Would it Be Optimal for Central Banks to Include Asset Prices in their Loss Function ?

Alain Durré*

June 1, 2001

Abstract

This paper has three purposes. First, we discuss under which conditions a Central Bank should include financial asset prices in its objectives' function and how this affects the optimal monetary policy in a rational expectations forward-looking model. Second, we show that the volatility of the policy instrument (i.e. nominal interest rate) is modified compared to the case where financial asset prices do not appear in the monetary policy loss function. We find that the volatility of nominal interest rate is lower in the first case when the economy faces demand shocks contrary to supply and financial shocks. In both cases, the reaction of monetary policy instruments to several shocks in the economy is depending on the sensibility of aggregate demand to real stock prices. Third, we show that the shape of the nominal-interest rate response to shocks depends on the weights given to inflation targeting and financial stability's goal.

JEL Classification : E100, E310, E520

Keywords : Monetary Policy Objectives, Financial Asset Prices Targeting, Nominal Interest Rate

*I would like to thank Eric Dor, Jacques Drèze, Philippe Monfort, Jean-Charles Rochet and Mark Hall for helpful comments. This research is part of a programme supported by the Belgian government (Pôles d'Attraction inter-universitaires PAI P4/01). Correspondence : Institut de Recherches Économiques et Sociales, Université Catholique de Louvain (IRES-UCL), Department of Economics, 3, Place Montesquieu, B-1348 Louvain-la-Neuve (Belgium); e-mail : durre@ires.ucl.ac.be

1. Introduction

The interest of Central Banks in the evolution of financial markets has appeared in a explicit way in the last three years. Indeed, one can frequently read in the comments of the monetary policy committee that, beside the problem with the long-run productivity growth, the state of financial markets has become another important source of uncertainty. This uncertainty can bear on two aspects. The first one deals with the impact of real stock prices on aggregate demand. We can suppose that impact produces a wealth effect on consumption (Poterba, 2000) and a cost effect on investment[1] (Wadhwani, 1999). The second one is to wonder to what extent, in case of huge crises, a financial instability involves a macroeconomic one. Some authors associate several periods of economic weakness with a collapse of financial markets (see Bernanke and Lown (1991) for the United States and Bernanke and Gertler (1999) for emerging markets). We may also fear that severe corrections on stock markets may entail a huge confidence crisis for a long time. In this case, a financial crisis would hit all agents whatever their implications in the stock markets.

By the way, an interesting example is the Japanese experience during the eighties. Before the collapse of the financial markets, Japan had enjoyed low inflation and strong growth for several years. Moreover these developments occured against a backdrop of an appreciating yen, high rates of investment and accelerating productivity growth as well as large increases in stock and real estate prices (see figure 1.1).

So the question faced by the Bank of Japan was whether it needed or not to tighten monetary policy. It would have been for the government to implement a restrictive monetary policy and to receive public support while experiencing low inflation and high productivity growth rate[2].

In a matter of few years, stock and land prices tripled. From the level of 11,542 points at the end of 1984, the Nikkei index went up to 38,915 five years later. Two years later, the Commercial Land Price Index for large cities increased from 38.4 in 1986 to 103.0 at the beginning of the nineties. During this period, the real growth rate of gross domestic product grew 26%, fed on private consumption (+25%), housing investment (+53%) and industrial invest-

[1]Note that by definition the higher the earnings/price ratio, the lower the cost of risk capital.

[2]Even if the situations about real estate prices and the banking system are quite different, the recent experience in the United States presents some similar developments like Japan in the 80's.

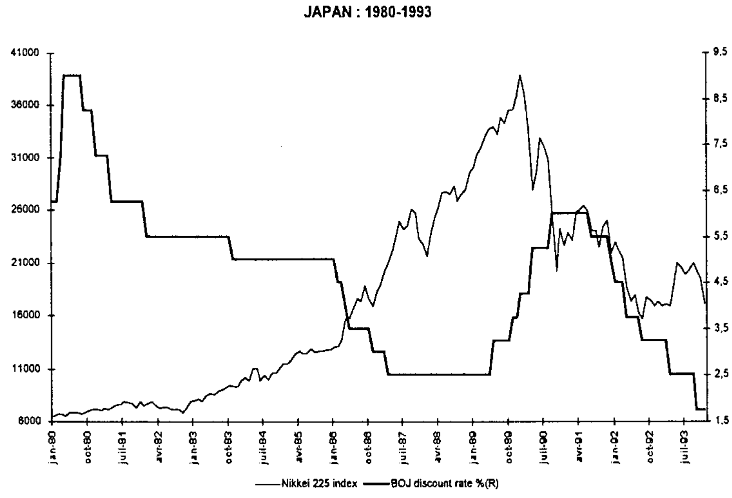

Figure 1.1: Stock Market Prices Index and Central Bank Discount Rate

ment (+47%). The next story is known : at the beginning of the 1990s, most of asset prices plummeted, sometimes cancelling the previous gains. As noted by Ito and Iwaisako (1996), these fluctuations in the financial asset prices did not only affect the balance sheets of the agents (indivuduals and firms) but caused serious macroeconomic problems[3].

The first aspect of the relation between asset prices and monetary policy, which deals with the role of asset prices in the monetary transmission mechanism, is studied in recent papers written by Smets (1997), Bernanke and Gertler (1999), Dor and Durré (2000) as well as Cecchetti, Genberg, Lipsky and Wadhwani (2000).

We analyse here the second aspect of the question. Using the same theoretical framework as Dor and Durré (2000), what are the consequences on monetary policy when establishing the stability of financial prices as a target ? By including

[3]In the first half of the 1990s, the real growth rate of gross domestic product was close to zero on average. At this stage, it could be difficult to attribute the poor economic performance entirely to the financial markets collapse because of the structural weakness of banking system at that time which implied a credit crunch. But, the financial crisis may have an important indirect impact on activity through its effects on the general confidence index. In this sense, we agree with a possible relationship between stock prices and real activity explained by Poterba (2000).

a target for financial asset prices, the Central Bank shows deliberately its will to prevent any financial market collapse.

First, we find that the magnitude of the nominal-interest rate response depends on the nature of economic shocks. So that in case of demand shocks the monetary policy reaction is inferior to the case where monetary authorities only follow stabilization targets for output gap and inflation. Second, we find that the volatility of the nominal interest rate decreases when the sensibility of aggregate demand to stock market fluctuations increases. Third, we show that the arbitrage between inflation targeting and financial stability targeting modifies the shape of the nominal-interest rate response.

The plan of the paper is as follows. Section II presents the theoretical model with its informational structure : a new keneysian model with perfect competition and forward-looking rational expections. Section III justifies the integration of a financial stability parameter as a new target that should be integrated in the monetary policy reaction function. Section IV discusses the results. Section V deals with the trade-off between inflation targeting and financial asset prices targeting policies while section VI offers some concluding remarks.

2. The Model

In a context of a new keynesian model with perfect competition and forward-looking expectations, we consider the case of a closed economy. Aggregates demand and supply are equalized. However, aggregate demand is partly influenced by stock market prices, which are determined by the dividend discount model.

