Monetary Policy and the New Economy: Between Supply Shock and Financial Bubble*

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1 Introduction

In most industrial countries, the real growth rate of stock prices during the nineties was exceptional compared to historical levels. Stock prices even accelerated sharply between 1995 and 1999. During this latest period, a major part of the trends in stock price aggregate indices was due to the rapid rise of the prices of information technology equities (say IT hereafter). The emergence of the internet in 1993, along with the accelerating development of telecommunications worldwide, boosted investors’ optimism about the growth perspectives of the economy. The common opinion was that new technologies would accelerate productivity improvements, favouring a lasting era of sustained growth without inflation. Most financial analysts therefore associated the rapid diffusion of information technology with a new revolution. These financial analysts logically recommended buying those equities which, according to them, would most benefit from the new technology. So a distinction was made between traditional industrial equities (included in the so-called ‘Old Economy’) and those from the so-called ‘New Economy’. This massive preference for the so-called ‘new economy’ stocks

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* We thank two anonymous referees for very useful comments and suggestions. This paper was presented at the congress “The New Economy: Implications and Viability”, Université de Metz (France), April 27-28, 2001. All remaining errors are ours.

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resulted in a phenomenal rise of their prices. Even after including the recent decrease of high-tech stock prices since mid-2000, the average annual real growth rate of stock prices on the Nasdaq Market from 1995 to 2000 is roughly three times its value of the eighties.

The thesis according to which the development of information technologies had substantial spillover effects on other sectors was challenged by Gordon (1999), Boucekkine, del Rio and Licandro (1999), and Boucekkine (2000). The primary goal of the paper is to analyse how the monetary policy should react to the potential effects of the 'New economy' paradigm. We will argue in the following of the paper that these effects are mainly threefold. First, the growing use of the information technology may have implied a permanent supply shock. Second, a wave of optimism has led consumers to increase their spending. Third, this 'exuberance' also affected investors involving a decrease in the risk premium on equities. Byoant stock markets should have increased the sensibility of aggregate consumption to stock market prices by inducing a greater interest of middle class households for stock market investments. Using a simple aggregate macroeconomic model with rational expectations, we show how monetary authorities should react in such circumstances.

The plan of the paper is as follows. Section II presents some evidence and discusses some issues related to the 'New Economy' paradigm. Section III presents the theoretical model used to analyse the optimal monetary policy reaction. Section IV discusses the results while section V offers some concluding remarks.

2 Some evidence

2.1 The 'New Economy' paradigm and Stock Prices

During each new technological wave in history, stock markets were bullish reflecting the enthusiasm of investors about the implied new era. The rapid development of new information technologies during the nineties is an additional example of this rule.

As shown in table 1, the National Association of Securities Dealers Automated Quotations System (NASDAQ) index has always enjoyed a stronger real growth rate than the Standard and Poors index, except during the eighties. Between 1973 and 2000, the real annual growth rate was 15.5% for the Nasdaq and 10.8% for the Standard and Poors index. These average real returns can be compared to the mean annual growth rate of real gross domestic product which amounted to 3.2% from 1973 to 2000.

The growth of the high-tech stock prices accelerated during the nineties, principally from 1995 onwards (see table 1). This acceleration may be related to the emergence of internet in 1993, and the impressive amount of
### Table 1: Annualized Real Growth of Stock Prices and GDP in the United States

<table>
<thead>
<tr>
<th>yoy, real, %</th>
<th>73-80</th>
<th>81-90</th>
<th>91-00</th>
<th>95-00</th>
<th>98-99</th>
<th>73-00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasdaq Index</td>
<td>4.9</td>
<td>12.4</td>
<td>27.0</td>
<td>32.6</td>
<td>39.3</td>
<td>15.5</td>
</tr>
<tr>
<td>S&amp;P 500 Index</td>
<td>1.2</td>
<td>13.0</td>
<td>16.2</td>
<td>20.9</td>
<td>17.3</td>
<td>10.8</td>
</tr>
<tr>
<td>GDP</td>
<td>2.9</td>
<td>3.2</td>
<td>3.4</td>
<td>4.0</td>
<td>4.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Source: Authors' tabulations using Thomson Primark data.

