existence of global markets. To the extent that they confine policy adaptations, they will also contain the tendency to yield to market pressures and thus they will help to contain moral hazard risks. On the other hand, discretionary regimes, which underscore the importance of flexible policy implementation and therefore are less transparent, are likely to find it difficult to resist market pressures and to incur in the consequent risks.

Therefore, there are reasons to believe that rules might outperform discretion. Thus we continue by explaining the characteristics of a good rule, and why a nominal income rule is a possibility for the conduct of monetary policy.

3.2 Characteristics of a good rule

In evaluating the desirability of a particular rule, there are four principal characteristics to consider according to Hall & Mankiew (1993, pp. 4-5). The first is *efficiency*. A good rule should deliver the minimum amount of variability for a given level of employment variability and it should deliver satisfactory performance across a wide spectrum of macro models. The second characteristic is *simplicity*. A rule that is simple has a better chance to be adopted and a better chance of continuing to be enforced. The third characteristic is *precision*. With a precise rule there is no doubt as to whether the central bank is adhering to the rule. And finally, the fourth characteristic is *accountability*. Monetary policy is more credible if the citizens can hold the central bank responsible for monetary policy.

Furthermore McCallum (1987, pp. 12-13) has emphasized four principles that should be respected in the design of a monetary rule. First, the rule should set the behaviour of a variable that the monetary authority can control directly and/or accurately. Second, the rule should not rely in any essential way on a presumed absence of regulatory change and technical progress in the financial industry. Third, neither money stock nor (nominal) interest rate paths are important for their own sake; these variables are relevant only to the extent that they are useful in facilitating good performance in terms of inflation and output or employment magnitudes. And fourth, a well-designed rule should recognize the limits of macroeconomic knowledge, i.e. in the absence of a single superior macro model, a good rule should perform well in a wide variety of models.

It is worth noting that these principles of a good rule are presented by advocates of nominal income targeting and may therefore be biased in favour of such targeting. Furthermore, it may be difficult to design a rule which would observe all of these principles. For example, a precise rule which would be successful and is modeled efficiently enough to persuade the sceptics of nominal income targeting would hardly be simple to the public or the policymakers.

In several studies nominal income is targeted by using a monetary aggregate (another procedure would be to use a short-term interest rate). In order to conclude that such monetary targeting rules would be useful in practice as well as in principle, three requirements can be cited (Feldstein & Stock 1993, pp. 9-12): a sufficiently stable link between money and nominal GDP, satisfactory behaviour of the monetary authority and a limited system response to changes in monetary policy.

Finally, Friedman (1993, p. 2) has pointed out that in a discussion of how to conduct monetary policy, the most important question is whether it is possible to identify before the event a set of regularities of sufficient centrality and robustness to provide the qualitative and quantitative bases for sound policymaking.

3.3 Nominal income as an intermediate target

One possibility for a monetary policy rule is to use nominal income as an intermediate target. In most of the studies, nominal gross domestic product (GDP) is generally used as the measure of nominal income (nominal GNP is also used sometimes). By definition, nominal GDP equals the product of real GDP and the price level. Similarly, the growth of nominal GDP equals the sum of real GDP growth and inflation. From the quantity theory of money, nominal GDP is the product of money and velocity.

3.3.1 The potential benefits of nominal income targeting

One argument for the nominal income rule emphasized by early advocates of this rule is that the public would understand and believe the logic behind the nominal income targeting rule better than the logic behind e.g. the money supply targeting rule. The public is assumed to be more interested in movements in aggregates such as output, price level and employment, which are precisely those aggregates which the nominal income rule policy directly targets.

In the short run, changes in nominal GDP growth produce similar changes in real GDP growth with little or no impact on inflation. In the long term, changes in nominal GDP growth are, by contrast closely related to inflation, having no impact on real GDP. Since, in the long run real GDP grows at a fairly constant trend, long-run inflation will tend to equal nominal GDP growth minus the trend growth of real GDP. (Clark 1994, p. 12) For example, if the trend rate for real GDP growth is 3 percent, the central bank could achieve a long-run inflation goal of 2 percent by maintaining nominal GDP growth at 5 percent.

In addition, there are in principle two potential benefits of nominal GDP targeting. First, monetary policy would adjust to offset disturbances to aggregate demand. In the short run, an adverse aggregate demand disturbance, such as a fall in exports resulting from a recession in a major trade partner, tends to slow real GDP growth and, accordingly, nominal GDP growth. In response to this drop in nominal GDP growth below the target rate, the central bank would ease monetary policy so as to return nominal GDP growth to its target. This would stimulate aggregate demand and return both demand and real GDP growth to their predisturbance levels.

Second, in the case of an adverse supply disturbance, nominal GDP targeting would help the central bank to balance the goals of stable growth and inflation. In the short run, such a supply disturbance, e.g. an increase in oil prices, would cause falling real GDP and rising inflation (i.e. stagflation). These undesirable consequences pose a dilemma, since changing monetary policy to stabilize one variable promotes additional volatility in the other. For example, in a case of a rise in oil prices, easing monetary policy to stimulate the economy would limit the fall in real GDP growth but would accelerate inflation, whereas tightening monetary policy to stabilize inflation would worsen the decline in real GDP[8]. Nominal GDP targeting would help this dilemma by placing equal emphasis on the stability of each of these variables. For example, if an increase in oil prices caused real GDP growth to fall by 1 percent and inflation to rise by 0.5 percent, it would reduce nominal GDP growth by 0.5 percent. Monetary policy would respond to this by stimulating the economy enough to raise nominal GDP growth back to its target level. As a result, in a simple model of aggregate demand and supply, the same precise amount by which real GDP falls and inflation rises depends on the slope of the aggregate supply curve, say for example by 0.75. (Clark 1994, pp. 12-13) A more detailed analysis is presented in the context of theoretical studies in section 4.2.

Nominal GDP targeting may be implemented by a variety of targeting procedures. Either the level or the growth rate of nominal GDP can be targeted. Such targeting can also be subdivided into lagged adjustment rules and forecast adjustment rules. The former means that monetary policy would change when actual nominal GDP is observed to deviate from target. The latter means that monetary policy would change when projected future nominal GDP deviates from target. Furthermore, the monetary authority might use a simple formal rule or discretion in adjusting monetary policy. Typically a nominal GDP rule entails the adjustment of an instrument variable of monetary policy (e.g. the monetary base or a short-term interest rate). A rule would specify when and by how much the central bank should adjust policy to deviations from the nominal GDP target. In the discretion case, the central bank could for example monitor the actual rate of nominal GDP growth relative to target, along with other indicators, in making discretionary adjustments to monetary policy. As mentioned earlier, a rule-based policy is argued by some analysts to be superior since it would produce lower inflation than a discretionary policy. A number of specific formal rules have been proposed, and some of the advocates of these rules stress that these rules might also be used as baseline paths around which discretionary policy decisions could

[8]Another strategy would be to simply wait for the recession and unemployment to lower prices sufficiently for the economy to return slowly to the predisturbanced level.

be oriented, rather than as strict rules.

The alternative intermediate target usually compared to nominal income is a monetary aggregate in a floating exchange rate system. There are three possible advantages of the former over the latter, according to McCallum (1990, p. 7). First, the average rate of nominal income growth needed to yield a desired average inflation rate over an extended span of time can be more accurately determined. There is uncertainty concerning the average growth rates of monetary aggregate velocities and therefore to the growth rate of a monetary aggregate that would yield low and steady inflation. Second, the maintenance of a steady growth rate for nominal income has better automatic stabilization properties in response to money-demand and saving-investment shocks. And third, regulatory changes and technological innovations in the payments industry require revisions in the operational measures of the money stock. On the other hand, it may be emphasized that the data for monetary aggregates are published considerably earlier than for nominal income, which can be seen as an argument for a monetary aggregate.

4 A survey of the literature on nominal income targeting

4.1 How to evaluate and model hypothetical policy rules

Poole (1970) studied how to set monetary policy optimally in a simple IS-LM model. Poole's innovation was to shift attention from particular outcomes of policy actions to the properties of the distributions of the variables of interest to policymakers, such as the mean and variance of inflation, output or unemployment. He studied how the joint distribution of output and the nominal interest rate were influenced by the stance of monetary policy. Poole studied two rules (a rule that fixed the interest rate and a rule that fixed the money supply) testing two types of shocks to the economy. Shocks to the goods market and shocks to the money market. His famous conclusion was that using the money supply as an instrument was preferred if the output deviation is mainly due to shocks to the goods market, whereas shocks to the money market are best eliminated using the interest rate as an instrument.

Methods such as Poole's allow researchers to model policy from outside the actual policymaking environment. These methods give policymakers a specific set of rules for policy and then allow researchers to study how well, on average, a model economy adopting these rules would perform.

The early proposals of nominal income targeting were made, for instance, by Meade (1978), and Tobin (1980). The arguments behind the earlier proposals are for the most part informal, not relying on an explicit model. Bean's (1983) analysis is an exception.

4.2 Theoretical studies

Bean (1983) developed a theoretical analysis of nominal income targeting, examining the properties of such a policy in a stochastic macro model under rational expectations. Given that the monetary authority's objective is to minimize the divergence of output from its full information (equilibrium) level, nominal income is the optimal policy if labour supply is perfectly inelastic. This includes both demand and supply side shocks. With an elastic labour supply, however, nominal income targeting provides the optimal response to demand side shocks but not to supply side shocks. Even if labour supply is elastic, nominal income targets would still perform better than monetary targets in the case of productivity shocks if the price elasticity of aggregate demand is less than unity. Furthermore, according to Bean targeting the level of nominal income is preferable to targeting the growth rate.

