Economics Bulletin

Volume 30, Issue 1

Financial volatility and optimal instrument choice: A revisit to Poole's analysis

Meixing Dai
BETA, University of Strasbourg, France

Abstract

In this paper, using an IS-LM model with reserve market, we examine weather the operating procedure actually adopted by many central banks in the world, i.e. targeting directly short run interest rates and hence indirectly market interest rates, is more efficient in stabilizing output than a monetary base operating procedure if shocks affecting the interest rate policy are taken into account. Our results suggest that for an interest rate policy to be more efficient than a monetary aggregate oriented policy, central banks should directly target market interest rates which are narrowly linked to the aggregate spending.

Acknowledgments: I am grateful to Gilbert Koenig for stimulant discussions.
Citation: Meixing Dai, (2010) "Financial volatility and optimal instrument choice: A revisit to Poole's analysis ", *Economics Bulletin*, Vol. 30 no.1 pp. 605-613.
Submitted: Jan 14 2010. **Published:** February 18, 2010.

1. Introduction

In a seminal contribution, Poole (1970) has analyzed how the monetary policy authority can choose between employing an interest rate or a monetary aggregate as its policy instrument. He has shown that the stochastic structure of the economy, i.e. the relative importance of different disturbances, would determine the optimal instrument choice. Since then, a large literature has been developed to examine this issue by incorporating other factors ignored in Poole's model, notably inflation, expectations, and aggregate supply disturbances on the one hand, and to extend the framework for investigating the role of policy targets, intermediate targets, and information in the conduct of policy on the other hand (Sargent and Wallace 1975, B. Friedman 1975, Craine and Havenner 1981, Turnovsky 1980, Canzoneri *et al*. 1983, McCallum 1988).[1] The Poole's analysis has also inspired the literature on central bank's operating procedures (Goodfriends 1983, Waller 1990, Walsh 1982, 2003). Recent general discussions about the optimal instrument choice for the objectives of achieving price and output stability include McCallum (1999, 2005) and Woodford (2008). Some studies explore Poole-type scenarios within modern general equilibrium models (Carlstrom and Fuerst 1995, Ireland 2000, Galì 2003, Collard and Dellas 2005, Hoffmann and Kempa 2009). Current financial crisis contributes to renew the debate over the optimal instrument choice by including the objective of financial stability for the central bank. Goodhart *et al*. (2009) suggest that the interbank interest rate is the optimal monetary instrument for prudential purposes and can be used for ensuring the financial stability. This contrasts with the analysis of De Grauwe and Gros (2009) who consider that the central bank must use a second instrument (reserve requirement or macro-prudential measures) besides the interest rate to simultaneously stabilize inflation expectations and the financial markets.

The Poole's analysis has had a considerable impact on the practice of monetary policy making. Observing increasing instability in money demand due to financial innovation in the 1970s and 1980s, many central banks have abandoned money supply rules in favour of interest rate targets, considered to have the advantage of being more transparent.[2] In practice, major central banks in the world usually target the very short-run interest rates (Walsh, 2003). In the case of the Fed, Goodfriend (1991) has shown that central bankers prefer continuity of the short rate and indirect rate targeting because this gives the Fed, accepting the risk of being misinterpreted, the option of quietly changing its target.

We remark that most theoretical studies examining the optimal instrument choice do not distinguish the short run interbank rate and other medium and long run rates affecting aggregate demand. In the absence of distinction between these interest rates, one well-known result obtained in the literature is: increased financial sector volatility (notably, money demand or money multiplier shocks) increases the desirability of an interest rate oriented policy procedure. If the main source of short-run instability arises from aggregate spending, a policy that stabilizes a monetary aggregate will lead to greater output stability. Since the money demand is viewed as highly unstable and difficult to predict over short time horizons since the 1980s, the consensus among policy analysts is that greater output stability can be achieved by stabilizing interest rates, letting monetary aggregates fluctuate. However, this result is obtained in a framework where the control of market interest rates is very simplified, i.e. the central banks directly controls the lending interest rates at which consumers and firms borrow to consume and to invest.