IPO’s of equities by internet related companies since 1995. The rise of stock markets, and especially of IT equities, has become a subject of worry at the end of the nineties because several indicators seemed to suggest that stock prices were sharply overvalued (see figure 1 in appendix).

Indeed, the average value for the price/earnings ratio for IT equities was 21.9 for the period 1974-2001 (and only 17.7 during the period 1974-1994). The average yield of dividends for this kind of equities was 2.1% during 1974-2001 (and 2.6% during 1974-1994). But, during the first quarter of 2000, the price/earnings ratio reached 70 while the dividend yield was below 1%. It is particularly striking to observe that from 1995 onwards realised earnings growth was systematically inferior to expected earnings growth.

However, from mid-2000, bad news in terms of expected profits affected the dot.com optimisim. So, between the first and the fourth quarter of 2000, the quarterly average real value of the Nasdaq composite index fell by 50% while the S&P 500 composite index fell (only) by 5% in real terms.

The downturn of the market was driven by the failures\(^1\) of a lot of companies active in e-business, internet access providing and information technologies along with profit warnings issued by major companies of the telecommunication sector, the computer industry and the software services.

#### 2.2 Households Financial Investment and Expenditure Behaviour

In order to detect the potential impact of the ‘New Economy’ mania on agents behaviour, several aspects of the question must be distinguished.

A first aspect is the widespread\(^2\) optimism about the future growth rate of the economy. Most economic agents were convinced that information

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1. See for example Boo.com (Internet), Lernout and Hauspie (vocal technologies) and eToys.com (purchases of toys on internet).
2. In a recent edition of the Wall Street Journal, Greg, Kulish and Schlesinger (2001) stated the argument that a lot has changed in the nearly 10 years since the U.S. economy last faced recession. The stock market has become a much more powerful force in the economy. Business spending on high technology has soared. Productivity is growing at much faster rates and boosting wages. Information about the economy moves faster and more freely than ever before, thanks largely to an Internet known to only a comparative few during the last recession.
technologies would persistently level up the growth path of aggregate production, employment and income. Therefore investors based the valuation of equities on the hypothesis that real earnings would grow more rapidly than in the past. Similarly most consumers, being investors or not, based their spending behaviour on the hypothesis that their labour income would rise more strongly than before. This increasing confidence is confirmed by the temporal evolution of the results of the Shiller's surveys\(^3\). The most striking feature of these results is that optimism of respondents sharply increased between the 1989 and 1999 surveys. To summarize, consumer spending and households investment behaved as if the economy had been hit by a persistent positive supply shock. The question arises as to whether the perceived magnitude of this shock has been exaggerated or not.

A second aspect is a likely decrease of the risk premium. Several years of sustained stock price growth, led by the IT segment of the market, may have led new investors to underestimate the riskiness of investment, and therefore to require a too low risk premium. For a growing fraction of people the stock market had subjectively become a very safe place. We argue that the emergence of information technologies is partially responsible for this feeling. Their long term benefits indeed tended to be exaggerated. They also induced such a persistent increase of IT equity prices, whatever their fundamentals, that investors lost a right perception of risk.

A third aspect is the likely emergence of a rational bubble on the stock market, induced by the observation of the quick capital gains made by investors in the IT equities. Bernanke and Gertler (1999) explain that non fundamental factors sometimes underlie asset market volatility because of poor regulatory practice and imperfect rationality on the part of investors. It is however true that is very difficult to decide whether a given change in asset value results from fundamental factors or not, as shown by Cogley (1999) and Bernanke and Gertler (1999). In particular this literature shows that the effect of a bubble is similar to the effect of a too low discount rate of expected earnings, which is observationally equivalent to a too low risk premium.