2.1. Aggregate demand

The aggregate demand is a standard IS function involving a negative effect from the expected real interest rate and a positive one from an exogenous disturbance, ε_t^d. Additionally, we assume that real stock prices evolution influences the real aggregate demand, y_t^d, through consumption as well as industrial investment . Recent works in the litterature find some empirical evidence of this assumption (Ludvigson and Steindel (1999) or Poterba (2000)). The real aggregate demand then becomes :

$$y_t^d = \alpha - \beta(R_t - E_t\pi_{t+1}) + \gamma l_t + \varepsilon_t^d \tag{2.1}$$

where α is a constant, R_t is the nominal-interest rate at date t, and l_t is the real stock price at date t. Note that π_t is the inflation rate and the expected one is

$E_t\pi_{t+1} = E_t(p_{t+1} - p_t)$ in which p_t and p_{t+1} are respectively the price level at date t and at date t+1.

2.2. Aggregate supply

The real aggregate supply, y_t^s,which can be derived from profit maximization under perfect competition with nominal rigidities, assumes that the nominal wage is set in a labour contract prior the realization of the price level[4]. This function reflects the maximizing behavior of private agents on localized markets when they have only partial information about contemporaneous nominal aggregates:

$$y_t^s = \overline{y} + \theta(p_t - E_{t-1}p_t) + \varepsilon_t^s \tag{2.2}$$

So, aggregate supply can deviate from its natural level $\overline{y}$ either by deviations of current prices from expectations or by exogenous technological shocks ε_t^s. Deviations of current prices from expectations are represented by the terms $p_t - E_{t-1}p_t$ where $E_{t-1}p_t$ is the expectation at date t-1 on the price level in the next period, at date t.

2.3. Stock market dynamics

On the stock market, we assume that the real stock price, l_t, follows an arbitrage condition according to which the expected return on equities must be equal to the expected real riskless interest rate plus a time-varying risk premium, ε_t^l[5]. A log-linear approximation of this arbitrage condition, in an usual notation, is given by :

$$R_t - E_t\pi_{t+1} + \varepsilon_t^l = \rho E_t l_{t+1} + (1-\rho)E_t d_{t+1} - l_t \tag{2.3}$$

[4]The wage level is expected to clear the labour market. Later, during the period, firms learn the price from the output market and the contract which maximizes their profits. Because that price level is not known when the contract is made, the expected utility-maximization strategy for wage setters is thus to pose an equalization between wages, w_t, and the expected price level, E_tp_t, and then $w_t = E_tp_t$. Substituting this prediction in the supply function results in a familiar predicton error model of supply (see Gray (1976) and Fischer (1977)) like our equation.

[5]Note that by definition the real required return on stocks by investors, which is equal to the cost of risk capital for firms, is a positive function of the expected growth of earnings and a negative function of the contemporaneous real stock price. This specification will be useful for the discussion in the next section.

where the expected capital gains are represented by $E_t l_{t+1} - l_t$, while the expected real dividends are $E_t d_{t+1}$. In turn, the real dividends at date t+1 are equal to the real production level in the previous period, so that:

$$d_{t+1} = y_t \tag{2.4}$$

We also define the real stock price, l_t, in the following way :

$$l_t = L_t - E_t p_t \tag{2.5}$$

where L_t is the nominal stock price and $E_t p_t$ is the expected price level at date t since p_t is not contemporaneously observed.

2.4. Equilibrium condition

Production satisfies the following equilibrium condition :

$$y_t^s = y_t^d = y_t \tag{2.6}$$

2.5. Informational framework

We assume that aggregate price and output levels are only known with a lag of one period as it is usually the case in practice. However, nominal financial prices can be observed contemporenously on the markets where they are quoted so that $E_t R_t = R_t$ and $E_t L_t = L_t$.

The economy also faces several kinds of shocks. In the spirit of the real business cycle analysis, we assume that the supply shock is a random walk :

$$\varepsilon_t^s = \varepsilon_{t-1}^s + \nu_t \tag{2.7}$$

where ν_t is white noise, while the aggregate demand disturbance is first order auto-correlated, i.e. its effects on output disappear over time :

$$\varepsilon_t^d = \delta \varepsilon_{t-1}^d + \upsilon_t \tag{2.8}$$

where υ_t is white noise and $0 < \delta < 1$. This comes from the fact that we deal with the supply shock as a technological one where the effects on the output are permanent. Concerning the shock on stock prices, ε_t^l, we define it as a white noise.

Combining eqs. 2.1, 2.2, 2.5, 2.6 and collecting the terms in p_t, we obtain[6] :

$$p_t = E_{t-1}p_t + \frac{\beta}{\theta}E_t\pi_{t+1} + \frac{\gamma}{\theta}L_t - \frac{\gamma}{\theta}E_tp_t - \frac{\beta}{\theta}R_t + \frac{1}{\theta}(\varepsilon_t^d - \varepsilon_t^s) \tag{2.9}$$

which is the rule that prices p_t have to follow to clear the goods market. Since the current price level p_t is unobservable, people may only rely on a guess about this price level using available information. This guess is the price perception E_tp_t. Taking the expectation of both sides of equation 2.9, we obtain the following rule for E_tp_t :

$$E_tp_t = E_{t-1}p_t + \frac{\beta}{\theta}E_t\pi_{t+1} + \frac{\gamma}{\theta}E_tL_t - \frac{\gamma}{\theta}E_tp_t - \frac{\beta}{\theta}E_tR_t + \frac{1}{\theta}E_t(\varepsilon_t^d - \varepsilon_t^s) \tag{2.10}$$

Let note η_t as the price perception error $p_t - E_tp_t$. Since the nominal prices for financial variables are observable, $E_tR_t = R_t$ and $E_tL_t = L_t$, we can write the value of η_t as follows :

$$\eta_t = \frac{1}{\theta}\left\{(\varepsilon_t^d - \varepsilon_t^s) - E_t(\varepsilon_t^d - \varepsilon_t^s)\right\} \tag{2.11}$$

3. Monetary Policy Rule and Stock Market Prices

3.1. Beyond traditional objectives

Our proposal is to modify the traditional objective function[7] of the monetary authorities in order to include an explicit target for stock prices. In that way the Central Bank would pursue a macroeconomic stability target as well as a financial stability one.

Several academics have tried to justify the incorporation of such a target in the monetary policy reaction function. First, many authors argue that the consumption price index (CPI hereafter) can be misleading in the sense that it

[6]Note that in the follow of the paper we will ignore uninteresting constants.

[7]The loss function of the Central Bank traditionnally presented in textbooks follows an objective of macroeconomic stability. It consists generally in an arbitrage between minimizing deviations from the trend in the long-run production and deviations from an inflation target. It can be noted that the presence of inflation as the only macroeconomic variable in addition to output in this kind of loss function reflects in part the fact that, right or wrong, inflation is perceived as costly by people and is costly for policymakers to ignore (see Blanchard and Fischer, 1989, Chap.11).

only reflects the price evolution of the real sector. From this point of view, the monetary policy would have to follow an inflation targeting in the real sector as well as in the financial sector. Asset prices might constitute an adequate index for the latter (see Alchian and Klein, 1973).