In Bean's analysis of nominal income targets (adapted from Friedman 1990, pp. 1207-1209) firms are assumed to face a Cobb-Douglas production function.

$$x_t = \gamma_1[(p_t - E_{t-1}(p_t)) + \gamma_2 E_{t-1}(z_t)] + \gamma_3 z_t \tag{4.1}$$

Function (4.1) is the aggregate supply function where (x) is the log of output and (p) is the log of the price level and (z) is the technological disturbance to an underlying Cobb-Douglas production function. The three coefficients bear the structural interpretations:

$$\gamma_1 = \frac{1-\phi}{\phi},\ \gamma_2 = \frac{\theta}{\phi+\theta},\ \gamma_3 = \frac{1}{\phi}, \tag{4.2}$$

where $-1/\phi$ is the wage elasticity of labour demand ($(1-\phi)$ is the labour coefficient in the production function) and $1/\theta$ is the wage elasticity of labour supply. Function (4.3) represents the aggregate demand relation

$$x_t = \psi(m_t - p_t) + e_t, \tag{4.3}$$

where (m) is the (logarithm of) money supply and is taken as the exogenous policy instrument. Stochastic shocks (z) and (e) in (4.1) and (4.3), are serially correlated and each consists of the sum of a permanent component which follows a random walk, and a transitory component which is white noise. Bean posited that the objective governing monetary policy is to minimize the variance of real output around the corresponding equilibrium value in the presence of a supply shock (z), which for (4.1) is

$$x_t - x_t^e = \gamma_1[(p_t - E_{t-1}(p_t)) + \gamma_2(z_t - E_{t-1}(z_t))]. \tag{4.4}$$

Given observations on the endogenous variables in period t-1, the policy that minimizes $E_{t-1}(x_t - x_t^e)^2$ in the presence of rigid nominal wages is a feedback rule which relates m_t to the random walk components of (z) and (e) in period t-1, but not to the corresponding white noise components. Either fixing the money stock at $m_t = 0$ without reacting to this information or using nominal income as an intermediate target, i.e. setting m_t so that $E_{t-1}(x_t + p_t | m_t) = 0$, is in general inferior to this optimal feedback policy. The resulting variances are,

$$E_{t-1}(x_t - x_t^e)^2|_m = \sum^2 + \left(\frac{\gamma_1}{\gamma_1+\psi}\right)^2[\sigma_{ep}^2 + (\gamma_2(\gamma_1+\psi) - \gamma_3)^2)\sigma_{zp}^2] \tag{4.5}$$

and

$$E_{t-1}(x_t - x_t^e)^2|_{E_{t-1}(x+p)} = \sum^2 + (\frac{\gamma_1}{\gamma_1 + \psi})^2[\gamma_2(\gamma_1 + \psi) - \gamma_3 - \psi + 1]^2\sigma^2_{zp}, \tag{4.6}$$

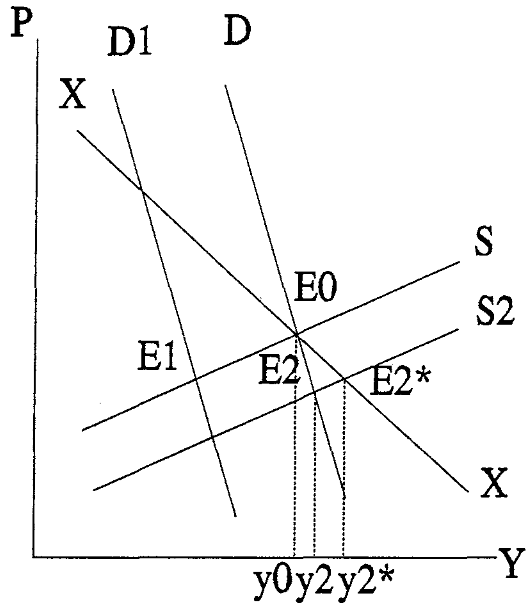
where $\sum^2$ is the minimum feasible value of $E_{t-1}(x_t - x_t^e)^2$ achieved by the optimal feedback policy. Parameters σ^2_{ep} and σ^2_{zp} are the one-period variances of the random walk components of the disturbances to aggregate demand and aggregate supply, respectively.

The policy of $m_t = 0$ is inferior to the optimal feedback rule because it always fails to take proper account of what is known about the demand disturbance. And, except when $\psi = 1$, it fails to consider the supply disturbance. The policy of setting $E_{t-1}(x_t + p_t) = 0$ eliminates the effect of the predictable component of the demand disturbance. But this is also inferior to the optimal feedback policy because it fails to take account of supply disturbance; except when $\gamma_2 = 1$, which from (4.2) implies an inelastic labour supply. The choice of these policies rests on the comparison between (4.5) and (4.6). Because a sufficient condition for the variance in (4.6) to be less than in (4.5) is $\psi < 1$ and because the available empirical evidence suggests a less than unity elasticity of real aggregate demand with respect to real balances, Bean drew the conclusion that nominal income as an intermediate target is preferable to monetary targeting.

West (1986) examined whether Bean's conclusions still hold if his aggregate supply function is replaced with an expectations-augmented Phillips curve (also called a Lucas supply function). In West's formulation expectations are assumed to be formed adaptively, shocks are serially uncorrelated and the desirability of policies is measured by their ability to reduce unconditional variance of output ($E_{t-1} = x_t^2$; note the difference as compared to Bean's policy objective). Otherwise West's model was similar to Bean's. In West's model, a nominal income target is preferable to money supply targeting if and only if the elasticity of demand with respect to real balances is greater than unity. This includes both supply and demand shocks. This necessary and sufficient condition is precisely the opposite of Bean's sufficient condition in the face of supply shocks. West noted that the contrast between the results are due to different aggregate supply functions and to different criteria for measuring the desirability of policies. This is illustrated in figure 2.

In figure 2, D and S are the demand and supply curves in an initial equilibrium with $y = y_0$. X is a constant nominal income line. Suppose that the only shock in this model is a demand shock in period 1 which pushes demand to D_1. (The illustration is similar in the case of a supply shock). Since price falls in period 1, supply shifts outwards in period 2 to S_2. Supply then slowly shifts back up towards S. Then the path followed by output depends on the monetary policy followed. First, a constant money supply rule is followed. Then demand shifts back to D in period 2, and equilibrium in period 2 is at E_2. In future periods, output shifts from y_2 to y_0. Instead, with a constant nominal income rule, the monetary authority adjusts the money supply so that nominal income from period 2 onwards falls on the X line. Since supply in period 2 is S_2, the equilibrium is at E^*_2. In future periods output shifts from y^*_2 to y_0. Thus nominal income targeting leads to greater variability of income. This results because D is steeper than X, i.e. because the elasticity of demand with respect to real balances is less than one. Nominal income would lead to less variability of income if the elasticity is greater than one. (West 1986, p. 1080-1081)

Figure 2 **Nominal income rule with demand shock**



Source: West 1986, p. 1080

Figure 2 also illustrates the role played by the different specifications of supply in Bean's and West's models. In both models, once a demand shock causes output to deviate from y_0, supply shifts. In West's model, the shift is such that nominal income targeting does not return output to y_0 until long-run equilibrium is achieved. In Bean's model, the shift is such that nominal income targeting does return output to its optimal level in the period following the shock. Hence in the face of demand shocks, nominal income targeting may or may not be optimal in West's model but it is optimal in Bean's model. Further, it can be seen that there is an inverse relationship between output and price variability. Therefore when nominal income targeting leads to less output variability it leads to more price variability than does money supply targeting and vice versa. Therefore the criteria for measuring the desirability of policies is part of the explanation of the difference between Bean's and West's results. (West 1986, pp. 1081-1082)

Bradley & Jansen (1989) also extended the results of Bean. They analyzed nominal income targeting in a model where nominal wages are indexed to the price level. They find that the combination of nominal income targeting and optimal wage indexing provides the optimal monetary response (perfect stabilization) to both demand and supply shocks, regardless of the elasticity of labour supply.

Jansen & Kim (1992) extended the work of Bean and Bradley & Jansen further to the case of an interest elastic and wealth elastic labour supply and came to contradictory conclusions. They summarized that Bean's and Bradley and Jansen's results, favouring nominal income targeting, both depend on their use of an interest and wealth insensitive aggregate supply curve. Including interest rate or wealth effects eliminates their perfect stabilization results. Furthermore, they concluded that nominal income targeting does not generally provide an optimal response to demand (IS/LM) shocks, even with wage indexing and even in the absence of supply shocks. They find that a fixed money supply rule may be perfectly stabilizing when wages are indexed to price and there are only IS shocks or only LM shocks. Nominal income targeting, however, even coupled with wage indexing to price will not be perfectly stabilizing in that case.

Furthermore, following the models of Bean and West, Asako & Wagner (1992) focused on the role of price expectations in the aggregate demand function. In their model aggregate demand is a function of both real balances and the expected inflation rate formed on the basis of current information (rational expectations). The aggregate supply function is an expectations-augmented Phillips curve, as in West's model. Asako & Wagner compared an activist rule of nominal income targeting with a passive rule of money supply targeting for different cases: supply vs demand shocks, temporary vs permanent shocks and with vs without the use of current information by the monetary authority. Their conclusion was that, contrary to Bean's and West's results, there is no simple condition under which one policy rule is universally favoured over the other. Only if there is rather certain knowledge on the source of shocks, on their persistence and on whether there is an information advantage of the authority, does a certain rule outperform another. This result sums up the section on theoretical studies and illustrates the complexity of monetary policy-setting in this context.

4.3 Lagged adjustment rules

In spite of the fact that the result of one theoretical model contradicts another, there are still reasons to believe that nominal income targeting rules might be a good procedure for monetary policy-setting. A theoretical proposal needs to be supported empirically before general acceptance (or rejection) can take place.

Policymakers have no experience with rules targeting nominal income and as a result, direct evidence is not available on their performance. Instead, statistical simulations are used to provide indirect evidence on how well the rules for nominal income targeting might perform. In the following, some of the empirical studies on nominal income targeting are presented, which are subdivided into lagged adjustment rules and forecast adjustment rules. A lagged adjustment rule dictates that monetary policy would change when actual nominal GDP is observed to deviate from the target.

4.3.1 McCallum's rule

McCallum (1984) proposed in qualitative terms a rule that respects all four principles of a good rule explained earlier in section 3.2, which he formalized in McCallum (1987). First, the rule began with the specification of a target path for nominal GNP that grows evenly at a prespecified rate equal to the economy's prevailing long-term average rate of real output growth. McCallum postulated that the appropriate figure would be about 3 percent per year in the United States. Hence, keeping the nominal GNP growth at that level should yield approximately zero inflation. Furthermore, he suggested that the prevention of fluctuations in nominal GNP growth should help to prevent swings of real output from its trend path. Second, an operational mechanism had to be specified for keeping nominal GNP growth close to the prespecified growth path. McCallum suggested using the monetary base as an instrument, since it can be controlled by the monetary authority. The rule would adjust the base growth rate each month or quarter, increasing the rate if nominal GNP is below its target path, and vice versa. The algebraic form is as follows, where b_t is log of the monetary base for period t, x_t is the log of nominal GNP and x_t^* is target path value for x_t:

$$\Delta b_t = \Delta b_{t-1} + \lambda(x_{t-1}^* - x_{t-1}),\ \lambda > 0. \tag{4.7}$$

The parameter λ has to be chosen so as to provide adequate responsiveness of base growth to departures of x_t from its target path but without inducing dynamic instability of the type that can occur when feedback effects are too strong. Furthermore, McCallum proposed another specification which would have better properties:

$$\Delta b_t = 0.00739 - (1/16)[x_{t-1} - x_{t-17} - b_{t-1} + b_{t-17}] + \lambda(x_{t-1}^* - x_{t-1}),\ \lambda > 0, \tag{4.8}$$

where 0.00739 is a 3 per cent annual growth rate expressed in quarterly logarithmic units. The second term subtracts the average growth rate of base velocity over the previous four years and the third term adds an adjustment response to cyclical departures of GNP from its target path.