A fourth aspect is the positive influence that the stock prices appreciation, induced by the technological revolution, may have had on consumer spending through a direct wealth effect, independently of expectations about future income. Since financial information gained a growing audience in the media, it is also well possible that the Nasdaq performance contributed to raising the confidence level of many consumers, whatever their own implication in the stock market (it is what Poterba (2000) called the 'confidence channel'). The performance of the stock market indeed tended to be subjectively associated with the performance of the whole real economy. The impact of stock prices on aggregate demand is very difficult to measure empirically. Several econometric studies try to measure the impact of stock markets fluctuations on aggregate demand and especially on consumption

\(^3\) See Shiller (2000) for details about the surveys.
and/or industrial investment (see for example Morck, Scheifer, and Vishny (1990), Ludvigson and Steindel (1999), Poterba (2000), and Lettau and Ludvigson(2001)). In general, these studies find a positive but weak link between real stock price fluctuations and the volume of private expenses, especially consumption. The smallness of this estimated impact seems to be in opposition with the widespread opinion among financial analysts. They generally argue that the impact of stock market prices on consumption is relatively important⁴.

An assessment of the impact of the New Economy Paradigm on financial investment is complicated by the concomitance of the emergence of information technologies and an increasing implication of households on the stock market. This increasing implication can be partly explained by technical factors which are independent of the New Economy paradigm. The expansion of Mutual Funds in the United States was phenomenal. Since 1998, the number of online traders was growing sharply. The volume of trading also displayed a strong run-up of the turnover rate. The growing interest of households in the stock market was accelerated by reforms in favour of pension plans and tax cuts for financial investment. So equity mutual fund shareholder accounts sharply increased from 1982 to 1998. Recently, attracted by the decrease of transaction costs allowed by internet technologies the number of the so-called 'daytraders' grew quickly. It is thus fair to conclude that the stock market buoying performance was favoured by several interacting factors, among which the democratization of stock market participation, optimistic earnings expectations, a decreasing risk premium and a likely bubble.

2.3 The challenges of monetary policy

Since Greenspan famous discussion about the 'irrational exuberance' of stock markets, the question has arisen as to whether monetary policy has to react to sharp fluctuations of equity prices. Rising stock prices were not the sole aspect of the problem related to the emergence of new information technologies. The Federal Reserve System had to decide whether the strong lasting growth of real activity was sustainable without inflationary pressures or whether preventive monetary policy actions were to be undertaken. The answer to this question crucially depended on a correct assessment of the underlying causes of the observed real growth. Was real activity driven by persistent supply shocks or by strong demand shocks entailed by some irrational wave of exaggerated optimism? Advocators of the 'New Economy Paradigm' were clearly on the first side.

Real and financial aspects of the issue were intrinsically related. Under the 'New Economy' hypothesis, production was boosted by productivity improvements and rising stock prices correctly reflected better earnings ex-

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⁴ See for example Greg, Kulish and Schlesinger (2001).
pectations. If aggregate demand then responded to increasing equity prices through some wealth effect, this reaction was rational. Under the second hypothesis, both rising stock prices and positive demand shocks reflected the same wave of 'irrational' optimism. Strong demand and high stock prices reinforced each other through a wealth effect.

In the next section we propose to analyse how monetary authorities should react to such developments entailed by the ‘New economy’ paradigm within a simple aggregate model.

3 A Simple Aggregate Model

The purpose of this section is to develop a simple aggregate model designed to account for the impact of technology shocks and changing behaviors on stock prices and monetary policy. This model is a version of those developed by Smets (1997) and Dor and Durré (2000). The main issues discussed in the precedent section may be easily modeled in this framework.

