(Re) Introducing Money into the New Keynesian Framework: Does It Matter?

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Abstract:

Modern macroeconomic models such as the New Keynesian framework ignore money aggregates. The theoretical implications of this omission have been studied and found to be negligible. Surprisingly, little research has been conducted on whether central banks respond to changes in money aggregates in practice. We show how an optimizing central bank adjusts the policy setting in response to deviations of changes in the money supply from target. Using data from New Zealand and Switzerland, we then examine whether the respective central bank has used a monetary aggregate as a target in the recent past. We find no significant relationship between the setting of interest rates and money growth in New Zealand or Switzerland.

Introduction

It is ironic that the modern macroeconomic models used to analyse how monetary policy affects economic outcomes do not include any reference to the money market. This abandonment of money in the New Keynesian framework comes in response to central banks maintaining control over interest rates instead of the monetary supply (Woodford, 2006). The variables that are important to a central bank, such as gross domestic product (GDP) or inflation, can be affected directly by the interest rate. The money supply responds endogenously so as to be consistent with the interest rate setting chosen by the central bank.

Many academic commentators have discussed the advantages and failings of implementing monetary policy via interest rates within the New Keynesian framework. In practice, most central banks conduct monetary policy using interest rates. Some central banks, however, such as the German Bundesbank and Swiss National Bank have had explicit money targets rather than inflation targets (Swiss National Bank (n.d.a.) & Clarida & Gertler (1997). In addition, the European Central Bank (ECB) implements its monetary policy with a "two-tier strategy" which focuses on both price stability as well as the targets involving money growth (see Moutot, Jung & Mongelli, 2008 p. 33. for details).

This paper investigates whether central banks ignore movements in money or credit aggregates in practice, regardless of their official position on the targets of monetary policy. Evidence that central banks respond to movements in money aggregates clearly signifies that central banks pay attention to money aggregates when setting the policy rate. As such monetary aggregates serve either as information variables that central banks act upon or represent proper target variables. At the very least, feedback from movements in monetary aggregates to the policy instrument would lend credence to the view that monetary aggregates still have an important role to play in the conduct of monetary policy in practice. This paper looks specifically at two central banks: the Reserve Bank of New Zealand (RBNZ) which has no explicit money target and the Swiss National Bank (SNB) which had an explicit money target during 1985 – 1996.

This paper is structured as follows: Section 2 summarises briefly the literature on money targeting. Section 3 presents the building blocks of the New Keynesian model and the derivation of the central bank's reaction function. Section 4 describes the data and methodology applied. Section 5 presents the results. A brief summary is offered in Section 6.

2. On the Role of Money in Traditional Models and in the New Keynesian Framework

The academic literature has investigated two possible benefits of money targeting. Firstly, money aggregates may contain useful information regarding possible changes in future economic variables. McCallum's (2001) paper investigates whether the exclusion of money from models such as the New Keynesian Framework is due to misspecification. If this is the case, then exogenous money shocks could affect or be affected by unobserved (or yet to be observed) economic variables. This would imply that money could contain information relevant to the implementation of policy. McCallum finds that a simplifying assumption in the New Keynesian framework results in money disappearing from the aggregate equations. He argues that this assumption - a (multiplicatively) separable transactions demand function in the utility function of the representative agent - is unlikely to be correct. This is because it allows households to increase their consumption without changing the amount of money withdrawn from the bank or the frequency of withdrawals.

Correcting this assumption implies a possible informational role for money. To analyse the degree to which money targeting can improve policy, McCallum compares simulations of the policy responses of the baseline New Keynesian model with his 'corrected' model. He finds only a marginal improvement in monetary policy when central banks respond to changes in the money market. McCallum (2001, p.145) tentatively concludes that "although these answers suggest that policy analysis in models without money is not fundamentally misguided, they do not imply that conducting policy in this manner is necessarily a desirable strategy."