McCallum tested whether this rule performs well in a variety of models as there does not exist one agreed-upon model. As mentioned earlier, McCallum claimed that there does not exist a satisfactory macro-model of the short-run dynamics of aggregate supply or Phillips-curve behaviour. Therefore, McCallum (1987, 1988, 1990) presented simulations with simple models that are regressions of nominal GNP on past values of itself and values of the monetary base (e.g. equation (4.11)), with a number of vector autoregression (VAR)[9] systems and three small models which were designed to represent three competing theories concerning the interaction of nominal and real variables: the real business cycle theory (RBC) of Kydland and Prescot, the monetary-misperceptions theory (MM) of Lucas and Barro, and a more Keynesian theory patterned on the Phillips-curve and price-adjustment specifications of the Fed's quarterly MPS model.

The models were estimated with quarterly seasonally-adjusted data for 1954.1-1985.4, and the simulations were conducted over the same period with each quarter's residuals fed into the system as estimates of shock realizations. In the

[9] The VAR systems included the following variables: real GNP, GNP deflator, monetary base, 90-day Treasury bill rate, real government purchases of goods and services and trade-weighted value of the dollar.

simulations, b_t values generated by rule (4.8) were used instead of actual historical values. For each model and values of λ, ranging from 0.0 to 0.5, root-mean-square error (RMSE)[10] values were calculated. McCallum concluded that rule (4.8) performed well for λ values in the range of 0.1 to above 0.25 with all five models. The performance is clearly superior to $\lambda = 0$. Higher values induce the possibility of dynamic instrument stability (e.g. with $\lambda = 0.5$ in the VAR system). Therefore, with moderate values of λ, the x_t values were kept close to the x_t^* target path, thus implying inflation rates close to zero for the period. Main results are summarized in table 1. For comparative purposes, the RMSE value for the actual historical path is 0.771, and the RMSE for the actual historical path relative to a fitted trend line is 0.0854, which may be a more relevant comparison (McCallum 1994, p. 40).

Table 1 **McCallum's rule: Basic results for U.S. economy, 1954-1985. RMSE values with five models.**

Model	Value of λ in rule (4.8)			
	0.00	0.10	0.25	0.50
Single equation	0.0488	0.0249	0.0197	0.0162
4-variable VAR	0.0479	0.0216	0.0220	0.1656
Real business cycle	0.0281	0.0200	0.0160	0.0132
Monetary misperception	0.0238	0.0194	0.0161	0.0137
Phillips curve	0.0311	0.0236	0.0191	0.0174

Source: McCallum 1994, p. 13

Furthermore, McCallum considered alternative rules in order to determine whether a policy rule comparable to (4.8) could be devised that would be effective in promoting a smooth and non-inflationary path for the price level. A rule is provided by a modified version of (4.8) in which the final cyclical adjustment term $\lambda(x^*_{t-1} - x_{t-1})$ is replaced with a counterpart that pertains to the price level. Target values of p^*_t are assumed to be constant over time:

$$\Delta b_t = 0.00739 - (1/16)[x_{t-1} - x_{t-17} - b_{t-1} + b_{t-17}] + \lambda(p^*_{t-1} - p_{t-1}). \qquad (4.9)$$

The same simulations as with rule (4.8) indicate that successful stabilization of p_t is obtained with the VAR, RBC, and Lucas-Barro models. However, the RMSE values are quite large for the Phillips-curve model and explosive oscillations are encountered with λ values equal to 0.25 or greater. The following modification was also investigated:

[10] E.g. the RMSE value of 0.0197 in table 1 indicates that the root-mean-squared deviation of nominal GDP from its target path is about 2.0 percent.

$$\Delta b_t = -(1/16)[p_{t-1} - p_{t-17} - b_{t-1} + b_{t-17}] + \lambda(p^*_{t-1} - p_{t-1}), \qquad (4.10)$$

which gave less satisfactory results than rule (4.8).

The RMSE values for real GNP (for $\lambda = 0.1, 0.25$) were calculated relative to fitted trend with each of the four models to provide some indication of the cyclical effects on real variables provided by the different rules. In RBC model, monetary policy has no effect on the evaluation of real output, so the RMSE values are same for all three rules. The Lucas-Barro theory presumes that monetary actions can have real effects, but only if unanticipated. As all the rules are deterministic, none gives rise to monetary surprises and nor hence to output movements. The same RMSE values prevail for all rules. By contrast, in the VAR system the RMSE values are just slightly smaller with the nominal income target rule (4.8) than with rules (4.9) and (4.10). With the Phillips-curve model real GNP variability is small with rule (4.8) but very large with rule (4.9) and even larger with (4.10). From these results McCallum concluded that rules (4.9) and (4.10) are not as robust for modelling the specification as is rule (4.8).

McCallum also considered short-term interest rate as an alternative variable for use as the operating instrument for monetary policy in nominal income targeting and it appeared that rules with short-term interest rate were somewhat less robust than with monetary base. This result requires special attention, since several other proposals of rules for nominal income targeting call for the adjustment of a short-term interest rate to keep nominal income on target (see sections 4.3.4 - 4.4). For example, Judd & Motley (1993) suggested that whenever the last quarter's annualized nominal GDP growth rate deviates from target by one percentage point, the central bank would adjust the short-term interest rate by 0.20 percent. In contrast, in a similar study by Clark (1994) with parameter value 0.20 the lagged adjustment rule fails. However, while policymakers have no direct control over nominal income, they do have a strong influence on short-term interest rates[11]. Through open market operations, for example, policymakers can increase the degree of pressure on reserve positions, thereby causing the short-term interest rate to rise. Short-term interest rates are widely used instruments in central banks and therefore interest-based rules seem to be attractive because they offer the advantage that they involve little change from central banks' current policy-setting practices.

In addition to his earlier studies McCallum (1994) considers other targeting methods. Namely, expressing the target in terms of growth rates, rather than levels corresponding to a single predetermined growth path. The main reason for a growth-rate target according to McCallum is that, since real shocks that affect the economy's natural-rate output level are highly persistent, it may be undesirable to drive quickly x_t to the predetermined x_t^* path after shocks have occurred. Instead, it would seem preferable to treat past shocks as bygones, which could be accomplished by adopting $x_t^{**} = x_{t-1} + 0.0739$, rather than $x_t^* = x_{t-1}^* + 0.0739$, as the target value for period t. This sort of rebased growth-rate target has two additional merits. First, instrument variability should be reduced for any given value of λ. And second, it should accordingly be possible to use larger λ values,

[11]See e.g. Dale & Haldane 1993.

implying stronger feedback, without inducing instrument variability.

According to McCallum's simulations, a rule which would use a weighted average of x_t^* and x_t^{**} as the target variable would be superior. In table 2 simulation results for the same period as in table 1 are summarized with $\lambda = 0.25$ and $x_t^{*a} = 0.2x_t^* + 0.8x_t^{**}$ as the target variable. The RMSE values relative to the x_t^{*a} target are only about 0.01. Furthermore, the variability of the Δb_t instrument is reduced considerably relative to its magnitude in the simulations of table 1, in which x_t^* is the target.

Table 2 **McCallum's rule: Additional results for U.S. economy, 1954-1985. Results with x_t^{*a} target value and λ=0.25**

MODEL	RMSE relative to x_t^{*a}	RMSE relative to x_t^{**}	RMSE relative to x_t^*	Standard deviation of Δb_t	Standard deviation of Δb_t using x_t^* target
Single eq.	0.0102	0.0104	0.0244	0.0041	0.0063
4-var. VAR	0.0104	0.0105	0.0218	0.0039	0.0069
RBS	0.0105	0.0109	0.0197	0.0043	0.0054
MM	0.0110	0.0116	0.0184	0.0039	0.0051
Phillips	0.0104	0.0103	0.0234	0.0048	0.0066

Source: McCallum 1994, p. 13

McCallum has continued to study and modify his earlier rule. A recent contribution is a rule which involves smoothing week-to-week movements of an interest rate instrument so as to achieve quarterly-average intermediate targets for the monetary base, with these specified so as to keep nominal income growing steadily at a noninflationary rate (McCallum 1994).

If the central bank were to target nominal income with McCallum's rule, it would require forecasts of the velocity of the monetary base. McCallum uses the four-year moving average (MA) velocity growth over the past four years as a forecast of the next quarter's velocity growth. Dueker (1993) made comparisons of models of monetary policy that use the MA method and an alternative, a time-varying coefficient (TVC) regression model with heteroscedastic errors. The TVC model includes not only past values of dependent variable, but also a host of explanatory variables. The advantage is that the TVC model can adapt to structural breaks in the relationship between the dependent and explanatory variables. A comparison of these methods showed that the MA forecasts display much less variation than forecasts from the TVC model and the mean-squared forecast error for the MA is more than three times that of the TVC model. Simulations were conducted with these two types of forecasting methods. The constant term (the growth rate of target nominal GDP) in equation (4.8) was changed to be a parameter λ_0. Then the parameter values for λ_0 and λ were chosen to minimize the mean-squared error between actual monetary base growth and the model-implied base growth. The simulation results show that these alternative models explain base growth with a fairly similar success, while implying dramatically different target paths for nominal GDP. Furthermore, Dueker concluded that a rebased target, such as in table 2, appears to outperform both above-mentioned targeting procedures.

4.3.2 Nominal income targeting in a small open economy

Although McCallum's rule assumes a closed economy setting, the rule has been simulated successfully for a number of small open economies. See for example Hall (1990) for Germany, Japan and Canada. McCallum (1987) suggests the possible replacement of nominal GNP with some other measure of nominal aggregate demand, e.g. real GDP multiplied by the consumer price index, as a response to the open-economy criticism. One disadvantage in applying a nominal income targeting rule to a small open economy is that it does not allow for potential feedback considerations arising from the exchange rate. A related feature is the need to consider periodic switches in the degree to which monetary policy uses feedback from the exchange rate, according to Dueker and Fisher (1994). They also claim that in small open economies exchange-rate concerns have occasionally led to disruptions in the path of money growth. Therefore they argued that a constant parameter model, such as MacCallum's rule, is not likely to uniformly explain monetary policy choices in small open economies.

Dueker and Fisher (1994) extend McCallum's rule to an inflation targeting rule for a small open economy (Switzerland), by allowing for feedback from the gap between the exchange rate and a baseline rate. The parameters are estimated using a Markow switching model, instead of setting parameters in a McCallum-type. This type of model with discrete parameter changes should succeed in capturing sudden changes in the policy regime regarding whether or not monetary policy admits feedback from the exchange rate. The objective of their study is to examine the legitimacy of an inflation targeting rule for Swiss monetary policy. According to their conclusions, their model provides Swiss monetary policy a guide, which could be used as a policy indicator.