3.1 Aggregate Demand and Wealth Effects of Stock Markets

The log of real aggregate demand, $y_t^d$, is supposed to behave according to the following equation:

$$y_t^d = \alpha - \beta(R_t - E_t\pi_{t+1}) + \gamma v_t + \varepsilon_t^d$$  \hspace{1cm} (1)

where $\alpha$ is a constant, $R_t$ is the nominal-interest rate at date $t$, and $v_t$ is the log of the real stock price at date $t$. Note that $\pi_t$ 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 logs of the price level at date $t$ and at date $t+1$. A positive value of the shock $\varepsilon_t^d$ may capture an increase of consumers confidence, entailed by a wave of optimism such as the one which was observed during the ‘New economy’ mania. The above demand equation is specific since it explicitly contains a direct influence of real stock prices on aggregate expenditure through a wealth effect or a ‘confidence channel’ as discussed in section 2. It is thus a convenient way to model the effect of an exuberant increase of stock markets which may boost the expenditure of consumers, even if they do not own equities. An increased sensibility of household expenditure to stock price variations, for structural reasons outlined in section 2.2, and related to the mediatization and democratization of stock market participaton, can be modeled as an increase of the parameter $\gamma$. 
3.2 Aggregate Supply and Technological Shocks

The log of real aggregate supply, $y^s_t$, is determined by a standard Lucas function:

$$y^s_t = \bar{y} + \theta(p_t - E_{t-1}p_t) + \varepsilon^s_t$$  \hspace{1cm} (2)

So, aggregate supply differs from its natural level $\bar{y}$ by an amount proportional to deviations of current prices from expectations and by an exogenous technological shock $\varepsilon^s_t$. 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 log of the price level in the next period, date $t$. Such a supply function can be rationalised by incomplete information about current prices or wages (Lucas, 1973 or Gray, 1976). The new economy paradigm can be here modeled as a positive value of $\varepsilon^s_t$ with persistent effects. Therefore it will be assumed that $\varepsilon^s_t$ is a random walk.

3.3 Stock Market Dynamics, Expected Dividends, Risk Premium and Bubbles

On the stock market, we assume that the real stock price follows an arbitrage condition according to which the expected real return on equities must be equal to the expected real riskless interest rate plus a time-varying risk premium, $\varepsilon^v_t$. A log-linear approximation\(^6\) of this arbitrage condition, in an usual notation, is given by:

$$R_t - E_t\pi_{t+1} + \varepsilon^v_t = \rho E_t v_{t+1} + (1 - \rho) E_t d_{t+1} - v_t$$  \hspace{1cm} (3)

where the expected capital gains are represented by $E_t v_{t+1} - v_t$, while the expected log of real dividends are $E_t d_{t+1}$. Note also that the parameter $\rho$ comes from the log-linear approximation of equation 3 and is equal to $\frac{1}{1+\exp(\bar{Z})}$ where $\bar{Z}$ is the average log divend-price ratio. In turn, the log of real dividends at date $t + 1$ are equal to the log of the real production level in the previous period, so that:

$$d_{t+1} = y_t$$  \hspace{1cm} (4)

Because the aggregate price level is not contemporaneously observed, the perceived real stock price in log, $v_t$, is defined by:

$$v_t = V_t - E_t p_t$$  \hspace{1cm} (5)

where $V_t$ is the log of the nominal stock price and $E_t p_t$ is the expected log price level at date $t$.

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\(^6\) Note that by definition the risk-premium is the real required return on stocks by investors, which is equal to the real cost of risk capital for firms, minus the real return on riskless assets.

\(^6\) See for example Campbell, Lo and MacKinlay (1997).
3.4 Equilibrium Condition

Production satisfies the following equilibrium condition:

\[ y_t^s = y_t^d = y_t \]  \hfill (6)

3.5 The Informational Structure

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 contemporaneously on the markets where they are quoted so that \( E_t R_t = R_t \) and \( E_t V_t = V_t \).