Clarida, Gali and Gertler (1999, pp 48-50) argue that delays in the release of inflation and output information may legitimize a focus on monetary aggregates. Since monetary aggregates are immediately observable and correlated with inflation, a money growth target may be a good way to set monetary policy in such an environment. Money targeting also allows monetary policy to be evaluated as it is being set. In contrast, Woodford (2006) argues that although information lags reduce the ability to immediately evaluate monetary policy, this does not seem to have mattered much in practice for controlling inflation and inflation expectations.

The second benefit of money targeting concerns the time inconsistency problem in setting monetary policy. Söderström (2005) investigates money targeting as a solution to this problem. Under discretion[1], the central bank has an incentive to focus more on output gap stabilisation than inflation stabilisation (when inflation is near the target). Agents in the economy are aware of this

[1] Discretion allows policymakers to achieve their goals with no restrictions on the method by which they do so. In monetary policy this means that policy makers re-evaluate interest rate policy each period.

preference and thus expect inflation to remain above target. This creates inflationary pressure, which slows down the stabilization process. If the policymaker could credibly convince agents of their intention to stabilize inflation, expectations would fall and stabilization would become less costly. Credibility can be established if agents believe that a particular response to an inflationary shock will persist considerably over time. This is often referred to as policy inertia.

Söderström asks whether a central bank could commit to money targeting as a means of creating the desired inertia in interest rates. Inflation expectations could thus be managed by holding central banks accountable for deviations of money from target. Using similar calibration methods to McCallum (2001), Söderström (2005) finds that money targeting does introduce some inertia into the movement of interest rates; however, policy inertia can be introduced more effectively by committing to other targets such as an output gap smoothing target or a nominal income target.

Empirical evidence suggests that prior use of broad money as an instrument has not produced desirable results. Friedman and Kuttner (1996) examine the use of money in the United States during the 'Volcker disinflation' period and find that use of broad money targets exposes the economy to the effect of volatile money market shocks. Historically, these shocks have been larger than aggregate demand shocks. Clarida and Gertler (1997) analyse Bundesbank, one of the few banks with an explicit money target, and find that it sets policy according to a Taylor rule, which excludes a money target.

3. (Re) introducing Money into the New Keynesian Framework

In this section we show how the linkage between the policy instrument and a monetary aggregate can be motivated. The starting point of our analysis is the specification of the central bank's objective function. The central bank aims to achieve targets for the rate of inflation, the output gap and money growth. The central bank minimizes this loss function subject to a constraint. This constraint is made up of the structure of the economy. Combining the optimizing conditions gives rise to a reaction function which shows how the setting of the policy instrument responds optimally to forward-looking variables, past information and current shocks.

The central bank's objective function is made up of squared deviations of the target variables from their fixed target levels:

$$L_t = (\pi_t - \pi^*)^2 + \lambda_x x_t^2 + \lambda_i \Delta i_t^2 + \lambda_m (\Delta m_t - \Delta m_t^*)^2 \quad (1)$$

x_t refers to the output gap at time t, π_t is the corresponding inflation rate, i_t is the nominal interest rate, and Δm_t is the change in the money supply. An asterisk denotes the fixed target level for the respective target variable. The parameters λ_i, λ_x and λ_m represent the weighting the central bank places on achieving each target relative to inflation.

Apart from the standard targets for output and inflation, the above loss function includes an interest rate smoothing target and money growth target. If movements in monetary aggregates are of primary concern to a central bank – a target of monetary policy – then unexpected deviations from target should appear in the loss function. The interest rate smoothing target has been added because it is common for central banks to move interest rates gradually. For instance, the Reserve Bank of New Zealand (RBNZ), the Swiss National Bank (SNB) and the European Central Bank (ECB), have clauses specifying that the pursuit of price stability should not come at the expense of unnecessary fluctuations in real economic activity and financial variables.[2,3]

The structure of the economy is described by the canonical New Keynesian model.

$$x_t = E_t x_{t+1} - \varphi(i_t - E_t \pi_{t+1} - r_t^n) + v_t \quad (2)$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t + u_t \quad (3)$$

u_t and v_t are stochastic shocks while φ and κ are positive parameters. $0 < \beta \leq 1$. $E_t x_{t+1}$ and $E_t \pi_{t+1}$ refer to expectations taken at time t of the future output gap and rate of inflation, respectively. All variables with the exception of the interest rate are in logarithm form[4].