Bordes (1993) did a simulation, based on McCallum's rule in order to examine how the Finnish economy would have developed over the past few years if recent policy had prevailed also earlier. The simulation was based on the following assumptions: First, the final objective of the authorities is an annual growth of 6 per cent in nominal GDP (hence the annual growth rate in potential real GDP is nearly constant at about 3 per cent; this should yield about 3 per cent inflation). Second, in the short-term, monetary policy is applied to stabilize the economy. And third, monetary policy takes into account a possible instability of monetary behaviour. The monetary rule corresponding to equation (4.8) is combined with a simple model of nominal GDP determination:

$$\Delta x_t = a_0 + a_1 \Delta x_{t-1} + a_2 \Delta b_{t-1} + RES. \tag{4.11}$$

The simulation indicates that with $\lambda = 5$, nominal income would have followed the target path quite closely. This, however implies an extra 20 per cent change in monetary base per year for each 1 per cent deviation of nominal GDP from its target path, which is clearly unrealistic. Bordes, however, emphasized that the monetary base is not the best instrument to consider, due to the institutional characteristics of the Finnish monetary system.

4.3.3 Monetary aggregate in a nominal income rule

Feldstein & Stock (1993), using U.S. data studied the possibility of using a monetary aggregate to influence the path of nominal GDP with the ultimate goal of reducing the average rate of inflation and the instability of real output. The statistical tests which they presented show that M2 is a useful predictor of nominal GDP. Tests for parameter stability failed to reject the hypothesis that the M2-GDP link is stable, but the M1-GDP and monetary base-GDP relations were found to be highly unstable. This contradicts the proposals, such as Milton Friedman's, that the M2-GDP relation is so unstable in the short run that it cannot be used to reduce the variance of nominal GDP growth. Furthermore, it contradicts McCallum's rule since he used monetary base as an instrument in his proposal.

Feldstein & Stock used M2 in their study to target the quarterly rate of growth of nominal GDP. They presented an optimal rule based on a VAR and a partial-adjustment rule that approximates the effect of the optimal rule. This optimizing rule reduced the mean ten-year standard deviation of annual GDP growth by over 20 per cent. Although there is uncertainty about this value due to the parameter instability and stochastic shocks to the economy, they estimated that the probability that the annual variance would be reduced over a ten year period exceeded 85 per cent. Since their rule involves multiple lags of several variables and therefore would be rather complicated to follow, they presented a simpler policy rule which would be easier to explain and to implement. This money growth rule has the partial adjustment form,

$$(m_t - \mu_m) = \lambda(\mu_x - x_{t-1}) + (1 - \lambda)(m_{t-1} - \mu_m) \qquad (4.12)$$

where m_t and x_t are the growth rates of M2 and nominal GDP respectively. μ_X is the target growth rate of nominal GDP, μ_m is the mean money growth rate, and $0 < \lambda < 1$. Thus money growth adjusts by a fraction λ when realized GDP growth in the previous quarter deviates from its target value by the amount μ_x - x_{t-1}. Feldstein & Stock suggested that long-run money demand is well-characterized as a cointegrating relationship between money, nominal GDP and interest rates, with a unit income elasticity. If interest rates are integrated of order one, I(1), with no drift, velocity growth has mean zero. Thus μ_m is set to equal μ_X, and the rule simplifies to

$$m_t = -\lambda x_{t-1} + (1 - \lambda)(m_{t-1}). \qquad (4.13)$$

This simpler rule produced nearly as good results as the optimal rule. The fraction of simulated decades of improved performance for nominal GDP was 70 per cent, compared with 88 per cent under the optimal rule, but 85 per cent of the simulated decades have reduced annual nominal GDP volatility. With both rules the improvements in inflation and real output variability are less than for nominal GDP.

Even if the link between a monetary aggregate and nominal GDP seems to be stable in the U.S., there are problems in implementing this kind of strategy. One is that the potential monetary aggregate has to be under the control of the central bank, which is not usually the case. Feldstein & Stock explained that regarding their proposal the central bank could control quarterly M2 growth completely by extending reserve requirements to all of the components of M2.

In the following sections (4.3.4 - 4.4) the monetary policy rules discussed call for adjustments of a short-term interest rate instead of a monetary aggregate.

4.3.4 Comparison of monetary policy rules in multi-country models

Flood and Mussa (1994) report the results of Bryant, Hooper and Mann (1993), BHM, where nine multi-country econometric models were used to simulate the effects of adopting a set of monetary policy rules. The rules studied are: (4.14) a money targeting rule, (4.15) a nominal income targeting rule, (4.16) a combination inflation and real output targeting rule, (4.17) an exchange rate targeting rule:

$$i_t - i^*_t = -5 \log (M^*_t / M_t) \quad (4.14)$$

$$i_t - i^*_t = -1.5 \log [(PY)_t / (PY)^*_t] \quad (4.15)$$

$$i_t - i^*_t = -1.5 [(\pi_t - \pi^*_t) + \log (Y_t / Y^*_t)] \quad (4.16)$$

$$i_t - i^*_t = 2.5 \log (S^*_t / S_t) \quad (4.17)$$

where i is the short-term nominal interest rate, M is the monetary base, P is the price level, Y is real GNP or GDP, π is inflation, S is the nominal exchange rate. The asterisk superscript (*) denotes a target (baseline) value.

The simulations were done as follows: First the models were estimated country by country and behavioural parameters were taken to be invariant to changes in policy. The properties of residuals from the estimated equations set the stochastic structure for shocks in the simulations. Second, the regime-specific equations for short-term interest rates replaced previously relevant interest rate equations for all countries. Third, the model produced a simulated history based on the new policy by drawing new disturbances whose stochastic properties were similar to the historical ones. Rational expectations were assumed.

According to the results of the models, the nominal income-based rules (4.15), (4.16) clearly outperformed money targeting (4.14) and exchange rate targeting (4.17) rules, if the variance of real GNP and inflation are to be minimized. These results, however, have been criticized because of the unrealistic information available to policymakers in the nominal income-based rules. Therefore, Flood and Mussa used a small-scale open-economy model, basically a realistically parametrized version of the Mundell-Fleming-Dornbusch model, to simulate the results of BHM rules with more realistic information assumptions for policymakers. They also allowed the assumption of uncovered interest rate parity to be relaxed, if desired. Their findings reinforced the earlier results. The nominal income targeting rule gave superior performance when judged on the basis of the variances of output and inflation.

4.4 Forecast adjustment rules

Under a forecast adjustment rule, policymakers look forward, recognizing that an adjustment in current monetary policy probably will affect nominal GDP until two or three quarters in the future. Using forecasts of future nominal GDP, a forecast adjustment rule adjusts current monetary policy to try to offset expected future deviations of nominal GDP from target. (Clark 1994, p. 14) A variety of forecasting procedures have been proposed, and in the following two of these are presented.

Hall & Mankiew (1993) investigated three types of nominal income targets, which differ in how they respond to past shocks, to prices, and real economic activity. The first is growth-rate targeting: Keep the growth of nominal income as close to a constant as possible. The second is level targeting: Keep the level of nominal income as close as possible to a path that is prescribed, once and for all, at the time the policy is first put into effect. And finally, hybrid targeting: Keep the growth of nominal income over the coming year as close as possible to a constant plus the current percentage gap between real income and its equilibrium level. (Hall & Mankiew, p. 11)

Hall & Mankiew suggested that as the feedback from monetary change to nominal income is slow and as stabilizing nominal income through optimal control rules based on estimated causal relations between money growth and nominal income growth may lack robustness, control rules must be biased strongly toward inaction in order to avoid the possibility of unstable feedback. They proposed that forecasts could help to deal with the long lags and unstable feedback. The idea is that policy is too expansionary when today's forecast of nominal income a year or two hence is above the target for that time. Although it takes many months for monetary policy to affect actual income, the feedback loop from current monetary policy to current forecasts of nominal income a year or two in the future is quick and powerful. Within a few days of a change in monetary policy, the consensus forecast (of outside forecasters) changes to reflect expert opinions about the effect on all macro variables, including nominal income. Furthermore, as there are random unpredictable determinants of nominal income, the central bank cannot be expected to keep nominal income itself exactly on target. Therefore, a band of a few percentage points in either direction would have to be a part of a rule formulated in terms of nominal income itself. In that case, the public could not know if a deviation from a rule is the result of random events or because the central bank has deviated from the rule. Instead, if policy is stated in terms of a forecast for a year or two into the future, there is no need for any band and there would not be such uncertainty. Thus the argument for tying the central bank to outside forecasts rests in part on the principal-agent argument[12]. (Hall & Mankiew, pp. 11-14).

The predictive power of the consensus forecast was examined with regressions of the change of the log of nominal GNP over four quarters on variables one might use to forecast this variable (prices, real GNP, and prices and real GNP

[12] A principal (the citizens) needs to set up incentives for their agent (e.g. the central bank) to deliver the result that the principal wants. The agent's own incentives can lead to behaviour quite undesirable for the principal.

together, growth in monetary aggregates and the Federal Funds Rate), including consensus forecast. These regressions indicate that substantial information is contained in the consensus forecast of nominal income and thus support the consensus as the target for monetary policy. (Hall & Mankiew, pp. 15-16)

How economic performance might have differed historically if the central bank had pursued a policy of targeting nominal income was examined in a simple model in terms of aggregate supply and aggregate demand, which allows for monetary-neutrality because of short-run price stickiness. All variables are in logarithms. Therefore, nominal income is the sum of price level and real income.

Under growth-rate targeting, the central bank tries to keep nominal income growth stable, but it allows base drift[13]. Therefore, growth in nominal income (x) is white noise around a constant mean (μ)

$$\Delta x = \mu + \varepsilon. \qquad (4.18)$$

This equation is interpreted as the aggregate demand schedule, where the policy rule is an endogenous element. The disturbance, ε represents the influence of factors that cause policy to miss the target, i.e. the error in consensus forecast, when policy is based on pegging the consensus forecast exactly. Under level targeting, no base drift is allowed. Therefore, nominal income obeys

$$x = \mu t + \varepsilon. \qquad (4.19)$$

Under the hybrid targeting, the central bank raises nominal income growth when output (y) falls below the natural rate (y^*), but it does not adjust nominal income growth when the price level deviates from target. Thus

$$\Delta x = + \mu + \varepsilon + (y^* - y)_{-1}, \qquad (4.20)$$

where the last term is the difference between potential and actual real output observed at the time the forecast is made. For all these policies the mean level of nominal income growth (μ) was set at 2.5 per cent per year. The model consists of an expectations-augmented Phillips curve, i.e. inflation depends on past inflation, the deviation of output from its natural rate, and supply shock (ν).

$$\Delta p = \pi + \lambda(\Delta p_{-1} - \pi) + \alpha(y - y^*)_{-1} + \nu, \qquad (4.21)$$

where π is the mean rate of inflation for the monetary region, λ measures the

[13] That is past shocks to nominal income, whether reflected in output or prices, do not influence future nominal income.

persistence of inflation, and α governs the short-run tradeoff between prices and output.

Hall & Mankiew drew the following conclusions based on simulation results. Table 3 shows the basic results under 4-quarter ahead and 8-quarter ahead targets.