Second, as explained by Wadhwani (1999), we may think that systematic overvaluations of asset prices may increasingly entail a misallocation of resources, as would an acceleration of the CPI. Since the earnings/price ratio reflects the level of the cost of risk capital, a sharp increase of stock prices reduces substantially this cost and could involve an over-investment in equipement and/or buildings from firms.

Third, on new markets, the financing of acquisitions by start-ups may also be disturbed by deep fluctuations of stock prices. This situation creates an uncertainty for companies extension plans.

Fourth, a financial crisis influences solvability of many financial intermediaries and then could affect the activity of firms through a rationing of credits[8] (the so-called credit crunch[9]). The implicit assumption is to suppose that price stability and financial stability are deeply complementary in order to maintain a sustainable non inflationary growth. However, as mentioned by Bernanke and Gertler (1999), there exists national and supranational organisations which control the solvability of financial institutions but, unfortunately, history shows us many periods where the reaction of those organisations came after the crises[10]. Following Solow's idea that central banks are responsible for the financial stability, we can also argue that high volatilities of risky-asset prices increase the probability of failures of financial institutions. If the central bank does not include the financial stability as a monetary policy target, we would have to accept either an increasing number of failures, or an increasing capital to create a financial institution. Whatever the case, it would be costly for the economy[11].

Finally, we may suppose that a financial crisis affects indirectly the real activity through a 'confidence effect'. Even if the proportion of agents who own stocks is relatively small (as noted for the United States by Poterba 2000), it

[8]It seems to be clear that such a problem restricted the real activity in Japan from 1992 to 1996.

[9]See for details Bernanke and Gertler (1995 and 1999).

[10]The two more recent examples of such a situation were given by the 1997 exchange rate crisis in Asia and the Russian financial crisis in 1998 with the near collapse of the hedge fund Long Term Capital Managment.

[11]This justification comes from the banking crises literature and from private discussion with Professor Jean-Charles Rochet.

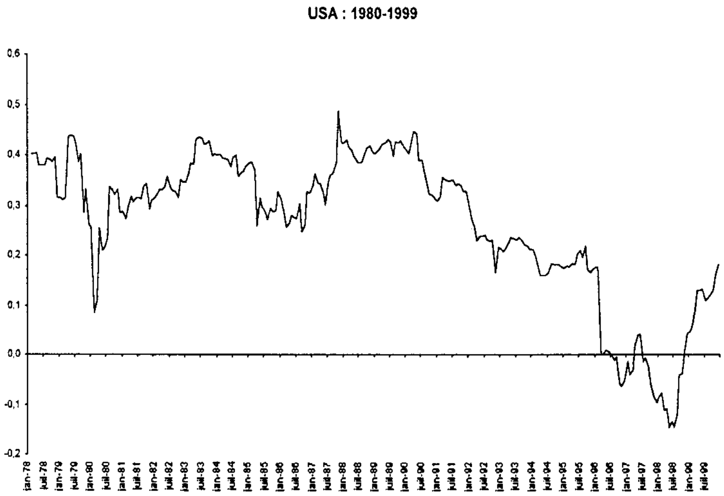

Figure 3.1: Rolling Correlation on 1 Year Between Monthly Consumers Confidence and Stock Market Returns

would be possible to have a huge confidence crisis caused by a prolonged financial crisis[12]. This intuition does not yet provide any empirical evidence, however we may suspect that such an effect did work in past economic crises.

Figure 3.1 shows the estimated correlation on a 1 year rolling sample between stock market and consumers confidence returns in the US. Apart from the periods characterized by financial disturbances (i.e. 1978-79, 1989-1990, 1994-95 and 1997-98), the correlation coefficients between these variables are positive and relatively high. Therefore, an increase in stock market returns would improve consumers confidence, and vice-versa. One can also notice a strong increase of the correlation during the 1985 economic recovery as well as at the end of the 1998 financial crisis.

Furthermore, table 1 indicates that the correlation between the returns of stock prices and the consumers confidence varies over time and that it was higher during the eighties. It's interesting to compare the stock prices/consumers confidence correlation with Ludvigson and Steindel (1999) analysis. This shows that the sensibility of consumption to stock market returns was higher before 1986.

Table 1 : Correlation coefficients between consumers confidence and stock prices returns in the United States

Correlations	1980-1999	1980-1989	1990-1999
Confidence index and total market return	.25	.36	.16

Moreover, one can suppose that stock market crashes increase uncertainty

[12] Following Wolf (1998) calculations based on 1998 Survey of Consumer Finances, there seems that the top one percent of equity owners in the United States hold more than fifty percent of corporate stocks (including "indirect participation" through mutual and pension funds).

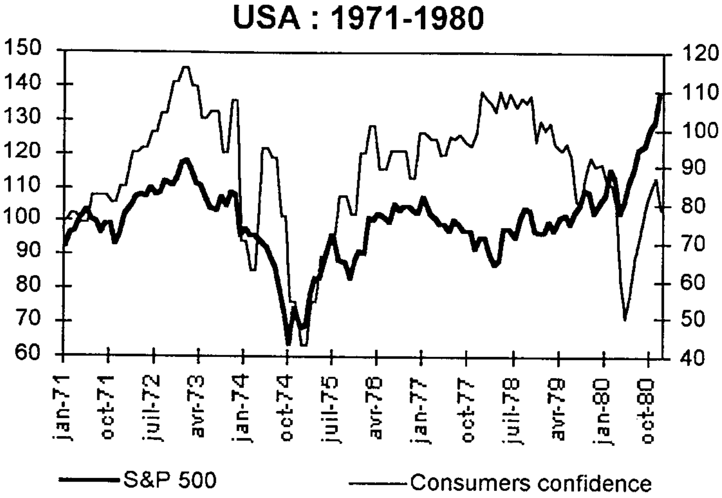

Figure 3.2: Stock Prices Index and Confidence Index

in households, which consequently could have a negative impact on real growth. However, this question requires a more detailed study.

If one now looks at the figures below, we can see that the stock prices index and the consumers confidence follow a parallel evolution, especially in crisis periods (both oil shocks in figure 3.2 or during the stock market crash in october 1987 in figure 3.3). However, when looking at consumption's profile during crises, one notices that the length of time needed to recuperate was shorter during the 1978 and 1987 crises than during the 1973 crisis. These differences can be explained by the fact that the Federal Reserve in the past took in account a limited number of parameters. Since by including a larger number of economic indicators, it brought a different reaction to economic shocks, as studied by Clarida, Gali and Gertler (1999). Indeed, they emphasize some differences between the pre-Volcker area (before June 1979) and the post-Volcker one (since July 1979).

It's also interesting to notice that the recent improvement of american household's confidence was parallel to the increase of stock prices (voir figure 3.4).