Equation (2) describes an IS curve where the current output gap is positively related to expectations of the future output gap and inversely related to the difference between the expected real interest rate and the neutral rate r_t^n. Equation (3) represents a Phillips curve where inflation is positively related to expectations of future inflation and positively related to the output gap.

Money is introduced into this framework by way of a simple money-market equilibrium relationship. The equation for the LM relation takes the following form:

$$(m_t - p_t) = \eta_y . y_t - \eta_i i_t + \varepsilon_t \quad (4)$$

[2] See Reserve Bank of New Zealand (n.d.b) and Swiss National Bank (n.d.a).
[3] For example, the Reserve Bank of New Zealand (n.d.b) has explicit instructions to implement policy in such a manner.
[4] This exception relates to the New Keynesian model only. For estimation purposes the interest rate estimated is: $\log(1+i_t)$

m_t refers to the money supply, y_t represents GDP, ε_t is a stochastic money shock, and η_i and η_y are positive parameters. The LM relation is omitted from the canonical New Keynesian model since it only affects equations 2 and 3 through the interest rate. The LM relation is not required to determine optimal policy since complete control over the interest rate ensures that the central bank responds optimally to the shocks of the model.

To dispose of the price level, we difference equation (4):

$$\Delta m_t = \pi_t + \eta_y \Delta y_t - \eta_i \Delta i_t + \Delta \varepsilon_t \tag{5}$$

The target for the change in the money supply Δm^* is set with reference to the target for the rate of inflation and changes in the level of potential output.

$$\Delta m^* = \pi^* + \eta_y \Delta y^P \tag{6}$$

Subtracting (6) from (5) yields the deviation of the money supply from its target level change.

$$\Delta m_t - \Delta m_t^* = \pi_t - \pi^* + \eta_y(\Delta y_t - \Delta y^P) - \eta_i \Delta i_t + \Delta \varepsilon_t$$

$$\Delta m_t - \Delta m_t^* = \pi_t - \pi^* + \eta_y \Delta x_t - \eta_i \Delta i_t + \Delta \varepsilon_t \tag{7}$$

The central bank acts under uncertainty. This being the case, it minimizes the expectation of the loss function. The central bank also uses discretion in determining optimal policy. The optimisation problem to be solved can be set up in the form of a Lagrangean:

$$\min \; E\,L(\pi_t, x_t, i_t, \Delta m_t) = \begin{bmatrix} (\pi_t - \pi^*)^2 + \lambda_x x_t^2 + \lambda_i\, \Delta i_t^2 + \lambda_m\, (\Delta m_t - \Delta m_t^*)^2 \\ +\phi_{t,1}(\beta E_t \pi_{t+1} + \kappa x_t + u_t - \pi_t) \\ +\phi_{t,2}(E_t x_{t+1} - \varphi(i_t - E_t \pi_{t+1} - r_t^n) + v_t - x_t) \\ +\phi_{t,3}\left(\pi_t - \pi^* + \eta_y \Delta x_t - \eta_i \Delta i_t + \Delta \varepsilon_t - \Delta m_t + \Delta m_t^*\right) \end{bmatrix} \tag{8}$$

where $\phi_{t,1}, \phi_{t,2}$ and $\phi_{t,3}$ are Lagrange multipliers.