Table 3 **Forecast adjustment rules: Performance under alternative 4- and 8-quarter ahead targets**

	Price level	Inflation (annual rate)	Output gap	Output growth (annual rate)
ACTUAL				
standard deviation	34.09	2.51	2.49	3.97
mean		5.74		
root mean squared deviat.		6.27		
SIMULATED, actual forecast errors		Standard deviations		
Growth 4(8)-Q ahead	4.43 (3.21)	3.26 (2.00)	5.15 (2.58)	18.60 (6.33)
Level 4(8)-Q ahead	1.92 (1.99)	2.14 (2.20)	3.20 (2.72)	6.64 (4.53)
Hybrid 4(8)-Q ahead	2.34 (2.26)	1.74 (1.58)	2.26 (1.90)	6.28 (3.56)
SIMULATED, perfect achievement of target (ε=0), 4-quarter ahead				
Growth and level	1.82	1.89	1.72	1.91
Hybrid	1.86	1.62	1.12	2.22

Source. Hall & Mankiew 1993, pp. 33-34

First, the volatility of the price level would have been much lower under any of these policies than it has been historically[14]. Although only the level-targeting policy would guarantee low volatility over a long period because with both the growth and hybrid policies an integrated (random walk) element was introduced into the price level. Second, these policies would have yielded a more stable inflation rate than has been experienced historically. The growth-rate target was less successful than the other policies. Third, the volatility of real income around its equilibrium level depends crucially on which policy target is considered. Only hybrid targeting delivered slightly lower volatility than actual historical volatility. Level targeting delivered above-actual volatility and growth-rate targeting doubled the actual volatility. Forecast errors were a major source of volatility when included. Thus the magnitude of the economic performance that would result from these policies depends crucially on how much forecasting would improve. Furthermore, the results indicated that a longer lead time (comparing 4- and 8-quarter ahead targets) for the forecasts could be desirable. Hall & Mankiew

[14]This statement, however, is only true when the historical volatility of inflation is measured by the root mean squared deviation of inflation, which is the variation of inflation about zero. If volatility is measured by the standard deviation of inflation (the variability of inflation about the historical mean rate of inflation), then the growth rule significantly raises inflation volatility above historical level as Clark (1994) pointed out.

concluded that a policy that combined features of the hybrid and level policies would dominate all others. (Hall & Mankiew, pp. 22-26)

These simulation results differ from Clark's (1994). He studied two growth rules, a forecast adjustment rule and a lagged adjustment rule, in two models. The first is an atheoretical model which relates current values of real GDP growth, inflation, M2 growth, and a short-term interest rate to previous values. The second is a structural model, which has a Phillips curve as an aggregate supply equation and the aggregate demand equation relates inflation to expected inflation and the gap between actual and potential real GDP. In his version of the forecast adjustment rule, policymakers would rely on their own projection for the next year in adjusting a current interest rate to keep projected nominal GDP growth on target.

He finds that the forecast adjustment rule succeeds at reducing volatility in real GDP growth and inflation contrary to Hall & Mankiew's growth rule. Furthermore, in simulations of Clark's models, hybrid rules failed. They raised volatility in both real GDP growth and inflation above historical levels, which conflicts with the results of Hall & Mankiew.

As seen, several kinds of rules for nominal income targeting have been proposed. In the next section some of the differences between rules which are divided into level or growth targeting and lagged or forecast adjustment are summarized and compared.

5 Comparison and criticism

5.1 Level targeting vs growth targeting

This distinction has no implication for the long-term inflation rate. However, it does have an effect on the optimal response of policy to short-term shocks to the economy. The key difference in these two approaches is that base drift is permitted in the target when attempting to stabilize the growth rate and when targeting the level around a constant path base drift is not allowed. Therefore, if the economy starts on the trend line, the two approaches are the same for the first period. But assuming a deviation from the target path during the first period implies a different adjustment for the second period. For example, not permitting base drift has the feature of leading to expansionary policy when nominal GDP is below its target path but is growing stably, for example at 3% per year and to contractionary policy when GDP growth is stable at 3% but GDP is above its target path. Likewise, level targeting would require contractionary policy after a positive productivity shock even though there had been no increase in inflation and expansionary policy with a negative productivity shock without a decrease in inflation.

Which of these two approaches is preferable can be summarized as depending on the type of shocks that are most likely to be encountered, the differential effects of money on real output and inflation, and the ultimate objective of monetary policy (Feldstein & Stock 1993, p. 4). The studies presented in this paper give contradictory results arising from the differences in the models and the methodology. However, especially recently, more proposals have been made based on growth rate targeting than level targeting. Also McCallum (1994), a famous advocate of level targeting has recently come to be an advocate of growth rate targeting.

5.2 Forecast rule vs lagged rule

In principle, the forecast adjustment rule should be superior to the lagged adjustment rule. The forecast rule adjusts policy now to prevent forecasted future deviations of nominal GDP from target. The lagged adjustment rule would adjust monetary policy only after nominal GDP actually deviates from target. Because of this delayed reaction and the lagged effects of monetary policy changes, several quarters may pass before policy succeeds in returning nominal GDP back toward the target.

In practice, however, forecasters make errors in predicting future movements in macroeconomic variables, including nominal GDP. If these errors are large and frequent, the lagged adjustment rule would be preferable. Therefore, the main argument concerns the magnitude of forecast errors. As analysts disagree on the magnitude of these errors, they disagree on which of these two approaches would better stabilize nominal GDP (Clark 1994, pp. 15-16).

5.3 Criticism

Nominal income targeting has generated an extended literature, both theoretical and empirical. As noted, there does not exist a rule which would dominate all others. One area of criticism thus arises from the fact that the results of several theoretical and empirical studies are conflicting. Since, for example, one targeting model differs only slightly from other models of the same type and yet produces different simulation results, these differences suggest that conclusions about rules drawn from simulations are sensitive to minor differences in models. Also some pieces of the simulation evidence differ considerably from most analysts' and policymakers' expectations about succesful policies (Clark 1994, p. 13).

Another problem according to Taylor (1985), who studied the effects of nominal income targeting on the business cycle, is that the instruments of monetary policy affect the components of nominal GDP, real GDP and inflation with different lags. The lag is longer for inflation than for output and occurs regardless of the policy instrument applied. Also data lags may create a problem. Data for nominal income are gathered only at a discrete time intervals and moreover, data for prices and output are published at different points of time (Asako & Wagner 1992, p. 180). One additional problem is the difficulty of estimating potential trend output and hence deviations from trend.

Furthermore, as mentioned earlier one potential benefit of nominal income targeting is the possible automatic countercyclical response to demand shocks, which will tend to stabilize output movements if prices are sticky. However, in response to supply shocks automatic policy responses may be counterproductive (McCallum 1990, 11-12). As an example, Taylor (1985) finds that nominal GDP rules that focus solely on the growth rate could always cause the economy to overshoot its equilibrium after shocks. This however can be dealt with by modifying the rule.

Another area of criticism is the vulnerability of the models to Lucas' critique. It is not certain that a shift of monetary policy in a way suggested by a certain rule would not change the parameters of the model. This problem cannot be resolved by empirical research and it applies equally to all exercises of this type. And finally, the debate on the rationality of rules versus discretion in general is still going on.

6 Testing McCallum's rule

Unfortunately, in economics there is no opportunity to conduct controlled experiments on actual economies in order to sort out the performance of monetary policy alternatives. Therefore policy simulations are constructed. These simulations are econometric models constructed from historical data, with the policy alternatives built in. Then it is hoped that the altered models behave as history would have behaved if the policies had actually been followed. Because these models are always deficient in various ways, McCallum (1988) recommended the reporting of results of policy simulations across a wide range of models rather than for just one particular model. However, because of the limited scope of this study, certain restrictions had to be made. Therefore, this empirical section reports a simulation based on McCallum's rule combined with a single-equation atheoretic determination of nominal GDP.

McCallum's rule was chosen for testing in this study because it is perhaps the best known rule. Furthermore, the rule has been quite successfully simulated also for Japan, Germany and Canada by Hall (1990). Also, as the only published study on nominal income targeting in Finland was done by Bordes (1993), who briefly studied McCallum's rule, it seemed natural to start by extending his study. In addition, McCallum's rule complies with the requirements for a monetary policy rule as set out in the literature and as explained in section 3.2.

The simulation of McCallum's rule has two other purposes. The first is to understand the uncertainties this type of simulation exercise involves. In other words, to find out how reliably conclusions can be drawn from this type of experiment. The second purpose is to find out how the results change when the rule is slightly modified, for example, by changing slightly the rule parameters or replacing the monetary base by other monetary aggregates[15].

6.1 Data description and methodology

The source of all the data used in this study is the Bank of Finland's database. The data is quarterly and covers the period 1980.1 to 1994.2.

Two data series for nominal GDP were used. The first (NGDPS) is exactly the same seasonal adjusted quarterly data as Bordes (1993) used in his study for the period 1980.1 - 1992.4. The estimation here started two quarters later than in his study, as the new monetary aggregates are only available since 1980.1. The other series for nominal GDP (NGDP) is not seasonally adjusted data from 1980.1 to 1994.2, where the seasonality is adjusted by using centered seasonal dummies. Also two determinations of monetary base were considered, the so-called official monetary base (MB) and the adjusted monetary base (MBA). These determinations differ in that in the latter the reserve requirements percentage is held over time at

[15] Ripatti (1994) is a recent study of the demand for money in Finland.

the level of January 1993. As an alternative to the monetary base, monetary aggregates M1 and M2 were also considered. The aggregate M3 is available only from the beginning of 1983 and is therefore excluded. In this empirical part of the study and in the appendices the letter l in upper or lower cases preceding variables denotes the logarithmic form. Likewise the letter d or Δ denotes first differences. All variables in identity equation (6.1) are in logarithmic form. In the estimation of the single-equation model of nominal GDP (6.2) the variables are in first log differences. The logarithms and first log differences of NGDP, NGDPS, MB, MBA, M1, and M2 as well as the velocities of MB, MBA, M1 and M2 are plotted in appendix A. Since a crucial property of a variable in time series is the extent to which the variable is stationary, unit-root tests are represented in appendix B.

The equations which are used in this simulation exercise are

$$\Delta b_t = 0.0122 - (1/16)[x_{t-1} - x_{t-17} - b_{t-1} + b_{t-17}] + \lambda(x^*_{t-1} - x_{t-1}), \quad \lambda > 0 \tag{6.1}$$

and

$$\Delta x_t = a_0 + a_1 \Delta x_{t-1} + a_2 \Delta b_{t-1} + RES, \tag{6.2}$$

which are the same equations as (4.8) and (4.11) except that the constant term in identity equation (6.1) is changed to conform with the current inflation goal of the Bank of Finland, therefore to be 5 per cent annual growth converted into a quarterly logarithmic unit, 0.0122. With 3 per cent annual growth rate in potential GDP this should yield about 2 per cent inflation. The second term in (6.1) subtracts the average growth rate of base velocity over the previous four years and the third term adds an adjustment for the response to cyclical departures of GDP from its target path. In the above equations, b_t is the log of monetary base (or another monetary aggregate) for period t, x_t is the log of nominal GDP and x_t^* is target path value for x_t. The parameter λ provides for the responsiveness of base growth to departures of x_t from its target path. In (6.2), RES denotes the estimated disturbance for period t. See again section 4.3.1, where the McCallum's rule is explained in detail.

