“Winners take all competition”, creative destruction and stock market bubble

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Christophe Boucher*

Abstract

From the model of Hobijn and Jovanovic (2001), we modelize a technological shock with uncertainty. We assume that this technological shock appears in the shape of new firms. Only a part of these firms will be productive. Uncertainty relates to the identification of the viable firms. This uncertainty decreases with the time and the diffusion of fundamentalist information that makes it possible to identify without error the viable firms. Without this fundamentalist information, the behavior of agents follows a rule of decision similar to that formulated by Heiner (1983). Uncertainty concerning the identification of viable firms which emerge of the technological shock, leads to a stock market bubble even though agents have a perfect knowledge of the impact of the shock and date on which it occurs. This type of uncertainty seems to characterize firms of the Information Communication Technology industries, which are confronted with a "winners take all" competition.

JEL: G12, O33, D81, D43.

Keywords: Uncertainty, technological change, asset price bubble, winner takes all.

* University of Paris-Nord
CEPN CNRS UMR 71-15
99 av. JB Clément
93430 Villetaneuse
France
e-mail:Cboucher75@aol.com

1. Introduction

For a few years, literature on stock market models with major technological change has expand (e.g., Greenwood and Yarukoglu, 1997; Greenwood and Jovanovic, 1999; Hobijn and Jovanovic, 2000; Manuelli, 2000), but asset price bubbles are never mentioned in these studies. However, financial history reveals that innovation and stock market bubbles are very close phenomena (Kindleberger, 1989; Chancellor, 1999): the Tulip Mania in the 1630's; the Railway Mania of 1845, the bull markets of the 1920s with speculation on radio, electricity, aviation, motor vehicle firms.

More recently, the development of Information Communication Technology (ICT) industries has been accompanied by a spectacular bubble over all of technological stock market on the world (tables 1 and 2).

ICT industries are characterized by increasing returns and network effects. Both of these factors give ICT industries a "winners take all" nature. First, firms in ICT industries tend to have fixed costs and low marginal costs. Fixed costs and sunk costs are a large part of factor payments because these firms invest in a physical or virtual network to create and deliver the product, and they must make substantial investments in research and development. Once the firms make the initial investment, it is cheap to product an additional unit (Evans and Schmalensee, 2001). This structure of production costs can be seen in industries such as microprocessors, computer softwares or services delivered by mobile telephony firms. That is, production in ICT industries exhibits increasing returns.

Second, many ICT industries (e.g., telephone network, internet site, computer software) have network effects. Network industries are characterized by the fact that the more consumers who use the product the more valuable it becomes (Shapiro and Varian, 1998). Networks effects are a source of scale economies and thus tend to produce markets with at most a small number of producers (Noe and Parker, 2000). Thus, for the ICT industries firms, the fundamental strategic stake becomes the conquest of the dominant position on its market. The particular structure of the production function of these companies which obeys increasing returns and which implies a competition of the type "winners take all" ensures the leader of high potential profits. The difficulty for investors is then to determine at the stage where all the companies are in competition, which will be essential in the long term like the dominant firm.

We modelize a technological shock with uncertainty. We assume that this technological shock appears in the shape of new firms but of which a part only will be productive.

Uncertainty relates to the identification of the viable firms. This uncertainty decreases with the time and the diffusion of fundamentalist information that makes it possible to identify without error the viable firms. In the absence of this fundamentalist information, the behavior of the agents follows a rule of decision similar to that formulated by Heiner (1983). The evolution of agents' confidence with regard to their own competences is then determined by the dynamic of prices noted on the market. Each agent uses the information contained in the contract price of the new firms by supposing that the other agents are better informed. The initial rise of the stock market that results from the technological shock is then self-sustained by the agents which see there information concerning the viability of the new firms that they have. The technological shock and the problem of coordination that is established between the agents leads to the emergence of a bubble. This bubble bursts only with the time and the progressive diffusion of fundamentalist information. This model makes it possible to explain a stock market bubble while at the same time the agents have a perfect knowledge of the impact of the technological shock on the economy and the date on which this shock occurs. The uncertainty relates only to the identification of the viable firms that emerges of this shock.