The first order conditions are:

$$\frac{\partial L}{\partial \pi} = 2(\pi_t - \pi_t^*) - \phi_{t,1} + \phi_{t,3} = 0 \tag{9}$$

$$\frac{\partial L}{\partial x} = 2\lambda_x x_t + \phi_{t,1}\kappa - \phi_{t,2} + \phi_{t,3}\eta_y = 0 \tag{10}$$

$$\frac{\partial L}{\partial (\Delta m)} = 2\lambda_m (\Delta m - \Delta m^*) - \phi_{t,3} = 0 \tag{11}$$

$$\frac{\partial L}{\partial i} = 2\lambda_i(i_t - i_{t-1}) - \phi_{t,2}\varphi + \phi_{t,3}\eta_i = 0 \tag{12}$$

We can solve these optimizing conditions for the Lagrange multipliers:

First $\phi_{t,3}$ can be found by solving equation (11):

$$\phi_{t,3} = 2\lambda_m(\Delta m_t - \Delta m_t^*) \tag{13}$$

Second, $\phi_{t,1}$ can be determined by substituting equation (13) into equation (9):

$$\phi_{t,1} = 2(\pi_t - \pi^*) + 2\lambda_m(\Delta m_t - \Delta m_t^*) \tag{14}$$

Third, $\phi_{t,2}$ can be found by substituting equation (13) into equation (12):

$$\phi_{t,2} = \frac{2}{\varphi}[\lambda_x(i_t - i_{t-1}) - \lambda_m\eta_i(\Delta m_t - \Delta m_t^*)] \tag{15}$$

Substituting equations (13), (14) and (15) into equation (10) yields the target rule. This equation shows the systematic relationship among the target variables under optimal policy.

$$\varphi\left[\lambda_x x_t + \kappa(\pi_t - \pi^*)\right] + \lambda_m\left[(\eta_i + \varphi(\kappa + \eta_y))(\Delta m_t - \Delta m_t^*)\right] = \lambda_i \Delta i_t \tag{16}$$

Next combine the target rule with the IS relation and the Phillips curve and solve for the nominal interest rate:

$$i_t = \frac{1}{\lambda_x\varphi^2 + \kappa\varphi^2 + \lambda_i}\begin{bmatrix} \varphi(\lambda_x + \kappa^2)E_t x_{t+1} + \varphi(\lambda_x\varphi + \kappa\beta + \kappa^2\varphi)E_t\pi_{t+1} + \varphi^2(\lambda_x - \kappa)r_t^n \\ +\kappa\varphi u_t - \kappa\varphi\pi_t^* + \lambda_i i_{t-1} + \lambda_m(\kappa\varphi + \eta_i + \eta_y\varphi)(\Delta m_t - \Delta m_t^*) \end{bmatrix} \tag{17}$$

Equation (17) represents the central bank's reaction function. The nominal interest rate responds to expected future inflation, the expected future output gap, the lagged interest rate, the inflation target, the natural rate of interest, the shocks of the model and, importantly, to movements in the money supply. Specifically, the central bank raises the setting of the policy instrument if the observed change in the money supply exceeds the exogenous target level change. The response of the policy instrument is unambiguous as the coefficients on the deviation are all positive. Note that the LM parameters η_i and η_y appear only in the term preceding the money supply deviation. This implies that the response of the policy setting to money target misses is influenced in no small measure by money demand elasticities.

In the next section, the above reaction function is taken to the data. We employ data from New Zealand, where money supply targets have played no role in policy discussions and Switzerland where monetary aggregates have played a much more conspicuous role[5]. Is the link between monetary aggregates and the policy instrument absent in New Zealand? Is it present in Swiss data? The specific hypothesis to be tested is:

$$H_0: \quad \lambda_m = 0$$

$$H_1: \quad \lambda_m > 0$$

4. Data and Methodology

Data was obtained from either the RBNZ or SNB's online databases (RBNZ, n.d.c & SNB, n.d.c)[6]. For New Zealand, the data range is from 1989Q4 to 2010Q1. For the SNB the data begins in 1980Q1 and ends in 2010Q1. The SNB operated under an explicit money target regime with published targets from 1985 to 1996 (SNB, n.d.a).In New Zealand the targeting of broad monetary aggregates had been abandoned in the late 1980s even though the operational framework still focused on targeting a narrow reserves aggregate.[7]