---

[1] See Friedman B. (1990) and Walsh (2003) for a survey.

[2] The stability of the money demand is used by the Bundesbank to justify its money supply targeting. The stability of velocity empirically observed in the Euro zone is often cited for justifying the monetary pillar in the two-pillar strategy of the European Central Bank.

The aim of this paper is to reexamine the above consensus by using an IS-LM model extended to include the money supply as function of monetary base and market interest rate, and the reserve market on which are determined the funds interest rate and total reserves given the central bank's discount interest rate. It is shown that increased financial sector volatility does not increase the desirability of an interest rate oriented policy procedure if its focus is the funds rate. Our study, by focusing on financial frictions in the first stage of the transmission mechanism of an interest rate policy, is related to some studies which examine the final stage of this transmission mechanism and analyze the responsiveness of the banking system to various monetary policy tools when determining the lending interest rates.[3]

The remainder of the paper is organized as follows. The next section presents an IS-LM model integrating a money supply function and the equilibrium condition on the reserve market. The third section summarizes the standard analysis of optimal instrument choice under three alternative operating procedures, i.e. monetary supply, interest rate and monetary base procedures. The fourth section examines the macroeconomic performance under the funds rate operating procedure in comparing it with the monetary base procedure. The final section concludes.

2. The Model

Aggregate spending and money market equilibrium condition are respectively given by:

$$y_t = -\alpha\, i_t + u_t\,, \qquad \alpha > 0\,, \tag{1}$$

$$m_t = y_t - \lambda i_t + v_t\,, \qquad \lambda > 0\,, \tag{2}$$

where y_t is the actual output, i_t the nominal interest rate at which banks lend to non-financial private agents, and m_t the money supply. The variables y and m are expressed in natural logarithm. u_t and v_t are respectively mean-zero disturbances affecting the demand of goods and the demand of money with their respective variance given by σ_u^2 and σ_v^2.

Equation (1) represents the IS curve and stipulates that the aggregate spending depends on the nominal interest rate since the realized and expected inflation rates are assumed to be zero. Equation (2) represents the LM curve with a real money demand depending on real income and the nominal interest rate.

The link between the money supply and the monetary base is modeled as follows:[4]

$$m_t = b_t + h i_t + \omega_t\,, \qquad h > 0\ . \tag{3}$$

where b_t $(\equiv \log MB_t)$ is the monetary base in log terms, and money multiplier ($m_t - b_t$, in log terms) is assumed to be an increasing function of nominal interest rate, and ω_t is a random money-multiplier disturbance with mean zero and variance σ_ω^2. The monetary base MB_t can be decomposed in two distinct parts, i.e. the total reserve TR_t and currency C_t. The latter is assumed to be fixed and it generally accounts for the majority of the monetary base. In log terms, we have:

$$b_t \equiv \log MB_t \approx \frac{TR^*}{MB^*}\log TR_t + \frac{C^*}{MB^*}\log C_t \equiv \psi\chi_t + (1-\psi)c_t\,, \tag{4}$$

where $\chi_t \equiv \log TR_t$, $c_t \equiv \log C_t$, $\psi \equiv \frac{TR^*}{MB^*}$ and the superscript asterisk designs the steady state.

[3] See e.g. Aftalion and White (1977) and VanHoose (1985).

[4] See Modigliani *et al.* (1970), and McCallum and Hoehn (1983).

We extend the model by introducing a simplified description of the reserve market. The central bank conducts open market operations to affect the supply of reserves in the banking system and the funds rate, i_t^f, the interest rate banks in need of reserves pay to borrow from banks with surplus reserves. Variations in the total quantity of bank reserves are associated with movements in broader money (M1, M2, etc.). Similarly, movements in the funds rate influence other market interest rates. The latter are represented in this model by i_t for simplification. If the central bank controls the discount rate (i_t^d), total reserves will depend on i_t^d and the monetary base b_t will be endogenous. Reserve demand arises primarily from the requirement that banks hold reserves equal to a specified fraction of their deposit liability and is assumed to be a negative function of i_t^d. Other factors such as aggregate income and prices are simply treated as part of the error term, ε_t^d, i.e. a disturbance of reserve demand with mean zero and variance $\sigma_{\varepsilon d}^2$. The function of total reserve demand is:

$$\chi_t^d \equiv \log TR_t^d = -ai_t^f + \varepsilon_t^d . \tag{5}$$

The total supply of reserves held by banking system can be expressed as the sum of the reserves that banks have borrowed from the central bank (BR_t) plus nonborrowed reserves (NBR_t), i.e. $TR_t^s = BR_t + NBR_t$. Expressed in log terms, we have:

$$\chi_t^s \equiv \log TR_t^s \approx \frac{BR^*}{TR^*}\log BR_t + \frac{NBR^*}{TR^*}\log NBR_t = \varphi\chi_t^b + (1-\varphi)\chi_t^{nb} , \tag{6}$$

where $\varphi \equiv \frac{BR^*}{TR^*}$, $\chi_t^b \equiv \log BR_t$ and $\chi_t^{nb} \equiv \log NBR_t$.

We postulate, similarly to Walsh (2003), a simple reserve borrowing function:[5]

$$\chi_t^b = \beta(i_t^f - i_t^d) + \varepsilon_t^b . \tag{7}$$

The manner in which a variation in i_t^f affects reserve borrowings, given by the coefficient $\beta > 0$ in (7) depends on how such a variation affects expectations of future funds rate levels which are not modelled here. The shock ε_t^b represents other factors affecting the reserve borrowings. The difference between i_t^f and i_t^d is due to non-price rationing of access to the central liquidity. If there were no nonprice rationing at the discount window, the funds interest rate would never rise above the discount interest rate, because a bank would never pay more for reserves than it would have to pay at the discount window (Goodfriend, 1983).

The central bank is assumed to target the funds rate through open market operations conducted once every day in the way that the effects on i_t^f of shocks affecting the reserve demand and the borrowed reserves are entirely compensated. Hence, the funds rate is determined by the discount rate. However, the funds rate targeting is imperfect since the latter is still subject to a monetary policy shock ε_t^s with mean zero and variance $\sigma_{\varepsilon s}^2$. This kind of interest rate policy implies that the nonborrowed reserves are given by:[6]

$$\chi_t^{nb} = \frac{1}{1-\varphi}\varepsilon_t^d - \frac{\varphi}{1-\varphi}\varepsilon_t^b + \varepsilon_t^s . \tag{8}$$

---

[5] In Walsh (2003), the functions BR_t and NBR_t are not specified in log terms. It is easy to rewrite them in logs terms so that we have not shown the details here. In a more sophisticated version of a reserve market model, the total supply of reserves could also depend on future interest rates (Walsh, 1982; Goodfriends, 1983).

[6] For the implications of other operating procedures, see Walsh (2003, pages 451-71) who gives also a brief history of operating procedures used by the Fed and some other central banks.

The equilibrium condition on the reserve market, i.e. $\chi_t^d = \chi_t^s$, can be rewritten using equations (5)-(8) as:

$$-ai_t^f = \varphi\beta(i_t^f - i_t^d) + (1-\varphi)\varepsilon_t^s . \qquad (9)$$

Equations (5) and (9) directly yield the solution of i_t^f and χ_t in terms of i_t^d and shocks:

$$i_t^f = \frac{\beta\varphi}{a+\beta\varphi} i_t^d - \frac{1-\varphi}{a+\beta\varphi}\varepsilon_t^s , \qquad (10)$$

$$\chi_t = -\frac{a\beta\varphi}{a+\beta\varphi} i_t^d + \frac{a(1-\varphi)}{a+\beta\varphi}\varepsilon_t^s + \varepsilon_t^d . \qquad (11)$$

The model is completed by a specification of the monetary policy maker's objective, assumed to be the minimization of the variance of output deviations. By normalizing the economy's equilibrium level of output so that the true steady state value of output is zero in the absence of shock, the central bank's loss function is quadratic in output around zero:

$$E[y_t]^2 . \qquad (12)$$

Since the central bank has not an objective of output higher than zero, this specification avoids the issue of time inconsistency. As a result, we can focus on the optimal choice of monetary policy instruments. For simplicity, all shocks are treated as mean-zero, serially and mutually non-correlated process.