Considering that the stock market's evolution is accessible to a growing number of economic agents, one could imagine that the climate on the financial markets would be progressively interpreted by households as an advanced indicator of the general economic health. If that was the case, a stagnation, or

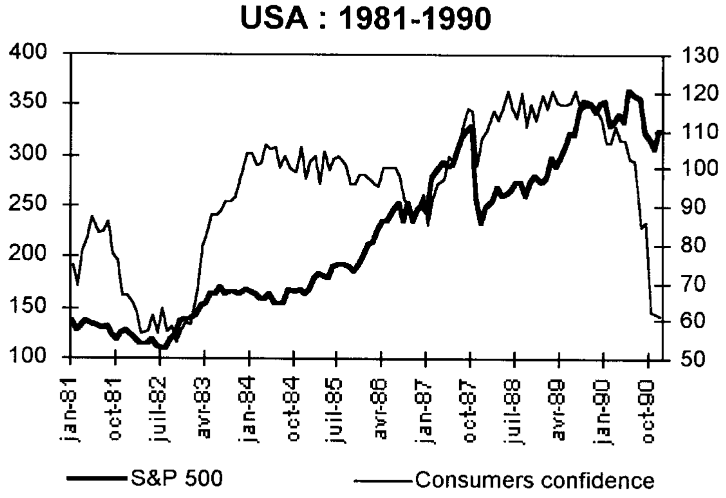

Figure 3.3: Stock Prices Index and Confidence Index

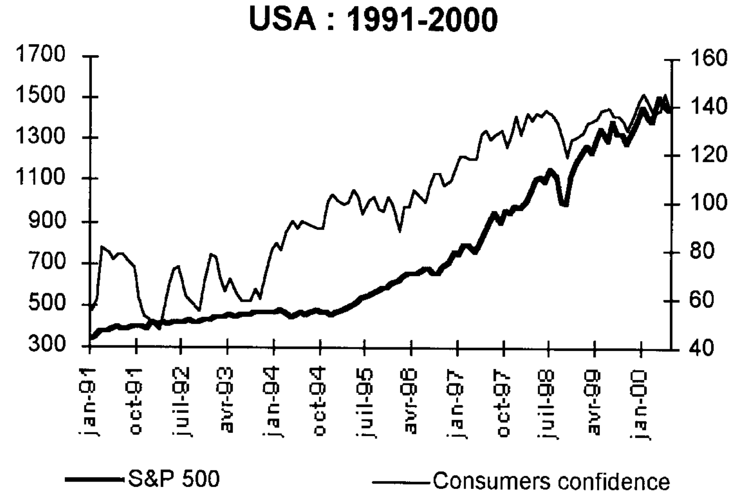

Figure 3.4: Stock Prices Index and Confidence Index

event a prolonged depression of stock market prices would affect the households confidence, whatever their implication in stock markets.

3.2. A Global Economic Stability Function Reaction

Based on the arguments in the previous section, our proposal is to modify the 'traditional' inflation targeting reaction function of the Central Bank in order to include explicitely a 'financial stability' target. Therefore, beside the minimization of deviations from their targets for production and inflation, the Central Bank aims to minimize deviations of real current stock prices index from some target. The loss function, $\pounds$, then becomes :

$$\pounds = E_t((y_t - \overline{y} - \varepsilon_t^s)^2 + \chi(\pi_t - \bar{\pi})^2 + \varphi(l_t - \bar{l})^2) \tag{3.1}$$

In each period, the Central Bank tends to minimize this function. The Central Bank observes the fundamentals in the economy and the several shocks and modifies the nominal interest rate in order to satisfy its policy objectives. Therefore the monetary authorities pursue three objectives. First, they intend to minimize any deviations from the long-run production trend (denoted here by $\overline{y} + E_t\varepsilon_t^s$). Second, they want to stabilize the current inflation rate around the target $\bar{\pi}$. Third, in order to preserve financial stability, they explicitely want to stabilize stock market prices around the target $\bar{l}$. Note that the authorities target for stock prices depends on the long-run production's trend. Thus $\bar{l}$ is equal to $(\overline{y} + E_t\varepsilon_t^s)$.

The monetary policy feedback rule can thus be written as :

$$R_t = f(\overline{y}, \bar{\pi}, \bar{l}, E_t\varepsilon_t^s, E_t\varepsilon_t^d, E_t\varepsilon_t^l \mid \Omega_t) \tag{3.2}$$

where R_t denotes the Central Bank instrument (e.g. the nominal interest rate), $\overline{y}$, $\bar{\pi}$, $\bar{l}$ respectively the monetary policy target for production, inflation and stock price level. R_t also depends on the agent's expectations on the various shocks in the economy while Ω_t is the information set at the time the interest rate is set. Note that since we consider ε_t^s as a technological shock, it could affect permanently the expected real dividends (and then the real stock prices) as well as the potential output.

The Central Bank minimizes its objective in each period, given the previous expectations $E_{t-1}p_t$ since we assume that policy is conducted without a precommitment ability. But expectations are rational, so that private agents know that monetary authorities are in this position. Private agents formulate their expectations by effectively solving the problem that the Central Bank has to solve. Monetary policy is thus the outcome of a non-cooperative game between the Central Bank and private agents. However, since the objective function is such that there is no reason to behave in a time-inconsistent manner, the rules-based and discretionary solutions will coincide in this case.

4. The Results

4.1. Solving the model

We solve the model mainly in three steps. First, by deriving the monetary policy function, we find the rule that the price expectations follow taking the specification of the model in order to find the specification of the nominal interest rate. Second, taking the specification of the nominal interest rate, we replace it in the arbitrage conditon for stock prices and in the equation of the expected prices level. We then obtain, after all substitutions, a system of three linear equations in R_t, L_t and $E_t p_t$ conditioned on expectations $E_{t-1}p_t$, $E_t p_{t+1}$ and $E_t L_{t+1}$. Using the method of the undetermined coefficients, we solve these three equations to find the solutions at equilibrium.