Expectations variables for New Zealand were obtained from surveys with quantitative questions such as, "What quarterly % change do you expect in the Consumers Price Index (C.P.I.) for the: [quarters *t*, *t+1*]?" (Reserve Bank of New Zealand, n.d.d). The SNB does not publish historical expectations data. To compensate for this we assume rational expectations so that we can proxy expected inflation and GDP with the lead of actual inflation and GDP. A corollary of expected CPI and GDP being correct on average is that actual CPI and GDP should be reasonable indicators of what their respective expectations were previously.

Data for the output gap was available in the RBNZ dataset but not the SNB dataset. In the case of the SNB, potential output was assumed to be the trend of output as given by applying a Hodrick-Prescott filter and the output gap was calculated from this. The RBNZ uses MV filters which can generate estimates of potential output based on de-trending methods that incorporate unemployment rates and productive capacity (Conway & Hunt, 1998).

Once output gap data was obtained, data on expectations need to be transformed from expected GDP growth to a form of the expected output gap. This paper assumes that potential

[5] In the counterfactual situation, λ_m=0 in Equation 5.
[6] Data was also gathered from Statistics New Zealand (n.d.)
[7] Officially the Reserve Bank targeted cash settlement balances, the volume of free reserves in circulation at the end of a given business day.

output was known to all agents and, therefore, all that is unknown at time t is actual GDP at time t+1. The following simplification can then be made:

We can convert the expected GDP series to an expected output gap series via the formula below:

$$E_t x_{t+1} = 100.E_t\left[\frac{y_{t+1} - y^P_{t+1}}{y^P_{t+1}}\right] \leftrightarrow E_t x_{t+1} = \frac{E_t y_{t+1} - y^P_{t+1}}{y^P_{t+1}}.100$$

The above assumption is quite strong; however it is unlikely to be significant with rational expectations. If rational expectations hypothesis applies to reality, then we would expect the above equation to be a reasonable approximation of the actual expectations of agents.

The overnight interbank lending rate is used as the proxy for the policy instrument for both countries. This accounts for the fact that central banks have the capacity to intervene in the money market on a daily basis and indeed do so (RBNZ, n.d.e & SNB, n.d.b).[8] We do not need data for the SNB's inflation target or the long run neutral[9] interest rate since these are assumed to be constant. Therefore, they are grouped into a single constant term in our estimation. New Zealand has changed its inflation target twice since it became independent and this has been taken into account.

Some uncertainty surrounds the exact definition of money. Are central banks worried more about movements in broad as opposed to narrow money aggregates? This paper will therefore examine the relationship of the policy instrument with both broad and narrow monetary aggregates. Additionally, we broaden the scope of the investigation by focusing on domestic credit, business loans, and total loans.[10] Domestic credit appears on the opposite side of the central bank balance sheet (Collins, Thorp & White, 1999). Business loans and total loans are credit extended by the domestic financial sector to firms and households. Another empirical issue is that there is no timeframe suggested regarding how far into the future expectations are formed regarding inflation and output. The degree to which agents are forward looking can be considered by estimating the above relationships using both quarterly and annual expectations data. (Unfortunately, explicit data of this is only available for New Zealand.)

Empirical estimations of money demand have identified a co-integrating relationship between income and money with a coefficient of 1 (See Sriram, 2001 for a summary of the

[8] The Official Cash Rate (OCR) only changes in discrete steps. Using it would result in biased OLS or VAR estimates (See Wooldridge, 2007 pp. 595-600 for details about why the count variable is biased and techniques to correct this). The log of the interest rate is used in the VAR estimates to follow.