3. Optimal instrument choice : the standard analysis

It is assumed that the central bank must set policy before observing the current disturbances to the goods and money markets, and that information on interest rates, but not output, is immediately available. This informational assumption reflects a situation in which the central bank can observe market interest rates continuously, but data on inflation and output might be available only monthly or quarterly. With imperfect information about the evolution of the economy, the central bank will be unable to determine from a movement in market interest rates the exact source of any economic disturbances that might be affecting the economy. In effect, a rise in interest rate could be induced by a positive money demand shock calling for letting the money supply expand or a positive aggregate demand shock calling for contractionary monetary policy to stabilize output.

Poole (1970) asks whether, in this kind of environment, the central bank should try to hold market interest rates constant or should hold a monetary quantity constant while allowing interest rates to move. Under the assumption that the objective of policy is to stabilize real output around its steady state value, the answer to his question can be obtained by comparing the variance of output implied by two alternatives policies.

If the central bank controls perfectly i_t and m_t, the solution to the Poole's problem of optimal instrument choice can be obtained by minimizing the loss function (12) under alternative choices of policy instruments, subject to the reduced model constituted by equations (1) and (2). The timing is as follows: the central bank sets either i_t or m_t at the start of the period; the stochastic shocks u_t and v_t occur, determining the value of the endogenous variables. If m_t is the policy instrument, y_t and i_t are endogenous. In this case, i_t is determined using equation (2) and then y_t is determined using the solution of i_t and equation (1). If the central bank chooses i_t as the policy instrument, the endogenous variables y_t and m_t are independent one another and they are determined respectively by equations (1) and (2). In effect, under the interest-rate operating procedure, the central bank allows the money stock to adjust endogenously to equal the money demand for given interest rate once the level of income is determined.

When the money stock is the instrument, the output is:

$$y_t = \frac{\alpha m_t - \alpha v_t + \lambda u_t}{\lambda + \alpha}, \tag{13}$$

Setting m_t so that $E[y_t] = 0$, the variance of output under money-supply procedure is:

$$E_m[y_t]^2 = \frac{\alpha^2 \sigma_v^2 + \lambda^2 \sigma_u^2}{(\lambda + \alpha)^2}. \tag{14}$$

Under the alternative policy, i.e. the central bank uses i_t as the policy instrument, the money market equilibrium condition is not anymore necessary for determining the output. The latter is determined using equation (1) as $y_t = -\alpha\, i_t + u_t$. Setting i_t so that $E[y_t] = 0$, the income is given by $y_t = u_t$ and the value of the objective function is:

$$E_i[y_t]^2 = \sigma_u^2. \tag{15}$$

The optimal instrument choice is decided by comparing the variance of output implied by these two alternative operating procedures. The interest rate operating procedure is a better choice than the money-supply operating procedure if $E_i[y_t]^2 < E_m[y_t]^2$, i.e.:

$$\sigma_v^2 > \frac{\alpha(2\lambda + \alpha)}{\alpha^2} \sigma_u^2. \tag{16}$$

Equation (17) implies that an interest-rate procedure is more likely preferred to a money-supply procedure when the variance of money demand disturbances is larger, the LM curve is steeper (smaller λ) and the IS curve is flatter (larger α), and *vice versa*. The control of money supply allows mitigating the effects of demand shock on the variance of output on the one hand, but contributes to increase it due to the money demand shock on the other hand.

In practice, no central bank has direct control over a narrow monetary aggregate such as the monetary base. Variations in this aggregate are associated with these in broader measures of money supply. To take account of the implications of the imperfect control of money supply, Poole’s model is modified to distinguish between the base as a policy instrument and the money supply (B. Friedman, 1990). Substituting m_t given by equation (3) into equation (2) yields

$$b_t + h i_t + \omega_t = y_t - \lambda i_t + v_t. \tag{17}$$

Assume that the central bank directly controls i_t. Under an interest-rate procedure, equation (17) is used to determine endogenously b_t and hence is irrelevant for output determination. The output is still determined by equation (1) so that $y_t = -\alpha\, i_t + u_t$. Setting i_t to minimize the variance of output leads to $E_i[y_t]^2 = \sigma_u^2$, the same as before.