The simulation followed as close as possible the simulations of McCallum and Bordes.[16] This same two-equation model was applied also by Hall (1990), with the difference that in equation (6.2) the contemporaneous value of the change in the log of the monetary base was used instead of the lagged value. One reason for the lagged value is to eliminate the possibility that the estimated effects of monetary policy on nominal GDP are actually due to a reverse-causation response of Δb_t to Δx_t (McCallum 1988).

The simulation procedure consists of two steps. First, an extremely simple single-equation model of nominal GDP determination (6.2), where the number of lags was chosen by using the Akaike and Schwarz criteria, was estimated and the

[16] As close as possible because previous writers did not document their study in detail and so there are some uncertainties regarding their procedures.

residuals were saved. Then a simulation model of two equations (6.1 and 6.2) was formed, where residual values were fed in each period as estimates of shocks that hit the economy during the period of estimation. The result of this simulation exercise (with the same seasonally adjusted data for nominal income as in Bordes study, i.e. NGDPS, and with MB and $\lambda = 0.25$) is shown in figure 3. Numerous simulations were done with different values for λ and with MB, MBA, M1 or M2 as an instrument variable, changing the lags in velocities to conform to the average growth rate of the previous one, two and four years. Simulations were done also for different time periods. Table 4 gives the estimate of the equation (6.2), with additional lags and with data series for MB and NGDPS. In appendix C estimations also with other series of monetary aggregates and with non-seasonally adjusted data for NGDP[17] are reported for comparative purposes.

Table 4 **Single-equation model of nominal GDP determination 1981.1 - 1992.4**

Variable	Coefficient	Std error	T-stat.
Constant	0.01782	0.00628	2.83982
Δx_{t-1}	0.21192	0.14443	1.46722
Δx_{t-2}	-0.54139	0.11032	-4.90733
Δx_{t-3}	0.26900	0.14230	1.89028
Δb_{t-1}	0.08000	0.04554	1.75642
R^2	0.44192	Mean of dependent	0.01804
Adjusted R^2	0.39000	Std error of depend	0.03465
σ	0.02706	RSS	0.03148
DW	2.62253	Regression F (4,43)	8.5122

This model is apparently an overly simplified version of nominal GDP determination, which argues that the following simulation exercise could lack credibility. One possibility would be to replace equation (6.2) with another aggregate supply specification (e.g. a Phillips curve or with a VAR model) as in many other studies. Furthermore, in table 5 some residual analysis of the above model is given.

The first column in table 5 gives the normality test statistics $\chi^2(2)$. The null hypothesis is normality, which cannot be rejected. The second and third columns give values for skewness and excess kurtosis. In the fourth and fifth columns, Lagrange-Multiplier test for serial correlation is reported, (since the model includes lagged dependent variables neither the DW nor the residual correlogram provide a valid test), which clearly indicates that residuals are autocorrelated. (This, however should not be significant for the simulation results). The sixth column gives the ARCH test (autoregressive conditional heteroscedasticity $\sim\chi^2(4)$), which indicates that the residuals do not have an ARCH structure. The seventh column reports White's test for heteroscedasticity and the eighth the functional form mis-specification test, neither of wich indicates a problem.

[17] Since it may not be correct procedure to combine seasonally adjusted and non-adjusted data.

Table 5 **Residual diagnostics**

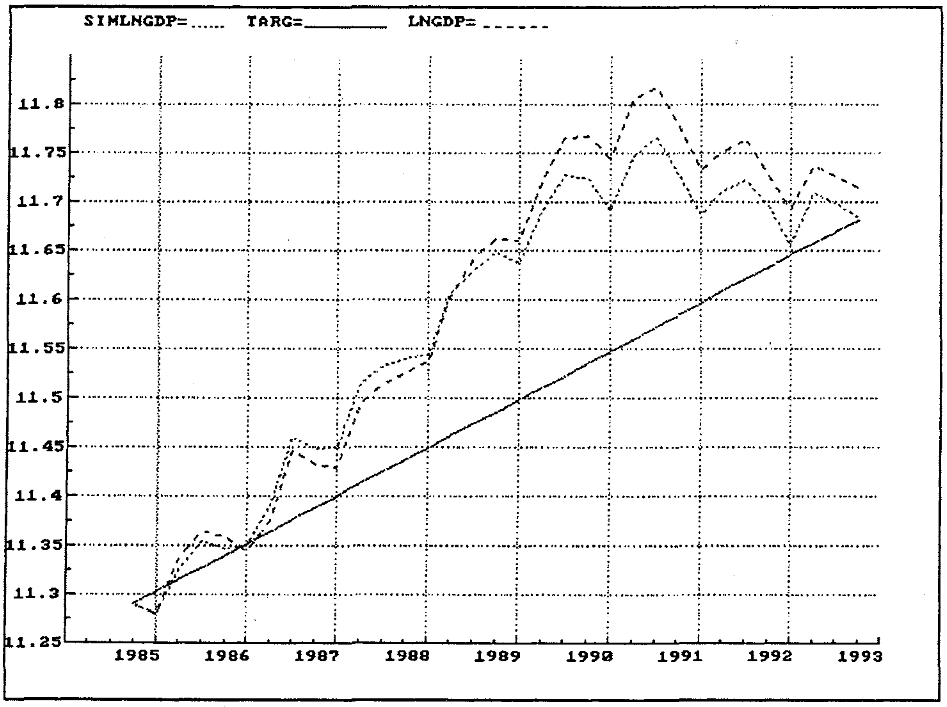
Normality			Autocorrelation	
Skewness	Exess Kurt	Norm $\chi^2(2)$	F-form (4,39)	$\chi^2(4)$
-0.1864	-0.7522	1.2627	11.949	26.432

ARCH	Heteroscedasticity	Functional form
$\chi^2(4)$	$\chi^2(8)$	$\chi^2(14)$
7.4986	10.785	7.4986

6.2 Simulation results

Simulations indicate that McCallum's rule with Finnish data for the period studied here does not perform as well as previous studies gave reason to believe. The simulation result is shown in figure 3, where SIMLNGDP denotes the simulated values, TARG the target path and LNGDP the actual values for nominal GDP. The target path increases by 0.0122 each quarter (5 % annual growth), starting from the actual value of nominal GDP for 1984.3. It can be clearly seen that with λ = 0.25 the rule does not induce simulated values to follow the target path. Recall that in McCallum's simulations the rule performed well with λ = 0.25, which implies an extra one percent base growth per year for each one percent deviation of nominal GDP from its target path.

Figure 3 **Simulation result with MB, NGDPS and λ = 0.25.**



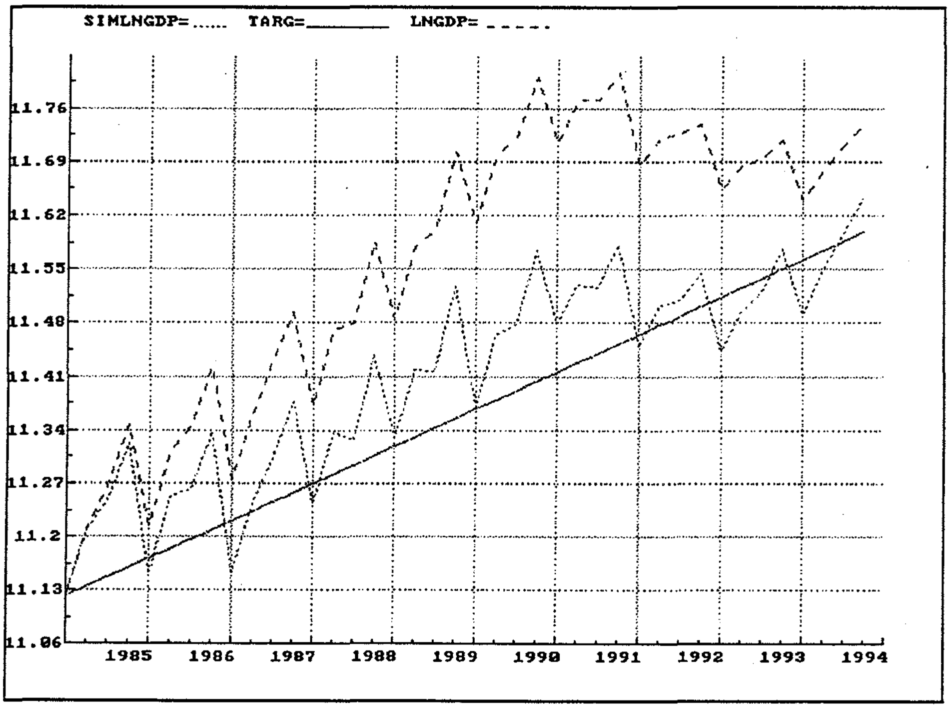
Since graphical inspection reveals quite clearly that the McCallum's rule does not perform well with Finnish data for the period studied here, more accurate statistical tests are excluded.

As earlier mentioned, numerous simulations were done with different series for monetary aggregates and nominal GDP and by modifying the model for example by changing the value of λ and the lags of velocity in equation (6.1) and the lags of the explanatory variables in equation (6.2). Some conclusions suggested by these simulations are as follows:

First, longer lags for velocity are preferable. Second, when using monetary base as an instrument variable, increasing the value of λ induces the simulated values to follow more closely the target path until the downturn of nominal GDP (1990.2), but induce the simulated values to continue declining below the target path after that. In other words, simulated values do not stabilize around the target path for any values of λ. Very high values of λ are necessary to induce the simulated nominal GDP to follow more closely the target path even for early periods. For instance, one such value is λ = 5, which implies an extra 20 percent base growth each year when nominal GDP deviates one percent from its target path. This would mean clearly unrealistic values for monetary base growth.

The rule does not induce simulated values to follow the target path when monetary base is replaced by either adjusted monetary base or M1. However, with monetary aggregate M2 the simulated nominal GDP follows the target path fairly closely, but only with smaller values of λ. However, implementing this kind of strategy would presuppose that the M2 is under the control of the central bank, which is not the case in reality. In figure 4, the simulation is constructed with non-seasonally adjusted data for nominal GDP and with λ = 0.10. For the simulation result there is no significant difference if non-seasonally adjusted data for nominal GDP are used instead of seasonally adjusted data.