[9] A Neutral real interest rate is defined as an interest rate that neither expands nor contracts the economy.

[10] Due to data limitations this is done for New Zealand only.

literature's findings and Hendry & Mizon, 1978 for the first paper to attempt this type of estimation). We use both the value cited above as well as the estimates shown in Table 1.

Table 1: Estimates of η_y for New Zealand

	MB	M1		M2		M3		Domestic Credit	Business Loans	Loans	
	NZ	NZ	SNB	NZ	SNB	NZ	SNB	NZ	NZ	NZ	SNB
η_y	0.18	0.48	0.88	0.19	0.19	0.63	0.78	0.77	1.24	0.81	0.33
$\eta_y=1$	0.64	0.4	0.85	0.22	0.15	0.18	0.5	0.35	0.61	0.37	0.00

Table 2: Unit Root Tests

	New Zealand				Switzerland			
	P-Value		Test-Stat		P-Value		Test-Stat	
Variables	**ADF**	**PP**	**KPSS**	**Overall**	**ADF**	**PP**	**KPSS**	**Overall**
Interbank Lending Rates	0.06	0.20	0.76	Non-Stationary	0.26	0.46	0.11	Non-Stationary
Expected Annual Inflation	0.13	0.00	0.09	Stationary	-	-	-	-
Expected Quarterly Inflation	0.00	0.00	0.52	Stationary	0.02	0.31	0.08	Stationary
Actual Inflation	0.00	0.00	0.14	Stationary	0.00	0.00	0.11	Stationary
Expected Quarterly Output Gap	0.04	0.03	0.37	Stationary	0.01	0.26	0.17	Stationary
Expected Annual Output Gap	0.07	0.07	0.40	Non-Stationary	0.03	0.42	0.15	Stationary
Actual Output Gap	0.08	0.18	0.40	Non-Stationary	0.00	0.16	0.03	Stationary
Growth in M3	0.00	0.00	0.08	Stationary	0.00	0.00	0.06	Stationary
Growth in M2	0.00	0.00	0.08	Stationary	0.00	0.01	0.21	Stationary
Growth in M1	0.01	0.00	0.14	Stationary	0.00	0.00	0.06	Stationary
Growth in Domestic Credit	0.00	0.00	0.19	Stationary	0.00	0.00	0.11	Stationary
30 year interest rates	0.00	0.00	1.44	Stationary	-	-	-	-

These estimates were obtained for the LM curve introduced in Section 1. To solve a possible endogeneity problem between interest rates and the money variable, the lagged interest rate is included as an instrument. Most variables in the LM curve are I(1) processes (see Table 2) requiring the equation to be estimated in differences. In most cases, the estimates shown above are less than 1, but not significantly so. Moreover, many coefficients are not statistically significantly different from 0.

The last two potential issues are solved by applying a VAR methodology. This removes any bias in estimates arising from bidirectional causation in lags of the variables in question.[11] However,

[11] Bi-directional causation may occur between interest rates and money due to the relationship between money and interest rates in the LM curve in addition to possible money targeting undertaken by central banks.

we are unable to measure the responses to contemporaneous movements in variables using this methodology. In addition, some of the variables analysed here are non-stationary, particularly the interbank interest rate. To minimise this problem, we test for co-integration relationships. Fortunately, in all cases using quarterly expectations, the data is co-integrated and is therefore estimated in levels. When we test for robustness using annual expectations variables, co-integration is not always present, and so we omit these results from our robustness checks.[12] Table 2 shows the results of three different unit root tests on the variables used. In addition, we use the Schwartz information criterion (SIC) to determine the optimal lag structure. In all cases the optimal lag length is 1.

5. Empirical Results

Table 3 presents the empirical results of fitting the reaction function to New Zealand data. These results suggest that the RBNZ does not engage in money targeting; however, there is some evidence that RBNZ adjusts interest rates in response to excessive growth in total loans. As business loans are insignificant, this may indicate that the central bank pays attention to residential loans (the largest component of total loans).