The economy also faces several kinds of shocks. In the spirit of the real business cycle analysis, we assume that the supply shock is supposed to be a random walk, because we define it as a persistent technological shock:

\[ \epsilon_t^s = \epsilon_{t-1}^s + \xi_t \]  \hfill (7)

where \( \xi_t \) is white noise, while the aggregate demand shock and the financial disturbance are stationary and first order auto-correlated:

\[ \epsilon_t^d = \delta \epsilon_{t-1}^d + \zeta_t \]  \hfill (8)

\[ \epsilon_t^u = \tau \epsilon_{t-1}^u + \upsilon_t \]  \hfill (9)

where \( \zeta_t \) and \( \upsilon_t \) are white noises and \( 0 < \delta < 1 \) as \( 0 < \tau < 1 \). As mentioned above, an increase of consumption due to a psychological wave of optimism, as described in section 2.2, can be easily modeled as a strong positive value of the demand shock, \( \epsilon_t^d \). Since in reality such waves of optimism last for several periods, it is appropriate to assume that is positively autocorrelated. A decrease of the risk premium, induced by a decrease of the perceived variance of earnings, can be modeled by a negative value of \( \epsilon_t^u \). Such a negative financial shock is also a simple way to model approximately the effect of a bubble, since Bernanke and Gertler (1999) and Cogley (1999) show that this effect is similar to a decrease of the discount rate applied to expected earnings.

Combining eqs. 1, 2, 5, 6 and collecting the terms in \( p_t \), we obtain\(^8\):

\[ p_t = E_{t-1} p_t + \frac{\beta}{\theta} E_t \pi_{t+1} + \frac{\gamma}{\theta} V_t - \frac{\gamma}{\theta} E_t p_t - \frac{\beta}{\theta} R_t + \frac{1}{\theta} (\epsilon_t^d - \epsilon_t^s) \]  \hfill (10)

\(^7\) To introduce a bubble in equation 9, it is necessary to add a super martingale process, i.e. a process \( \epsilon_t^b \) such that \( \epsilon_t^b = (\frac{1}{\lambda}) \epsilon_{t-1}^b + \mu_t \) where \( \mu_t \) is white noise. The process \( \epsilon_t^b \) has the typical bubble property:

\[ \epsilon_t^b = \xi_t \epsilon_{t+1}^b. \]

\(^8\) Note that in the following of the paper we will ignore uninteresting constants.
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 $E_t p_t$. Taking the expectation of both sides of equation 10, we obtain the following rule for $E_t p_t$:

$$E_t p_t = E_{t-1} p_t + \frac{\beta}{\theta} E_t \pi_{t+1} + \frac{\gamma}{\theta} E_t V_t - \frac{\gamma}{\theta} E_t p_t - \frac{\beta}{\theta} E_t R_t + \frac{1}{\theta} E_t (\varepsilon_t^d - \varepsilon_t^s) \quad (11)$$

Let $\eta_t$ be the price perception error $p_t - E_t p_t$. Since the nominal prices for financial variables are observable, $E_t R_t = R_t$ and $E_t V_t = V_t$, the value of $\eta_t$ is:

$$\eta_t = \frac{1}{\theta} ((\varepsilon_t^d - \varepsilon_t^s) - E_t (\varepsilon_t^d - \varepsilon_t^s)) \quad (12)$$

### 3.6 The Optimal Monetary Policy

In this model the two extreme interpretations of the 'New Economy' mania can be explicitly modeled. According to the first interpretation, the new economy paradigm is true and the economy simply experienced a positive supply shock: $\varepsilon_t^s > 0$. According to the second interpretation, there was an irrational wave of optimism leading to a positive demand shock and a negative shock on the risk premium: $\varepsilon_t^d > 0$ and $\varepsilon_t^q < 0$. The effects of these shocks may have been reinforced by a structural increase of the sensibility of expenditure to stock price, i.e an increase of $\gamma$. It is thus interesting to investigate how a central bank should respond to either of these cases, or to a combination of them. To achieve this objective, it is first necessary to define the preferences of the central bank. These preferences are represented here by a standard loss function of the monetary authorities.