Figure 4 **Simulation result with M2, NGDP and λ = 0.10.**



Why does McCallum's rule not perform well for the period studied here? One explanation could be that there is no certainty that the simulation results do not depend on the specific model of the economy applied in this analysis. Results might change when simulations are constructed with different models. For example, two problems concerning the single-equation model applied here may be presented. First, as seen in table 4 the coefficient of the monetary base is extremely small (see also appendix C), which indicates that the adjusting effect of the monetary base on simulations is relatively insignificant; therefore simulated nominal GDP follows the actual nominal GDP quite closely. For comparative purposes, the corresponding value for Δb_{t-1} is 0.549 in McCallum's original study. Second, one problem is residual autocorrelation, which is a symptom of poor model design (table 5).

Another explanation could relate to certain characteristics of Finnish data as, for example the severe recession in the beginning of the 1990s and the unstable velocity of monetary base (see appendix A). Also, as Bordes (1993) stated, it should be emphasized that the monetary base is not the best possible instrument variable to consider due to the institutional characteristics of the Finnish monetary system. Therefore in the future, it would be more useful to study a rule which would call for an adjustment of the short-term interest rate. Furthermore, as explained in chapter 5.1, growth rate targeting seems to be preferable to level targeting, which was used here. In addition, since Finland is a small open economy, it would be desirable to allow for potential feedback arising from the exchange rate.

7 Discussion

This study has investigated the possibility of using nominal income targeting as a rule for monetary policy. The rationale behind rules for monetary policy arises from the analysis of strategic behaviour. Kydland & Prescott (1977) stated that by committing in advance to a rule and not trying to create monetary surprises by discretion, the central bank could lower expected inflation and achieve better performance. Rule-based and discretion-based monetary policy differ fundamentally in that a rule dictates systematic monetary policy action and discretion does not. Nevertheless, both strategies have merits and in reality it seems unlikely that a central bank would renounce discretion altogether and adhere strictly to a rule. Therefore, some advocates of rules for monetary policy view these rules as more general guides around which discretionary policy decisions could be oriented.

Because financial market innovation and deregulation have made the monetary aggregates less reliable guides for monetary policy, attempts have been made to find an alternative fundamental guide. A frequently proposed rule is nominal income targeting. However, no country has yet adopted a specific rule for nominal income targeting.

A number of alternative rules for nominal income targeting have been proposed. Some of them express the target for nominal income in terms of growth rates and the others as levels corresponding to a predetermined growth path. Early proposals seem to favour level targeting while recent proposals favour growth targeting. Hybrid targeting has also been suggested, where the central bank would adjust the interest rate not only to the gap between actual and targeted nominal income growth but also to the gap between actual and potential real income levels.

Rules have also been suggested whereby the monetary base or some broad monetary aggregate (like M2), instead of a short-term interest rate, is adjusted so as to target nominal income. However, the potential monetary aggregate should be under the control of central bank, which is not usually the case. Short-term interest rates, on the other hand, are widely used as instruments by central banks and therefore seem to be more attractive for a nominal income rule because they offer the advantage that they involve little change from central banks' current policy-setting practice.

The rules for nominal income targeting differ also as to when the central bank would react to deviations of nominal income from target and can therefore be subdivided into lagged adjustment rules and forecast adjustment rules. Forecast adjustment rules should be preferable if forecast errors are not large and frequent. But because there is disagreement about the magnitude of forecast errors there is disagreement as to which of these two approaches is superior.

Theoretical models which compare nominal income targeting to money supply targeting yield different results. There is no simple condition under which one rule is universally favoured over the other. Only if there exists fairly certain knowledge of the source of shocks, of their persistence and of whether the authority has an information advantage does a certain rule outperform another (Asako & Wagner 1992).

Several empirical studies, however, suggest that rules for nominal income targeting outperform rules which target, for example, the money supply or the exchange rate when performance is measured by stability in output and prices. These studies are represented in sections 4.3 and 4.4. Still, some of the simulation results differ considerably from the results of earlier studies, which used slightly different models. This suggests that conclusions about rules drawn from simulation evidence are very sensitive to slight differences in models. Therefore, simulation analysis may not provide convincing evidence for a nominal income rule (Clark 1994).

It should be emphasized that in reality, central banks do not generally behave in a manner that can be easily summarized in a simple mathematical model. Furthermore, there are problems in studying policy rules. For example, there does not exist one agreed-upon macro-model which could be applied. Simulation exercises are still important since it is impossible to conduct controlled experiments on actual economies in order to compare the performance of alternative rules. Therefore, the practical importance and implications of simulation exercises need to be interpreted with an appropriate degree of caution.

The empirical part of this study consisted of a simulation exercise based on McCallum's rule combined with a single-equation atheoretic determination of nominal GDP. The rule did not induce simulated nominal GDP values to follow closely the target path when monetary base, adjusted monetary base or M1 were used as an instrument variable. With the monetary aggregate M2, the simulated nominal GDP follows the target path somewhat closely. There may be several reasons for this poor performance, as for example the apparent simplicity of the model applied and the characteristics of Finnish data. Therefore the results of this simulation exercise should be viewed with caution.

It would be necessary to construct simulations with different models so as to achieve more convincing evidence of the performance of nominal income targeting. One could consider a nominal income rule calling for the adjustment of a short-term interest rate in which a growth rate of nominal income is targeted. Also the feedback from exchange rates could be considered. Even more interesting would be to include a nominal income rule, on an experimental basis, among the factors upon which policymakers would base their decisions.