4.1.1. Deriving the optimal monetary policy

Using equation 2.2 and the definition of the inflation rate (i.e. $\pi_t = p_t - p_{t-1}$), equation 3.1 can be rewritten as :

$$\pounds = E_t(\theta^2(E_t p_t - E_{t-1}p_t)^2 + \chi(E_t p_t - p_{t-1} - \bar{\pi})^2 + \varphi(l_t - \overline{y} - \varepsilon_t^s)^2) \tag{4.1}$$

where, using eqs. 2.1, 2.2, 2.3, 2.4, 2.5, 2.7 , 2.8 and 2.6

$$E_t p_t = \frac{\theta}{\beta+\gamma+\theta} E_{t-1}p_t + \frac{1}{\beta+\gamma+\theta}\left\{\beta E_t p_{t+1} + \gamma L_t - \beta R_t + \delta\varepsilon_{t-1}^d - \varepsilon_{t-1}^s\right\} \tag{4.2}$$

and

$$L_t = (1-\rho)E_t p_{t+1} - R_t + \rho E_t L_{t+1} + (1-\rho)\varepsilon_{t-1}^s - \varepsilon_t^l \tag{4.3}$$

We replace l_t by its value in equation 4.1 using eqs. 2.5. We then take the first-order condition, $\frac{\partial \pounds}{\partial R_t} = 0$, characterizing the optimum which, after distributing the expectation factor and using equation 2.7, implies[13] :

$$E_t p_t = \frac{\theta^2}{\theta^2+\chi-\varphi} E_{t-1}p_t - \frac{\varphi}{\theta^2+\chi-\varphi} L_t + \frac{\varphi}{\theta^2+\chi-\varphi} \varepsilon^s_{t-1} \tag{4.4}$$

4.1.2. Solutions at equilibrium

We subsitute the value of L_t given by equation 4.3 in eqs. 4.2 and 4.4. We then equalize eqs. 4.2 and 4.4 in order to find the value of R_t. We then substitute the value of R_t in eqs. 4.2 and 4.3. This generates the following value for the three strategic variables:

$$\begin{aligned}
R_t &= \Lambda \left[\begin{array}{c}
\Big(\theta(\chi-\varphi) - \theta^2(\beta+\gamma)\Big) E_{t-1}p_t \\
+ \Big((1-\rho)(\gamma(\theta^2+\chi) + \varphi(\beta+\theta)) + \beta(\theta^2+\chi-\varphi)\Big) E_t p_{t+1} \\
+ \Big(\rho(\gamma(\theta^2+\chi) + \varphi(\beta+\theta))\Big) E_t L_{t+1} \\
+ \Big(\gamma(1-\rho)(\theta^2+\chi) + \varphi(1-\gamma-\rho(\beta+\theta)) - (\theta^2+\chi)\Big) \varepsilon^s_{t-1} \\
- \Big(\gamma(\theta^2+\chi) + \varphi(\beta+\theta)\Big) \varepsilon^l_t \\
+ \Big(\delta(\theta^2+\chi-\varphi)\Big) \varepsilon^d_{t-1}
\end{array} \right] \\
E_t p_t &= \Lambda \left[\begin{array}{c}
\Big(\theta\varphi + \theta^2(\beta+\gamma)\Big) E_{t-1}p_t \\
+ (\beta\varphi\rho)\, E_t p_{t+1} \\
- (\beta\varphi\rho)\, E_t L_{t+1} \\
+ (\varphi(\rho\beta+\gamma-1))\, \varepsilon^s_{t-1} \\
+ (\varphi(\beta+\gamma))\, \varepsilon^l_t \\
+ (\delta\varphi)\, \varepsilon^d_{t-1}
\end{array} \right] \\
L_t &= \Lambda \left[\begin{array}{c}
- \Big(\theta(\chi-\varphi) - \theta^2(\beta+\gamma)\Big) E_{t-1}p_t \\
- \Big(\rho\beta(\theta^2+\chi-\varphi)\Big) E_t p_{t+1} \\
+ \Big(\rho\beta(\theta^2+\chi-\varphi)\Big) E_t L_{t+1} \\
+ \Big((1-\rho)\beta(\theta^2+\chi) + \varphi(\rho\beta+\theta) + (\theta^2+\chi-\varphi)\Big) \varepsilon^s_{t-1} \\
- \Big(\beta(\theta^2+\chi-\varphi)\Big) \varepsilon^l_t \\
- \Big(\delta(\theta^2+\chi-\varphi)\Big) \varepsilon^d_{t-1}
\end{array} \right]
\end{aligned}$$

where

$$\Lambda = \frac{1}{(\beta+\gamma)(\theta^2+\chi-\varphi) + \varphi(\beta+\gamma+\theta)}$$

[13] Note that by definition $E_t\eta_t = 0$ using equation (2.11).

These equations form a system of three linear equations in R_t, L_t and $E_t p_t$ conditioned on expectations $E_{t-1}p_t$, $E_t p_{t+1}$ and $E_t L_{t+1}$. To solve them, we use the method of undetermined coefficients and we find that at equilibrium each variable depends only on the shocks in the economy :

$$\begin{aligned} R_t &= f(\varepsilon_{t-1}^d, \varepsilon_{t-1}^s, \varepsilon_t^l, \varepsilon_{t-2}^d, \varepsilon_{t-2}^s) && (4.5)\\ E_t p_t &= f(\varepsilon_{t-1}^d, \varepsilon_{t-1}^s, \varepsilon_t^l, \varepsilon_{t-2}^d, \varepsilon_{t-2}^s) && (4.6)\\ L_t &= f(\varepsilon_{t-1}^d, \varepsilon_{t-1}^s, \varepsilon_t^l, \varepsilon_{t-2}^d, \varepsilon_{t-2}^s) && (4.7) \end{aligned}$$

Especially in the case of the monetary policy instrument, we find that the nominal interest rate at equilibrium, R_t, becomes :

$$\begin{aligned} R_t = {} & \Theta\varepsilon_{t-1}^d + \Gamma\varepsilon_{t-1}^s \\ & - \frac{\varphi(\beta+\theta) - \gamma\left(\theta^2+\chi\right)}{\varphi(\beta+\gamma+\theta) + (\beta+\gamma)\left(\theta^2-\varphi+\chi\right)}\varepsilon_t^l \\ & + \Phi\varepsilon_{t-2}^d + \Psi\varepsilon_{t-2}^s \qquad (4.8) \end{aligned}$$

where $\Theta = f(\beta,\gamma,\theta,\chi,\varphi)$, $\Psi = f(\beta,\gamma,\theta,\chi,\varphi)$, $\Gamma = f(\beta,\gamma,\delta,\theta,\chi,\varphi)$ and $\Phi = f(\beta,\gamma,\delta,\theta,\chi,\varphi)$[14].

As we can see, the feedback rule of monetary policy has to react, in the case where financial stability becomes a policy target, to the contemporaneous shock on asset prices and to past shocks on aggregates demand and supply with two lags periods. In order to discuss clearly the results of the model, we calibrated the model using values for non strategic variables from empirical evidence reported in the literature. We assume then that $\rho = .96$, $\delta = .50$ and $\beta = .10$[15]. Moreover, we have to estimate the value of the policy parameters, θ, χ and φ. For instance, we take the simple case where the Central Bank allocates the same weight to each objective (i.e. $\theta = \chi = \varphi = 1/3$).

[14]Note for instance that Γ ,Φ and Ψ reduce to zero if the weight for financial system stability in the loss function of the monetary authorities, φ , is zero. In this case, the value of the coefficient of past demand shock, Θ, in the interest rate equilibrium solution becomes equal to $\frac{\delta-\delta^2\rho}{\beta+\gamma-\beta\delta\rho}$. The latter value corresponds to the value of the demand shock coefficient when the financial system stability does not play any role in the objective function of the Central Bank (see Smets, 1997).

[15]See Campbell, Lo and MacKinlay(1997) and Dor and Durré (2000).