Under a monetary-base operating procedure, setting b_t to minimize $E[y_t]^2$ subject to equations (1) and (17) yields the level and variance of output:

$$y_t = \frac{(\lambda + h)\, u_t - \alpha v_t + \alpha \omega_t}{\alpha + \lambda + h}, \tag{18}$$

$$E_b[y_t]^2 = \frac{(\lambda + h)^2 \sigma_u^2 + \alpha^2 (\sigma_v^2 + \sigma_\omega^2)}{(\alpha + \lambda + h)^2}. \tag{19}$$

The interest rate procedure is considered as a better choice than the monetary base procedure if and only if $E_i[y_t]^2 < E_b[y_t]^2$ or equivalently

$$\sigma_v^2 + \sigma_\omega^2 > \left[1 + \frac{2(\lambda + h)}{\alpha}\right]\sigma_u^2 . \qquad (20)$$

By directly controlling i_t, the central bank is able to neutralize the effects of shocks ω_t on output. In contrast, the presence of money-multiplier shock makes the monetary base procedure less attractive because it makes more likely that an interest rate procedure will yield a smaller variance of output. This well-known standard analysis suggests that, as long as shocks affecting the aggregate spending is not the main source of short run instability, if the money demand is viewed as highly unstable and difficult to predict over short run horizons and the money supply is controlled with much errors, greater output stability can be achieved by controlling interest rates, letting monetary aggregates fluctuate endogenously. Hence, the extension to monetary base operating procedure reinforces the basic message of Poole's analysis in the sense that increased financial sector volatility (ω_t and v_t) increases the desirability of an interest-rate operating procedure over a monetary aggregate procedure.

However, we remark that the above extension has introduced an asymmetrical assumption concerning the controllability of monetary aggregates and interest rates: the central bank controls imperfectly the money supply through the control of monetary base while it can perfectly control the interest rate.

In the following, we examine the implication of an alternative assumption according to which the central bank indirectly controls i_t through a funds rate operating procedure. Under this procedure, the central bank fixes the discount rate and regularly conducts open market operations to minimize the fluctuations of the funds rate and hence market interest rates.

4. Implication of imperfect control of market interest rates

Under the funds rate operating procedure, the central bank fixes the discount rate and conducts open market operations to stabilize the funds rate. Substituting χ_t given by equation (11) into equation (4), we obtain the monetary base for $c_t = \bar{c}$ (i.e. the amount of currency is given at period *t*) as follows:

$$b_t = -\frac{a\beta\varphi\psi}{a + \beta\varphi} i_t^d + \frac{a\psi(1-\varphi)}{a + \beta\varphi}\varepsilon_t^s + \psi\varepsilon_t^d + (1-\psi)\bar{c} . \qquad (21)$$

Using equations (17) and (21), the equilibrium condition on the money market becomes

$$-\frac{a\beta\varphi\psi}{a + \beta\varphi} i_t^d + \frac{a\psi(1-\varphi)}{a + \beta\varphi}\varepsilon_t^s + \psi\varepsilon_t^d + (1-\psi)\bar{c} + hi_t + \omega_t = y_t - \lambda i_t + v_t . \qquad (22)$$

Solving equation (22) for i_t yields

$$i_t = \frac{1}{\lambda + h}\left[y_t - (1-\psi)\bar{c} + v_t + \frac{a\beta\varphi\psi}{(a + \beta\varphi)} i_t^d - \frac{a\psi(1-\varphi)}{(a + \beta\varphi)}\varepsilon_t^s - \psi\varepsilon_t^d - \omega_t \right]. \qquad (23)$$