Table 3: New Zealand Reaction Function

		Aggregate Used						
		MB	**M1**	**M2**	**M3**	**DC**	**Business Loans**	**Total Loans**
Variables	**Lagged Interest Rate**	0.70***	0.71***	0.70***	0.70***	0.70***	0.68***	0.68***
	Expected Output Gap	0.19***	0.18***	0.19***	0.19***	0.18***	0.19***	0.18***
	Money/Credit Aggregate	0.00	0.01	0.00	0.02	0.01	0.04	0.12**
	Expected Inflation	2.26***	2.27***	2.26***	2.23***	2.30***	2.25***	2.34***
	Inflation Target	-1.19***	-1.18***	-1.20***	-1.19***	-1.20***	-1.22***	-1.16***
	Constant	2.36**	2.30***	2.38***	2.39***	2.35***	2.48***	2.23***

* denotes significance at the 10% level, ** at the 5% level and *** at the 1% level.

Coefficients for expected quarterly inflation, the lagged interest rate and the expected output gap are all positive and significant at the 1% level. The signs of these coefficients are in line with those predicted by equation (17), the reaction function. Furthermore, the coefficient for inflation is in line with the Taylor principle; namely, that inflation targeting central banks will raise interest rates by more than the rise in expected inflation: the coefficient on expected inflation

[12] Specifically, this applies to New Zealand with annual expectations and testing for targeting using M1, M3 and the money base.

exceeds one.[13] Our results confirm earlier results by Plantier & Scrimgeour (2002) that New Zealand adheres tothe Taylor principle. Lastly, the coefficient on the inflation target is negative and highly significant (as suggested by the reaction function derived above).

Table 4: The Reaction Function for Switzerland

Variables	Aggregate Used				
	MB	**M1**	**M2**	**M3**	**Loans**
Lagged Interest Rate	0.84***	0.81***	0.83***	0.84***	0.93***
Output Gap(t+1)	0.22*	0.02	0.07	0.17*	-0.03
Money/Credit Aggregate	0.19	-0.14*	-0.07	0.03	0.30**
Inflation(t+1)	0.57**	0.64***	0.60***	0.59**	0.47**
Constant	0.28	0.28	0.29	0.35	-0.4

* denotes significance at the 10% level, ** at the 5% level and *** at the 1% level.

For Switzerland, the results in Table 4 detail the effects on the interest rate from experiencing deviations in money growth from the SNB's reported money growth target (regardless of the aggregate analysed). Similar to the New Zealand results, the SNB appears to target total loans, but not any other aggregate. The SNB does target inflation significantly but not the output gap. However, due to assumption of rational expectations, we cannot interpret this as indicating that the SNB does not target the output gap. The New Keynesian framework posits that central banks target the *expected* output gap not the lead of the output gap. To validate output gap targeting we will need better data.

For the same reason, we cannot say that the SNB does not follow the Taylor principle; merely that the SNB does not raise rates more than 1 percentage point for each percentage point rise in ex-post future inflation. Due to errors in the forecasts of agents, little can be said about following the Taylor Principle ex-ante.

Overall, the results suggest that neither central bank targets money growth, although the RBNZ may be focussing on total loans issued. Tables 5 and 6 below show the results from slight changes to the data or money target to serve as robustness checks.

[13] Essentially, central banks with an inflation target wish to raise real interest rates in order to impact inflation or the output gap. Since real interest rates are equivalent to the difference between nominal interest rates and expected inflation, central banks need to raise nominal interest rates by more than any spike in expected inflation in order to raise real interest rates (see Davig & Leeper, 2005 for a more detailed discussion).