4.2. Effects on the nominal interest rate of past demand shocks

It is important to remember that the Central Bank will in our context hit the perceived prices to its desired level. So, it modifies its policy instrument in order to reach this objective. In case of a positive demand shock, the aggregate demand increases which, for a given level of production, makes inflation pressures. Following its policy specification function, the Central Bank reacts in increasing its nominal interest rates to avoid any deviations of perceived prices from its target. But the increase of the interest rate in turn decreases equity prices which makes downwards pressures on aggregate demand.

In the case of 'traditional' monetary policy objectives[16], this mechanism explains why the optimal reaction to demand shocks of the monetary policy is inferior in the case where there exists a wealth effect of asset prices on aggregate demand. But now, if there exists explicitely in the objective function of Central Bank a financial target, the monetary authorities will care about the impact of the interest rate reaction on equity prices compared to their target. In other words, at the first stage, past demand shocks have a negative impact on equity prices through the reaction of the interest rate to the increasing aggregate demand. But this decrease of equity prices does not reflect any revision of expected future dividends since expected future production remains unchanged. So, in the case where financial stability is included in the Central Bank loss function (case b hereafter, figure 4.2.), the reaction of the interest rate to past demand shocks will be lower than in the case of an inflation-output targeting (case a hereafter, figure 4.1.).

On the other hand, it is important to note that the slope of the interest rate is deeper in case a than in case b. In the case b, when the sensibility of aggregate demand to stock prices is relatively high (say near one), we could imagine a decrease of the interest rate.

The explanation of these developments is lying in the fact that, in case b, monetary authorities have to react in a two-step channel. The first one consists to modify the interest rate so that the increase of aggregate demand does not feed into inflationary pressures. The second stage consists to check that the variation of the interest rate, and thus its impact on stock prices, is compatible to the financial target. But, here, the demand shock makes no direct effect on

[16]We hear by 'traditional' monetary policy objectives a central bank loss function which minimizes any deviations of current output and prices from its long-run target as explained in Blanchard and Fischer (1989).

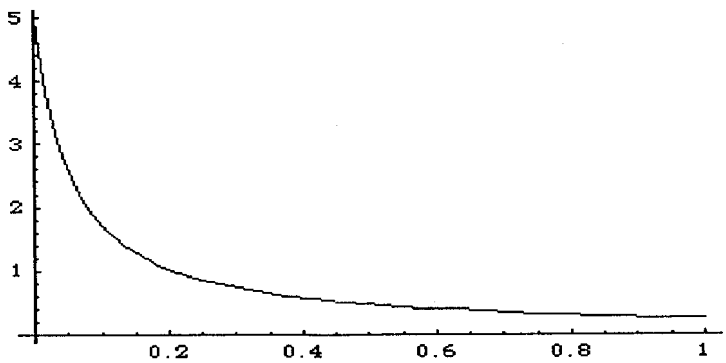

Figure 4.1: Case a. Nominal-Interest Rate Response to Past Demand Shocks

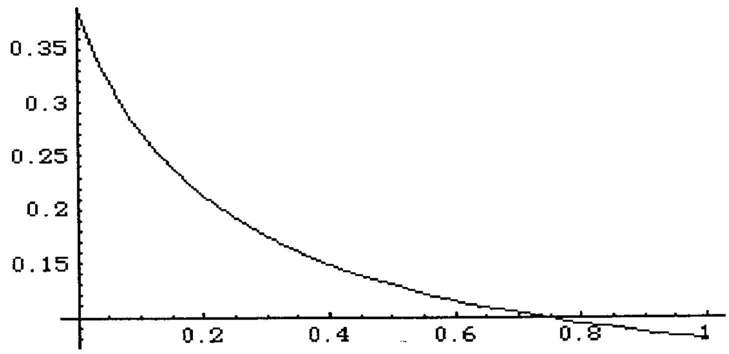

Figure 4.2: Case b. Nominal-Interest Rate Response to Past Demand Shocks

stock prices. The monetary policy could simply take account the fact that any change of nominal-interest rate would affect stock prices and then their reaction would be much lower than in the case where financial stability is not included in the loss function of monetary authorities.

4.3. Effects on the nominal interest rate of past supply shocks

In the case of supply shocks, the assumption about the nature of the shock is extremely important. Because we suppose a permanent technological shock, the expected future real dividends are permanently influenced and thus the equity prices. So, on one side, the aggregate demand increase following the impact of equity prices on aggregate demand (in a proportion γ) and on the other side,

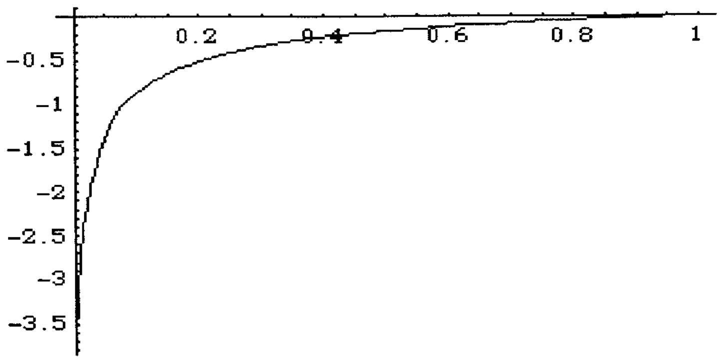

Figure 4.3: Case b. Nominal-Interest Rate Response to Past Supply Shocks

long-run real production is increased in a proportion ε_{t-1}^{s}.

In absence of wealth effect from equity prices on aggregate demand, monetary policy must react to a positive supply shock in reducing its nominal interest rate in order to increase aggregate demand which reaches then the new path of long-run production.

In an inflation targeting model with a wealth effect, there is no need for the Central Bank to react to a technological shock because the influence of equity prices on the demand-side automatically equalizes the aggregate demand to the new production level. Now, if we suppose that real asset prices are included in the loss function of Central Bank as a policy target, the reaction of the interest rate to a supply shock will depend deeply on the sensibility of aggregate demand to equity prices. As we can note in the figure 4.3, the reaction of the interest rate to a technological shock is reduced when the sensibility of aggregate demand to equity prices increases. For high values for the coefficient γ (higher than .7), there is not any need more to react to supply shock for monetary policy. However, if the impact of stock prices on aggregate demand is weak and then does not increase it sufficiently to equalize the (new) level of production, there is place for a monetary policy reaction. Indeed, the lower the impact of a supply shock on aggregate demand through the change in equity prices, the higher the probability that equity prices deviate from its long-run trend permanently.

4.4. Effects on the nominal interest rate of financial shocks

Now suppose that the stock market faces a positive shock. In that case the increase of the current risk premium depresses the stock prices according to the dividend discount model used for evaluation of risky asset prices. The decrease of the stock prices influences negatively aggregate demand (in a proportion γ). The production perspectives being unchanged, any downwards pressures on aggregate demand would affect negatively prices. In order to avoid the latter evolution, the monetary authorities brings down the nominal interest rate to rise aggregate demand. As we can see in figures below, the higher the sensibility of aggregate demand to financial asset prices, the higher the nominal interest rate response to financial shocks.