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Appendix A: Data figures

Figure 1 **Quarterly NGDP and NGDPS**

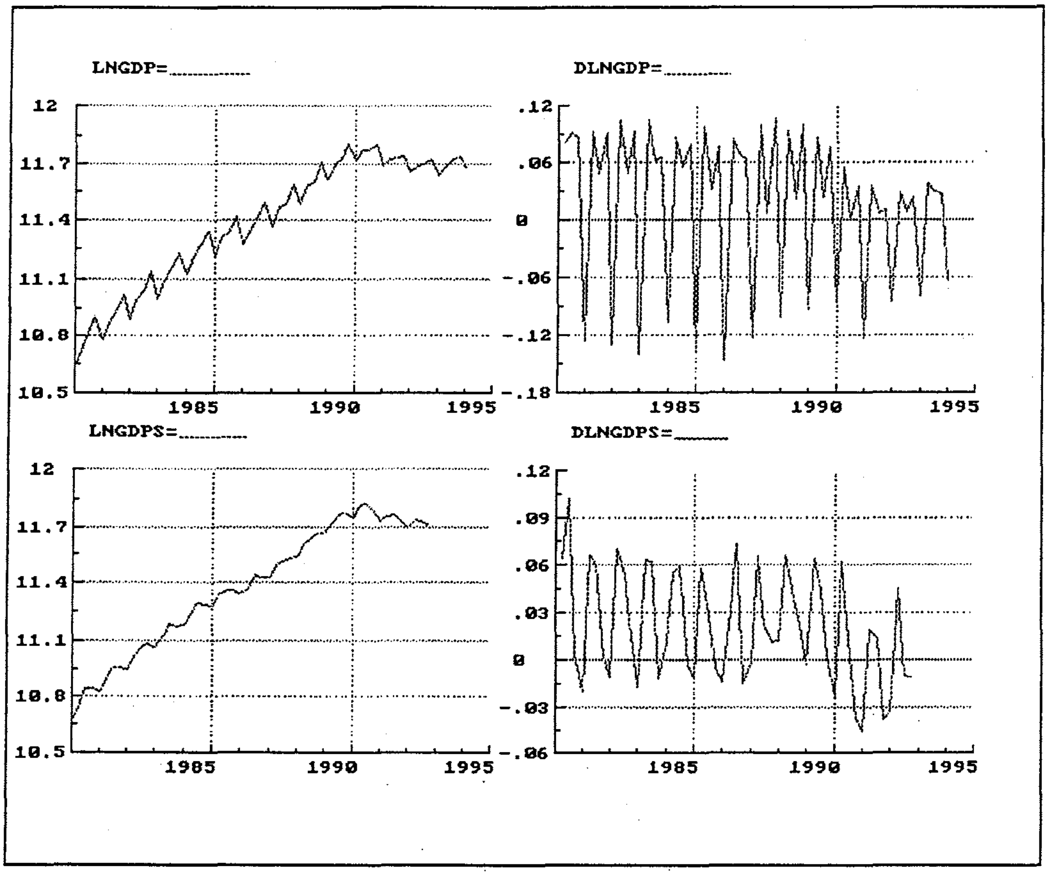


Figure 2 **Quarterly MB and MBA**

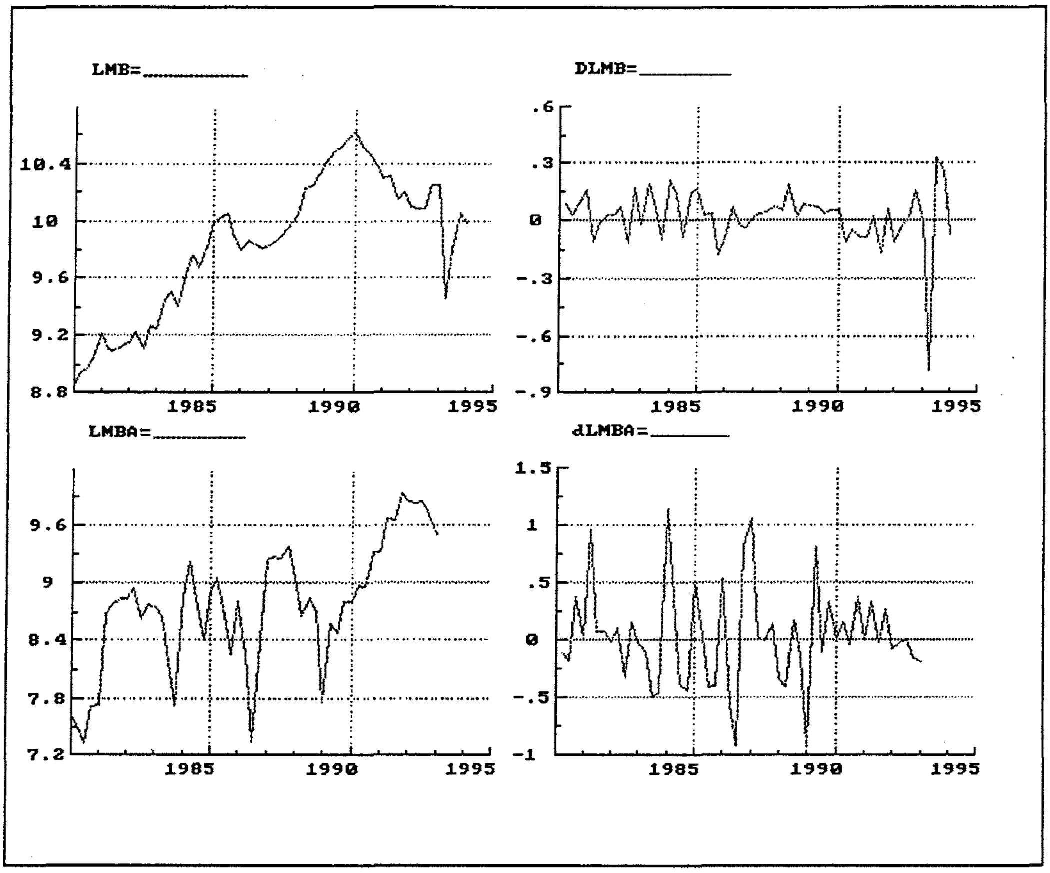


Figure 3 **Quarterly M1 and M2**

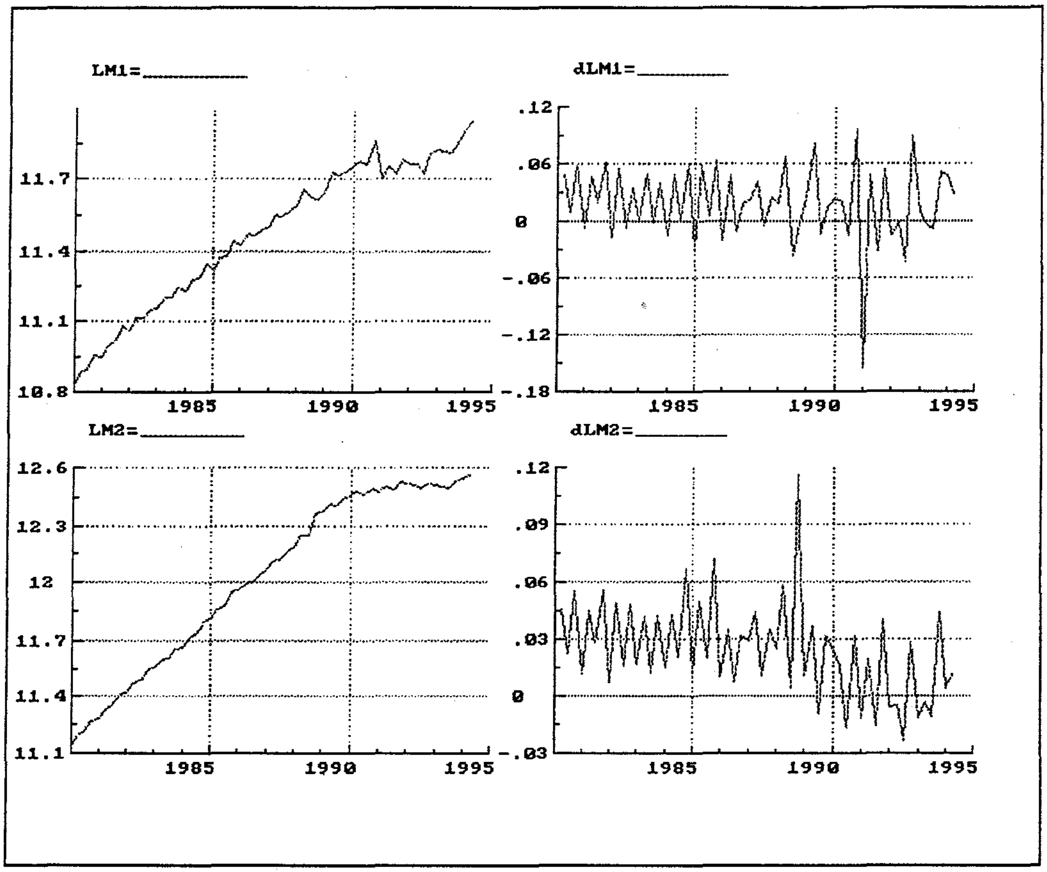
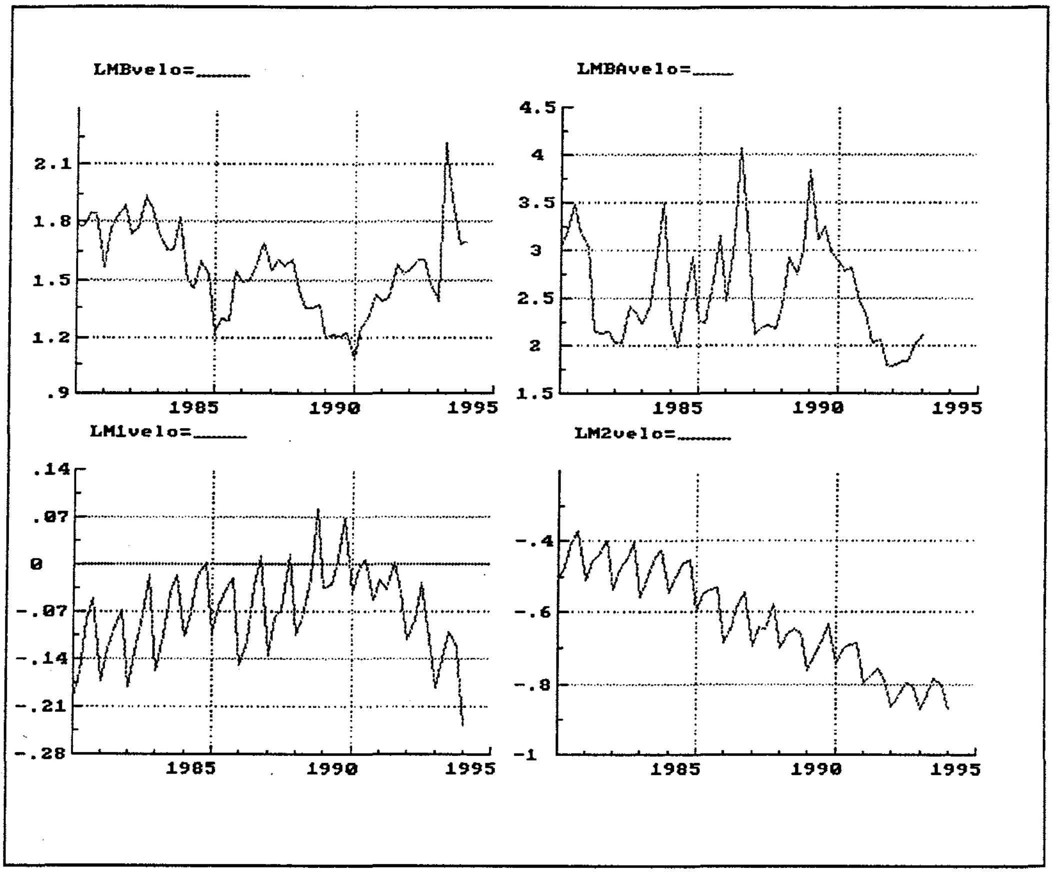


Figure 4 **Velocities of MB, MBA, M1 and M2**



The velocity of money is defined by the quantity theory of money, $V \equiv PT/M \equiv T/(M/P)$, i.e. the volume of transactions scaled by real money. Velocities are calculated with non-seasonally adjusted data.

Appendix B: Testing for a unit-root

A crucial property of a variable in time series is the extent to which the variable is stationary. A process with no unit root is said to be I(0), i.e. integrated of order zero. A process is I(d) if it needs to be differenced d times to become I(0) and thus to reach stationarity. The stationarity can be tested e.g. by the Dickey-Fuller (DF) and the augmented Dickey-Fuller (ADF) tests. The null hypothesis in these tests is the existence of a unit root. The DF and ADF test-statistics indicate clearly that the null hypothesis cannot be rejected for any of the variables. Since the seasonal data includes a unit-root, it is necessary to allow for differencing to achieve stationarity. The single-equation model of nominal GDP determination is estimated with first log differences. The ADF test-statistics which are reported in table 1 are calculated with two lagged values for each variable. For more on critical values and unit-roots see e.g. Banerjee et al (1993).

Table 1 **Testing for a unit-root**

	NGDP	NGDPS	MB	MBA	M1	M2
ADF	1.89	3.22	0.08	-0.03	3.59	2.00

Appendix C: Some estimations

Table 1 **Single-equation model of nominal GDP determination 1981.1 - 1994.1 with MB as Δb_t and NGDP as Δx_t.**

Variable	Coefficient	Std error	T-stat.
Constant	0.01313	0.00531	2.473
Δx_{t-1}	-0.13413	0.14831	-0.904
Δx_{t-2}	0.31250	0.13857	2.255
Δx_{t-3}	-0.03540	0.14991	-0.236
Δb_{t-1}	0.04896	0.02530	1.935
CSeason	-0.15335	0.03016	-5.084
$CSeason_{t-1}$	-0.00094	0.03625	-0.026
$CSeason_{t-2}$	0.03986	0.04006	0.995
R^2	0.91085	Regression F (7,45)	65.678
σ	0.02609	RSS	0.0306
DW	2.04		

Table 2 **Single-equation model of nominal GDP determination 1981.1 - 1994.1 with MBA as Δb_t and NGDP as Δx_t.**

Variable	Coefficient	Std error	T-stat.
Constant	0.01092	0.00576	1.895
Δx_{t-1}	-0.05205	0.16476	-0.316
Δx_{t-2}	0.25858	0.14719	1.757
Δx_{t-3}	0.10308	0.16532	0.624
Δb_{t-1}	0.00281	0.00996	0.282
CSeason	-0.19005	0.03380	-5.622
$CSeason_{t-1}$	-0.01235	0.04015	-0.308
$CSeason_{t-2}$	-0.00384	0.04489	-0.085
R^2	0.91223	Regression F (7,45)	62.362
σ	0.02654	RSS	0.0300
DW	2.06		

Table 3 **Single-equation model of nominal GDP determination 1981.1 - 1994.1 with M1 as Δb_t and NGDP as Δx_t.**

Variable	Coefficient	Std error	T-stat.
Constant	0.010459	0.00555	1.884
Δx_{t-1}	-0.13035	0.15064	-0.865
Δx_{t-2}	0.25358	0.14047	1.805
Δx_{t-3}	0.03279	0.14622	0.224
Δb_{t-1}	0.19208	0.12393	1.550
CSeason	-0.17809	0.02998	-5.940
CSeason_{t-1}	-0.00095	0.03668	-0.258
CSeason_{t-2}	0.00433	0.03938	0.110
R^2	0.90832	Regression F (7,45)	63.691
σ	0.02646	RSS	0.0315
DW	1.91		

Table 4 **Single-equation model of nominal GDP determination 1981.1 - 1994.1 with M2 as Δb_t and NGDP as Δx_t.**

Variable	Coefficient	Std error	T-stat.
Constant	0.00242	0.00594	0.407
Δx_{t-1}	-0.35079	0.15987	-2.194
Δx_{t-2}	0.16444	0.13450	1.223
Δx_{t-3}	-0.04843	0.13876	-0.349
Δb_{t-1}	0.74239	0.23484	3.161
CSeason	-0.18172	0.02761	-6.582
CSeason_{t-1}	-0.03519	0.03518	-1.000
CSeason_{t-2}	0.00076	0.03621	0.021
R^2	0.92098	Regression F (7,45)	74.921
σ	0.02457	RSS	0.0271
DW	1.92		

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