Substituting i_t given by equation (23) into equation (1) leads to

$$y_t = \frac{\alpha(1-\psi)\bar{c} - \alpha v_t + (\lambda + h)u_t + \alpha\psi\varepsilon_t^d + \alpha\omega_t}{\alpha + \lambda + h} + \frac{a\alpha\psi[(1-\varphi)\varepsilon_t^s - \beta\varphi i_t^d]}{(a + \beta\varphi)(\alpha + \lambda + h)} . \qquad (24)$$

Setting i_t^d in equation (24) to have $E[y_t] = 0$, the variance of output under the funds rate operating procedures is given by

$$E_f[y_t]^2 = \frac{(\lambda + h)^2\sigma_u^2 + \alpha^2(\sigma_v^2 + \sigma_\omega^2 + \psi^2\sigma_{\varepsilon d}^2)}{(\alpha + \lambda + h)^2} + \frac{a^2\alpha^2\psi^2(1-\varphi)^2\sigma_{\varepsilon s}^2}{(a + \beta\varphi)^2(\alpha + \lambda + h)^2} . \qquad (25)$$

Comparing the variance of output given by (19) and that given by (25), it follows that the funds rate procedure is preferred to monetary-base procedure if $E_f[y_t]^2 < E_b[y_t]^2$. That leads to the following condition:

$$\sigma_{\varepsilon d}^2 + \frac{a^2(1-\varphi)^2}{(a+\beta\varphi)^2}\sigma_{\varepsilon s}^2 < 0\,, \tag{26}$$

which is never verified since the left hand of (26) is superior to zero.

Controlling the discount rate and conducting open market operations to target the funds rate do not allow the central bank to neutralize the effects of shocks ω_t on output. Moreover, this procedure generates its own shocks so that the variance of output is in effect larger under the funds rate operating procedure whatever is the relative importance of shocks affecting the aggregate spending, money-multiplier and money demand. The presence of shocks affecting the reserve demand and the monetary policy shock (error term ε_t^s in the non-borrowed reserves) make the variance of output clearly larger under a funds rate procedure than under a monetary base procedure. Therefore, the well-known basic message of Poole's analysis according to which increased financial sector volatility increases the desirability of an interest-rate operating procedure over a monetary aggregate procedure is only valid if the interest rate procedure targets the market interest rates. In the event of relatively modest aggregate demand shocks, the central bank would prefer an interest rate procedure to a monetary-base procedure if it has the mandate to directly target the market interest rates determined by the equilibrium condition on the money market and other financial markets. Before the current crisis, central banks generally target the short run interest rates. There may be rather little inconvenience if shocks affecting the reserve demand and the monetary policy shock affecting the funds rate are very small. Furthermore, a funds rate procedure has the advantage of being more transparent than a monetary-base procedure. During the current crisis, central banks in some countries have intervened in asset markets to target the interest rates that directly affect the aggregate spending under what is call the quantitative easing policy. This shift in monetary operating procedure is coherent with the implications of our findings.

5. Conclusion

In an IS-LM model with reserve market, we have reexamined the issue of optimal instrument choice for monetary policy by comparing a funds rate operating procedure with other operating procedures targeting the money supply, the interest rate and the monetary base respectively. It is shown that, a short run interest rate operating procedure (such as funds rate procedure) is less effective in stabilizing output than a monetary base procedure. The fact that central banks, in practice, prefer to have the continuity of very short run interest rate and indirect rate targeting may be explained by the advantage in terms of transparency offered by a short run interest rate procedure, which might counterbalance the costs in terms of stabilization when shocks affecting the reserve demand and the monetary policy shock affecting the funds rate are small. In the event of extreme financial crisis, a central bank might have to directly target market interest rates for its interest rate policy to be successful.

References:

Aftalion, F., and L. J. White (1977) "A Study of a Monetary System with a Pegged Discount Rate under Different Market Structures" *Journal of Banking and Finance* **1**(4), 349-71.

Canzoneri, Matthew, Dale Henderson and Kenneth Rogoff (1983) "The Information Content of the Interest Rate and the Optimal Monetary Policy" *Quarterly Journal of Economics* **98**, 545-66.

Carlstrom, C. and T. Fuerst (1995) "Interest rate rules vs. money growth rules: A welfare comparison in a cash in advance economy" *Journal of Monetary Economics* **36**(2), 247-68.