However, it could be interesting to note that, in case b (where monetary authorities follow financial stability as a policy goal), the response of the nominal-interest rate to financial shocks is quite higher than in case a (where monetary authorities are only trying to minimize the ouput gap and deviations of prices from their target). Not surprisingly that could be understood because the financial shock (as well as a technological shock) affects directly the price of stocks. Then, with a goal of financial stability, monetary authorities have to react, on one side, to the decrease of stock prices and, on the other one, to the depressing aggregate demand[17].

[17]Note that, here, the financial shock, ε_t^l, is white noise. We then implicitly suppose that the Central Bank reacts at the end of each period, after all other agents. We could alternatively suppose that the financial shock, ε_t^l, is first order auto-correlated. In this case, $E_t\varepsilon_t^l = E_{t+1}\varepsilon_{t+1}^l = \tau\varepsilon_{t-1}^l$ and $E_{t-1}\varepsilon_t^l = E_t\varepsilon_{t+1}^l = \tau^2\varepsilon_{t-1}^l$, where $0 < \tau < 1$. At equilibrium, the nominal interest rate then becomes $R_t = f(\varepsilon_t^l, \varepsilon_{t-1}^d, \varepsilon_{t-1}^s, \varepsilon_{t-1}^l, \varepsilon_{t-2}^l, \varepsilon_{t-2}^d, \varepsilon_{t-2}^s)$ which is different to equation 4.5. In other words, two terms in ε_{t-1}^l and ε_{t-2}^l are added to equation 4.8. Note that $\frac{\partial R_t}{\partial \varepsilon_t^l} < 0$, $\frac{\partial R_t}{\partial \varepsilon_{t-1}^l} < 0$ and $\frac{\partial R_t}{\partial \varepsilon_{t-2}^l} < 0$.

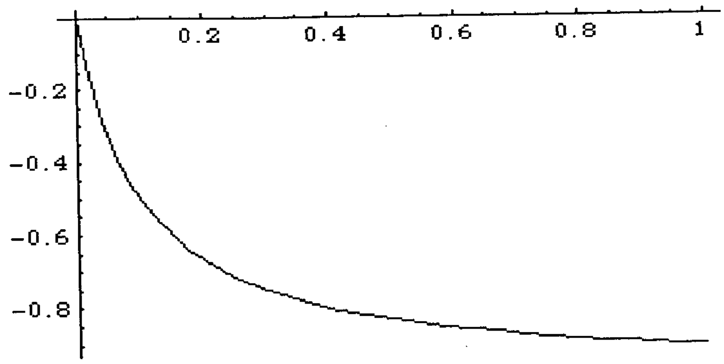

Figure 4.4: Case a. Nominal-Interest Rate Response to Financial Shocks

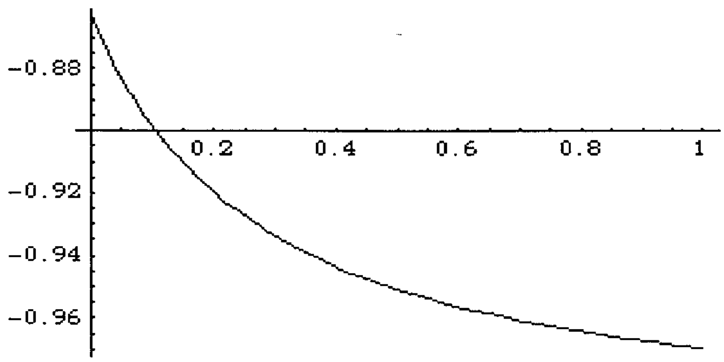

Figure 4.5: Case b. Nominal-Interest Rate Response to Financial Shocks

5. Trade-off between inflation targeting and financial asset prices targeting

It could be interesting to discuss the differences in the conduct of monetary policy following a variation in the weight of the inflation targeting and the financial asset prices stability for any given value of γ. For the latter, we use the more recent empirical study of Ludvigson and Steindel (1999) who find a value of 0.04 for γ over the period 1953-1997[18].

If we look now the discussion about the impact of a weight variation between the inflation target and the financial stability one within the central bank loss function, it becomes easier to understand why the magnitude of the nominal-interest rate is lower in case of demand shocks and higher in case of supply and financial shocks.

For convenience of the purpose, we suppose that the weight given to the output gap (e.g. θ) is .5[19]. We then let fluctuate the weights given to the inflation target (e.g. χ) and to the financial stability target (e.g. φ) according to the following rule : $\chi = .5 - \varphi$. The following figures show the nominal-interest rate response to the several shocks in the economy when χ and φ fluctuate between 0 and .5, the other parameters being given.

When the economy faces a positive demand shock, the nominal-interest rate response will be positive for any value of φ inferior to .3 (e.g. for any value for χ higher than .2). Higher the weight given to financial stability target, lower the increase of nominal interest rate in case of a positive demand shock. Contrary to the two other shocks, it could be interesting to note that the magnitude of nominal-interest rate response to a positive demand shock is inferior when the monetary authorities include financial stability as a policy target. This could find its explanation in the fact that from a value superior to .4 for φ, the monetary authorities could decrease nominal interest rate in order to maintain stock market prices evoltuion compatible to the policy target level (as shown in figure 5.1).

Concerning the nominal-interest rate response to supply shocks, two aspects

[18] The Ludvigson and Steindel study underlines some important differences between the sub-periods. Indeed, they estimate a much larger effect (where the value of γ is equal to .11) for the 1976-1985 sample and a smaller effect ($\gamma = .021$) for the post-1986 period. While these differences in the value of γ affect the magnitude of the interest rate reaction, they keep the shape of the reaction unchanged.

[19] This is compatible with the weight given to this objective in the context of a Taylor's rule (see for example Gerlach and Schnabel, 1999).

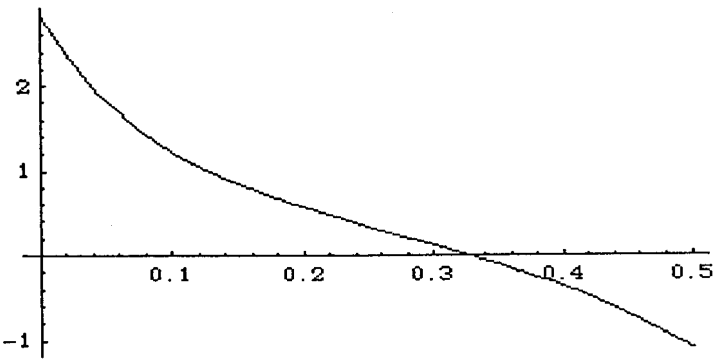

Figure 5.1: Nominal-Interest Rate Response to Demand Shocks when $0<\chi<0\varphi$

have to be underlined. First, when the central Bank loss function only consists in an arbitrage between minimizing the output gap and stabilizing the inflation rate (e.g. $\varphi = 0$), monetary authorities do not need to react to supply shocks because the impact of real stock prices fluctuations on aggregate demand brings up the latter to the new level path of production. Second, when monetary authorities want to stabilize real stock prices as well as the inflation rate, we could at first stage observe an increase of nominal interest rate (e.g. for small values of φ inferior to .2) and then a decrease of nominal interest rate (see figure 5.2). Finally, in case of financial shocks, the nominal-interest rate response decreases when the value for φ goes up. Indeed, a positive financial shock will depress stock prices which will in turn bring down aggregate demand. Both stabilizing targets for inflation and financial stability could be unreached and then monetary authorities would have to react more deeply (see figure 5.3).