Table 5: Robustness Checks - coefficients on money/credit aggregate only
New Zealand

	Aggregate Used						
	MB	M1	M2	M3	DC	Business Loans	Total Loans
Annual Expectations	-	-	0.01	-	-0.01	0.04	0.13**
Exclude Financial crisis	0.01	0.01	0.00	0.02	0.02	0.05	0.12**
OCR period only	0.00	-0.01	-0.01	-0.01	0.02	0.01	0.05
Post Disinflation (92Q3 – 10Q1)	0.00	0.01	0.00	0.02	0.02	0.04	0.12**
No Target	0.00	0.01	0.00	0.01	0.00	0.03	0.12**
Target with η=1	0.00	0.01	0.00	0.03	0.02	0.04	0.14**

* denotes significance at the 10% level, ** at the 5% level and *** at the 1% level.

Robustness checks include using annual expectations of inflation and the output gap, excluding the financial crisis (data up to 2008Q2), analysing only post disinflation data (after 92Q2 and 93Q1 for New Zealand and Switzerland respectively), removing the money target, or setting η_y to 1. Overall, they result in little changes to the coefficients or their significance. For New Zealand, however, it seems that once the OCR regime was adopted, loans ceased to be a policy target.

Table 6: Robustness Checks - coefficients on money/credit aggregate only
Switzerland

	Aggregate Used				
	MB	M1	M2	M3	Loans
Full Sample with Variable η Target	-0.05	-0.01	-0.02	0.00	0.24***
Exclude Financial Crisis	-0.07	0.00	0.01	0.05	0.23***
No Target	0.03	0.01	0.01	0.10**	0.21***
Target with η=1	0.01	0.00	0.00	0.04	0.23***
Post Disinflation (93Q1-10Q1)	0.00	0.00	0.01	0.02	0.02
No Target or Financial Crisis	0.02	0.00	0.01	0.08	0.21***
No Target & Post Disinflation	0.01	0.01	0.01	0.06	0.02

* denotes significance at the 10% level, ** at the 5% level and *** at the 1% level. Unless otherwise stated, the estimation period for the robustness checks is the full sample of 1985-2010.

Similarly, the coefficients for money aggregates for Switzerland remain insignificantly different from zero. The coefficient for M3 does become significant when no target is added; however, this result is not robust to excluding the financial crisis or the period of high inflation in the late 80s. The policy setting did, however, respond systematically to total loan changes during the sub-sample period that ended in 92Q4. If loan growth exceeded its target by one percentage point, the SNB raised the policy setting on average by slightly more than 20 basis points. There is no econometric evidence that the SNB continued to adjust its policy lever to total loan changes near the end of the whole sample period (93Q1-10Q1).

Conclusion

The question of whether central banks should target money growth has been a contentious issue in practice. Monetary targets do play a role in the monetary policy strategy of the European Central Bank. Elsewhere evidence for monetary targets is scant. The recent academic literature has turned its back on monetary aggregates. The New Keynesian framework does not include any reference to the money supply.

Using the canonical New Keynesian model, we analyse whether central banks significantly target money or credit growth. The results suggest that the Reserve Bank of New Zealand does not target money growth rates. There is some evidence though that it responds to the growth rate of total loans.

The same reaction function was applied to data from the Swiss National Bank. The SNB released an target for the growth in the money base over the 1985-1996 period. Due to data problems we cannot say with any degree of certainty whether the Swiss National Bank operated in a manner consistent with the reaction function underlying the New Keynesian framework. Indications are, however, that the SNB has not systematically reacted to any money aggregate – even during the period when SNB claimed to watch monetary aggregates very closely. Instead, the central bank of Switzerland raised the setting of the policy instrument if total loans grew faster than targeted. Just like in New Zealand, however, the once fairly close relationship between the short-term interest rate and total loan growth seems to have disappeared in more recent times.

Overall, these results suggest that the New Keynesian framework can reasonably explain the path of policy for New Zealand, and that monetary policy can be implemented in practice without reliance on monetary aggregates.

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