The loss function that the Central Bank minimizes is a weighted sum of squared deviations from an output target of $\bar{y} + \varepsilon_t^s$ and an inflation target of $\bar{\pi}$. A strictly positive value of $\bar{\pi}$ may involve the governments's optimal rate of taxation of cash balances, since the government obtains revenue from printing money (see for example Barro and Gordon, 1983). Formally, the policy maker's objective is to minimize subject to $R_t$, the following loss function:

$$\mathcal{L} = E_t \left( (y_t - \bar{y} - \varepsilon_t^s)^2 + \chi (\pi_t - \bar{\pi})^2 \right) \quad (13)$$

There is an arbitrage between minimizing the output gap and stabilizing the inflation rate. The coefficient $\chi$ is the relative weight the authorities attach to attaining their inflation target.

In each period, the Central Bank minimizes 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. However, the monetary authorities cannot control the aggregate price level
perfectly because it is not contemporaneously observable. This feature inevitably introduces a degree of error in the control of prices, equal to $\eta_t$. The Central Bank may only control the perceived price $E_t p_t$.

4 The Results

4.1 Solving the model

We solve the model mainly in three steps. First, by minimizing the monetary authorities loss function, we find the rule that the price expectations must follow at the optimal value of the nominal interest rate. Second, given the specification of the model, this rule implies, after all substitutions, a system of three linear equations in $R_t$, $E_t p_t$ and $V_t$ conditioned on expectations $E_{t-1} p_t$, $E_t p_{t+1}$ and $E_t V_{t+1}$ Third, 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 and the definition of the inflation rate (i.e. $\pi_t = p_t - p_{t-1}$), equation 13 can be rewritten as:

$$\mathcal{L} = E_t \left( \theta^2 (E_t p_t - E_{t-1} p_t)^2 + \chi (E_t p_t - p_{t-1} - \pi)^2 \right)$$  \hspace{1cm} (14)

The model implies that $E_t p_t$ depends on the interest rate since, using eqs. 1, 2, 3, 4, 5, 6, 7 and 8

$$E_t p_t = \frac{\theta}{\beta + \gamma + \theta} E_{t-1} p_t + \frac{1}{\beta + \gamma + \theta} \left( \beta E_{t+1} + \gamma V_t - \beta R_t + \delta \varepsilon_t - \varepsilon_{t-1}^e \right)$$  \hspace{1cm} (15)

where

$$V_t = (1 - \rho) E_{t+1} - R_t + \rho E_t V_{t+1} + (1 - \rho) \varepsilon_{t-1}^e - \varepsilon_t^e$$  \hspace{1cm} (16)

We then take the first-order condition, $\frac{\partial \mathcal{L}}{\partial R_t} = 0$, characterizing the optimum which, after distributing the expectation factor and using equation 7, implies$^9$:

$$E_t p_t = \frac{\theta^2}{\theta^2 + \chi} E_{t-1} p_t + \frac{\chi}{\theta^2 + \chi} p_{t-1}$$  \hspace{1cm} (17)

Therefore monetary authorities have to set the level of the interest rate $R_t$ at the value for which equation 17 is true.

$^9$ Note that by definition $E_t \eta_t = 0$ using equation (12).
4.1.2 Solutions at equilibrium

We substitute the value of $V_t$ given by equation 16 in equation 15. We then equalize eqs. 15 and 17 in order to find a rule for the optimal value of $R_t$. We then substitute this rule in eqs. 15 and 16. This generates a system of three linear equations in $R_t$, $V_t$ and $E_t p_t$ conditioned on expectations $E_{t-1} p_t$, $E_t p_{t+1}$ and $E_t V_{t+1}$.

This system is solved using the method of undetermined coefficients. The appropriate dynamic stability conditions require that $\beta > 0$, $\gamma > 0$ and $0 < \rho < 1$, given that $\theta$ and $\chi$ are strictly positive. We thus obtain the explicit solutions for the equity price $V_t$ and the interest rate $R_t$:

$$V_t = \frac{\delta(\delta - 1)}{\beta(1 - \rho \delta)(1 - \delta) + \gamma(1 - \delta)} \varepsilon_t^d + \varepsilon_t^s$$

$$ - \frac{\beta}{\beta + \gamma} \varepsilon_t^v - \frac{\beta(\beta \rho \tau^2)}{(\beta + \gamma)(\beta + \gamma - \beta \rho \tau)} \varepsilon_t^v + p_{t-1}$$