However, this could be important to note that the shape of these responses to several shocks in the economy remains the same whatever the sensibility of aggregate demand to stock prices fluctuations. The higher the latter, the lower the former will be.

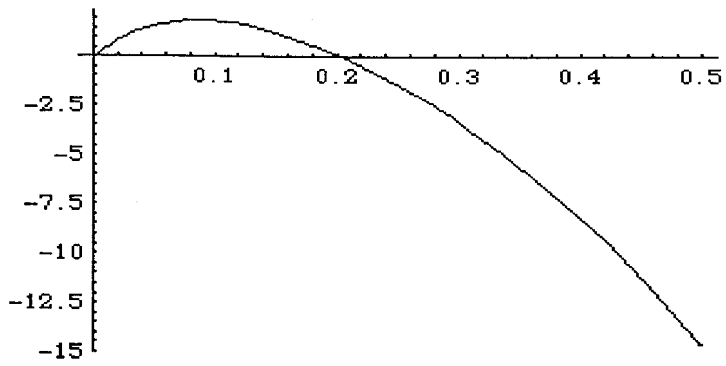

Figure 5.2: Nominal-Interest Rate Response to Supply Shocks when $0<\chi<.5$ and $0<\varphi<.5$

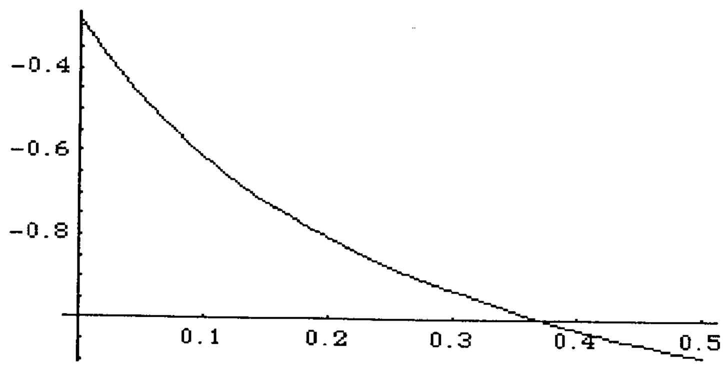

Figure 5.3: Nominal-Interest Rate Response to Financial Shocks when $0<\chi<.5$ and $0<\varphi<.5$

6. Concluding Remarks

When discussing about the relation between monetary policy and asset prices fluctuations, one usually concentrates to the question on the potential wealth effect of the latter on aggregate demand. The analysis usually consists then to wonder if, in a context of minimizing output gap and inflation targeting, monetary authorities should take into account fluctuations on financial markets. The most recent study on this question is lying in the Geneva Report on World Economy 2.

The purpose of our paper pushes the reflection on monetary policy and financial markets relation further. First, we suppose that aggregate demand is positively influenced by fluctuations on financial markets. Second, we defend a 'financial stability target'. To the extent that financial markets crises can-bring macroeconomic instability, it is the interest of Central banks to integrate a financial stability parameter as a priority.

In a forward-looking rational expectations model, where monetary authorities care about output gap, inflation and financial stability (called 'global economic stability' hereafter), we find the following results :

- When monetary policy takes account of the role played by financial prices in the monetary transmission mechanism the optimal monetary policy reaction to shocks is inferior to what it would be otherwise.

- The Central Bank, when encounting a demand shock situation, will intervene in a more subtile way on interest rates, if it had chosen to include financial stability as a priority.

- However if shocks do directly affect stock prices (permanently or temporary), the reaction of monetary authorities is quite higher.

- The shape of the nominal-interest rate response to several shocks in the economy depends on the relative weight given to each objective within the central bank loss function. The higher the weight given to the financial stability target, the higher the nominal-interest rate reaction will be in case of supply and financial shocks. In case of demand shocks, the reaction will be weaker.

7. References

Bernanke, B.S. and M. Gertler, 1995. Inside the Black Box : The Credit Channel of Monetary Transmission. Journal of Economic Perspectives, 9 (4), Fall, 27-48.

Bernanke, B.S. and M. Gertler, 1999. Monetary Policy and Asset Price Volatility. Federal Reserve of Kansas City Conference on "New Challenges for Monetary Policy", 1-62.

Bernanke, B.S. and C.S. Lown, 1991. The Credit Crunch. Brookings Papers on Economic Activity. Vol. 2, 205-39.

Blanchard, O.J. and S. Fischer, 1989. Lecture on Macroeconomics. MIT Press.

Campbell, J.Y., Lo, A.W., MacKinlay, A.C., 1997. The Econometrics of Financial Markets. Princeton University Press.

Cecchetti, S.G., Genberg, H., Lipsky, J. and Wadhwani, S., 2000. Asset Prices and Central Bank Policy. Geneva Reports on the World Economy 2. Centre for Economic Policy Research.

Clarida, R., J. Gali and M. Gertler, 2000. Monetary Policy Rules and Macroeconomic Stability : Evidence and Some Theory. Quaterly Journal of Economics, 115, 147-80.

Fischer, S., 1977. Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule. Journal of Political Economy, 85, 191-205.

Dor, E. and A. Durré, 2000. Stock Prices, Exchange Rates and Monetary Policy. IRES Discussion Paper n°2000-1 and Labores-CNRS working paper n°2000-10.

Gerlach, S. and G. Schnabel, 1999. The Taylor Rule and Interest Rates in the EMU : A Note. BIS Working Papers, n°73.

Gray, J., 1976. Wage Indexation : A Macroeconomic Approach. Journal of Monetary Economics, 2, 221-35.

Ito, T. and T. Iwaisako, 1996. Explaining Asset Bubbles in Japan. Bank of Japan Monetary and Economic Studies. Vol.14, n°1, 143-93.

Ludvigson, S. and Ch. Steindel, 1999. How Important is the Stock Market Effect on Consumption? Federal Reserve Bank of New York, Economic Policy Review, 5(2).

Poterba, J.M., 2000. Stock Market Wealth and Consumption. Journal of Economic Perspectives. Vol.14, n°2, 99-118.

Smets, F., 1997. Financial Asset Prices and Monetary Policy : Theory and Evidence. CEPR Discussion Paper Series n°1751.

Wadhwani, S.B., 1999. The US Stock Market and The Global Economic Crisis. National Institute Economic Review. January.

Wolf, E., 1998. Recent Trends in the Size Distribution of Household Wealth. Journal of Economic Perspectives. Summer, 12, 131-50.