Collard, Fabrice, Harris Dellas (2005) "Poole in the New Keynesian Model" *European Economic Review* **49**, 887-907.

Craine, Roger and Arthur Havenner (1981) "Choosing a Monetary Instrument: The Case of Supply-Side Shocks" *Journal of Economic Dynamics and Control* **2**, 217-234.

De Grauwe, Paul and Daniel Gros (2009) "A New Two-Pillar Strategy for the ECB" CEPS Policy Brief No. 191/30 June 2009.

Friedman, Benjamin (1975) "Targets, Instruments, and Indicators of Monetary Policy" *Journal of Monetary Economics* **1**, 443-73.

Gali, Jordi (2003): "New Perspectives on Monetary Policy, Inflation, and the Business Cycle" in: Dewatriport, Mathias et al. (Eds.), *Advances in Economics and Econometrics*: *Theory and Applications*; eighth World Congress, 151-197.

Goodfriend, Marvin (1983) "Discount window borrowing, monetary policy, and the post-October 6, 1979 Federal Reserve operating procedure," *Journal of Monetary Economics* **12**, 343-56.

Goodfriend, Marvin (1991) "Interest rates and the conduct of monetary policy," *Carnegie-Rochester Conference Series on Public Policy* **34**, 7-30.

Goodhart, C.A.E., P. Sunirand and D.P. Tsomocos (2009) "The optimal monetary instrument for prudential purposes" *Journal of financial stability*, forthcoming.

Hoffmann, Mathias and Bernd Kempa (2009) "A Poole Analysis in the New Open Economy Macroeconomic Framework" *Review of International Economics* **17**(5), 1074-97.

Ireland, Peter N. (2000) "Interest Rates, Inflation, and Federal Reserve Policy since 1980" *Journal of Money, Credit, and Banking* **32**, 417-434.

McCallum, Bennett T. and James G. Hoehn (1983) "Instrument Choice for Money Stock Control with Contemporaneous and Lagged Reserve Requirements: Note" *Journal of Money, Credit and Banking* **15**(1), 96-101.

McCallum, Bennett T. (1988) "Targets, Indicators, and Instruments of Monetary Policy" in: *Monetary Policy in an Era of Change,* Washington, D. C.: American Enterprise Institute.

McCallum, Bennett T. (1999) "Recent developments in the analysis of monetary policy rules" *Federal Reserve Bank of St Louis Review* **81**(6), 3-12.

McCallum, Bennett T. (2005) "What have we learned since October 1979" *Federal Reserve Bank of St Louis Review* **87**(2), 287-91.

Modigliani, Franco, Robert Rasche and J. Philip Cooper (1970) "Central Bank Policy, the Money Supply, and the Short-Term Rate of Interest" *Journal of Money, Credit and Banking* **2**(2), 166-218.

Poole, William (1970) "Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model" *Quarterly Journal of Economics* **84**, 197-216.

Sargent, Thomas J. and Wallace, Neil (1975) "Rational Expectations, the Optimal Monetary Instrument, and the Optimal Money Supply Rule" *Journal of Political Economy* **83**(2), 241-54.

Turnovsky, Stephen (1980) "The Choice of Monetary Instruments under Alternative Forms of Price Expectations" *The Manchester School of Economics and Social Studies* **48**, 39-62.

VanHoose, David (1985) "Bank Market Structure and Monetary Control" *Journal of Money, Credit, and Banking* **17**, 298-311.

Waller, Christopher J. (1990) "Administering the Window: A Game Theoretic Model of Discount Window Borrowing" *Journal of Monetary Economics* **25**(2), 273-87.

Walsh, Carl E. (1982) "The effects of alternative operating procedures on economic and financial relationships" *Monetary Policy and Issues in the 1980s*, Proceedings, Federal Reserve Bank of Kansas City, 133-80.

Walsh, Carl E. (2003), *Monetary Theory and Policy*, the MIT Press.

Woodford, Michael (2008) "How important is Money in the Conduct of Monetary Policy?" *Journal of Money, Credit and Banking* **40**(8), 1561-98.