(18)

$$R_t = \frac{\delta(1 - \rho \delta)(1 - \delta)}{\beta(1 - \rho \delta)(1 - \delta) + \gamma(1 - \delta)} \varepsilon_t^d$$

$$ - \frac{\gamma}{\beta + \gamma} \varepsilon_t^v$$

$$ - \frac{\beta \gamma \rho \tau^2}{(\beta + \gamma)(\beta + \gamma - \beta \rho \tau)} \varepsilon_t^v$$

(19)

For given volatilities of the other stochastic shocks, the effect of the volatility of demand shocks on the volatility of interest rates is:

$$\frac{\sigma_R^2}{\sigma_{\varepsilon_d}^2} = \left( \frac{\partial R_t}{\partial \varepsilon_{t-1}^d} \right)^2 = \left( \frac{\delta(1 - \rho \delta)(1 - \delta)}{\beta(1 - \rho \delta)(1 - \delta) + \gamma(1 - \delta)} \right)^2$$

and the effect of the volatility of past financial shocks on the volatility of interest rates is:

$$\frac{\sigma_R^2}{\sigma_{\varepsilon_v}^2} = \left( \frac{\partial R_t}{\partial \varepsilon_{t-1}^v} \right)^2 = \left( \frac{\beta \gamma \rho \tau^2}{(\beta + \gamma)(\beta + \gamma - \beta \rho \tau)} \right)^2$$

while the contemporaneous effect of the volatility of financial shocks on the volatility of interest rates is:

$$\frac{\sigma_R^2}{\sigma_{\varepsilon_v}^2} = \left( \frac{\partial R_t}{\partial \varepsilon_{t}^v} \right)^2 = \left( \frac{\gamma}{\beta + \gamma} \right)^2$$
4.2 Simulation and Interpretation

The model is simulated using parameters values that make sense for US data. Empirically, over the period 1926 to 1994, $\rho$ is about .96 in annual data (see Campbell and al. (1997) or Cogley (1999)). This is a prudent choice since this estimate would be higher if the run-up in stock prices during 1995-1999 was included in the sample. Concerning $\beta$, it is very hard to estimate it due to the simultaneity of real demand and interest rates (see for example Broadbent and Barro, 1997). Therefore a small value like $\beta = 0.10$ is a conservative choice. The value of $\delta$ and $\tau$ are arbitrarily chosen as the mean of its acceptable values (i.e. 0.5). However, given the uncertainty about the actual sensibility of aggregate demand to stock prices fluctuations, we let $\gamma$ fluctuate in the interval $[0, 1]$.

The solutions of the model enable us to assess the economic consequences of several rational and psychological factors which are related to the emergence of the new economy paradigm.

The rational factor is a positive and persistent supply shock due to the so-called IT revolution. The existence of this positive supply shock is subject to general agreement, even if there remains much uncertainty about its magnitude, which depends on the importance of spillover effects of productivity gains in the IT sector on traditional sectors. This objective factor is here modeled as a positive value of $\varepsilon_1^s$, which affects production, stock prices and aggregate demand through a wealth effect. If the pure version of the 'new economy paradigm' is true, the economy only experienced a positive supply shock, and the model tells us that the central bank has not to intervene, $\frac{\partial R_t}{\partial t_{t-1}} = 0$.

This result can be easily explained. Indeed, a positive supply shock induces a permanent increase of real production which is rationally reflected in an increase of real stock prices. Therefore, aggregate demand catches up aggregate supply without necessitating any interest rate movement.

Among psychological factors the IT revolution entailed a wave of optimism resulting in a decrease of the risk premium $\varepsilon^p$, and a positive demand shock $\varepsilon_1^d$. To account for the inertia of these movements, they have been modeled as positively autocorrelated shocks. Here also the model yields what should be the right reaction of the central bank.

First, the interest rate level must react positively to the demand shock, in order to avoid inflationary pressures. Equity prices then decrease in response to this hike of the interest rate. Note that expected future dividends are unaffected since expected future output remains constant. The decrease of asset prices depresses further aggregate expenditure. This indirect impact implies that the interest rate must rise less than if aggregate demand would not depend on equity prices. Figure 2 in appendix shows the optimal reaction of the nominal interest rate to a demand shock, as a function of $\gamma$.

Second, a decrease of the risk premium increases equity prices (see equation 3) and boosts aggregate demand (see equation 1). In response the
Central Bank adjusts interest rates upwards. These reactions describe the initial effects of the shock. The initial effects are the most important to determine the final outcome, but the full path to the equilibrium solution involves additional interactions between the variables. Moreover the increase of interest rates has a negative effect on equity prices (an effect which does not fully offset the initial depression of equity prices), which influences aggregate demand (already negatively affected by increasing interest rates) and stabilizes the system. As the impact of financial shocks on output disappears over time, it is necessary to note that the nominal interest rate will also react to the financial shock. Figures 3 and 4 in appendix show the reaction of the interest rate to the financial shock for any value of \( \gamma \) in a range between 0 and 1.

It is much likely that the US economy has experienced a combination of a positive supply shock, a positive demand shock and a negative financial shock. A strong productivity shock may rationalize part of the rise of real production and of stock market prices. But it is very likely that this favourable supply shock was quickly accompanied by a wave of exaggerated optimism which boosted demand and lowered the risk premium. It is then clear to understand the dilemma that monetary authorities faced. We have seen that the central bank should not react to a supply shock but should try to offset demand and financial shocks. In practice however, the central bank may not know, by observing the evolution of production and stock prices, which part is due to supply shocks and which part is due to other shocks. Moreover, the central bank knows that its reaction must be a decreasing function of the sensibility of expenditure to real asset prices. This issue raises an additional problem: this sensibility is suspected to have increased, even if it is very imperfectly measured. In view of all these uncertainties that arise in practice, it is easy to understand that the Fed has chosen to react moderately and very gradually during the second part of the nineties.

5 Concluding Remarks

In this paper, we study the impact of several objective and subjective factors which are related to what we called the 'New Economy' paradigm. The rational factor concerns a permanent technological shock implied by the information technology. The other factors are more psychological. On the one hand, the IT revolution entailed a huge optimism about the future perspectives of the economy, among investors and consumers which involves a decrease in the risk premium on equities and a positive demand shock. On the other hand, the growing diffusion of financial information, focused on the rapid capital gains incurred by investors in IT stocks, entailed a greater interest of middle class households for stock market investments, increasing the sensibility of aggregate demand to stock market fluctuations.
Within a simple aggregate model, we show how the monetary authorities should react to such developments in the economy when their objective involves a trade-off between minimizing the output gap and stabilizing the inflation rate. In the case of a pure technological shock, the Central Bank does not need to react because the adjustment of aggregate demand to the new output level is ensured through the impact of stock prices on aggregate demand. In the case of demand and financial shocks, the Central Bank increases its nominal interest rate in order to contain the inflationary pressures in the economy. In all cases, the reaction of monetary authorities is weaker than what would be in the case where the monetary authorities do not take into account the real impact of equity prices on the economy. Now, if the Central Bank is not convinced that the stock prices play a role in the transmission mechanism of monetary policy, there should involve a higher volatility in the monetary policy instrument at some point.
References

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


Appendix

Figure A.1: USA: Dividend Yields and Price/Earnings Ratio of Information Technology Stocks

Figure A.2: \( \text{for } 0 < \gamma < 1 \)

\[
\frac{\partial R_t}{\partial e_t^{d}^{\gamma}}<1
\]
Figure A.3: (for $0 < \gamma < 1$)

$$\frac{\partial R_t}{\partial \epsilon_t'}$$

Figure A.4: (for $0 < \gamma < 1$)

$$\frac{\partial R_t}{\partial \epsilon_{t-1}'}$$