The rest of the study is organized as follows. The economy is described in section 2. We present in section 3, the technological shock and the model of rationality followed by the agents. In section 4, we study the dynamic of the prices and section 5 presents results of simulations. We study in section 6, the consequences of the technological shock on the aggregate market, in particular when it involves the obsolescence of the old firms. Section 7 concludes.

2. Description of the economy

The model is based on the Hobijn and Jovanovic (2001) technological model that is a version of the Lucas trees model (1978). This is a production economy with a single final good, y, fruit juice, and two intermediate goods, x and z, apples and oranges. There is no storage and the fruit juice production is exactly equal to its consumption. This economy is populated by many infinitely identical agents. Preferences are

(1) $E_0\left[\sum_{t=0}^{\infty} \beta^t U(y_t)\right]$ with $\beta \in [0,1]$,

where y_t are gallons of juice produced and consumed at date t, β is the actualization rate, $U(\cdot)$ is the Utility Function and $E[\cdot]$, the esperance operator.

Competitive firms make juice using apples, x, oranges, z, and a third factor, n, as inputs in a constant-returns-to-scale production function for final goods:

(2) $y = \overline{F}(x, z, n)$.

Let p_x and p_z denote prices of fruits. The factor n is fixed; its supply is normalized to equal 1. The production function is rewritten:

(3) $F(x, z) \equiv \overline{F}(x, z, 1)$,

The cost shares of the three factors s, z and n are respectively s_x, s_z and s_n, where $(s_x + s_z + s_n) = 1$ since returns are constant. Factor payments equal output and firms make zero profits. Optimal input choice means that prices of x and z must equal their marginal products:

(4) $p_{x,t} = \frac{\delta F}{\delta x}(x_t, z_t)$ and $p_{z,t} = \frac{\delta F}{\delta z}(x_t, z_t)$.

The proceeds from the sales of apples and oranges are paid out as dividends. The prices of the fruit-trees that promised a stream of dividends would be:

(5) $P_{x,t} = \sum_{j=t}^{\infty} \beta^{j-t} \frac{U'(y_j)}{U'(y_t)} \frac{\delta F}{\delta x}(x_j, z_j) x_j$

and

(6) $P_{z,t} = \sum_{j=t}^{\infty} \beta^{j-t} \frac{U'(y_j)}{U'(y_t)} \frac{\delta F}{\delta z}(x_j, z_j) z_j$.

Initially, there are no orange trees. The economy comprises a unit measure of apple trees, each yielding x apples. Output and consumption are:

(7) $y = F(x, 0)$.

This state of affairs is expected to remain there indefinitely. Market capitalization at the date t is therefore:

$$(8) \quad M_t = \sum_{j=t}^{\infty} \beta^{j-t} \frac{U'(y)}{U'(y)} \frac{\delta F}{\delta x}(x,0)x = \frac{(1-s_n)y}{1-\beta},$$

because by Euler's Theorem: $\frac{\delta F(x,0)}{\delta x} x = (1-s_n)y$. The ratio of market capitalization to GDP is then $\frac{(1-s_n)}{(1-\beta)}$.

3. Technological change and uncertainty

A unit measure of new trees – orange trees – spring forth at date T_0 without any fruit. News arrives at date T_1 that a *share* of this unit measure of orange trees will yield z oranges per period and per tree at the date T_2. However, agents are not likely to distinguish viable trees between unproductive trees before the date T_2. Agents knows all the same at date T_1 that the arrival of orange trees permanently raises the output of juice at date T_2 to:

$$(9) \quad y' = F(x,z)$$

The uncertainty is caused from the difficulty for agents to distinguish productive orange trees between all orange trees. Agents faced with this uncertainty follows a behavior rationality suggested by Heiner (1983). Ronal Heiner has proposed a theory of predictable behavior, which has its roots in a competence-difficulty gap (called a *C-D gap*). This gap is a measure of the spread between an economic agent's competence to make an optimizing decision, c, and the complexity of the environment, e. The structure of uncertainty is represented by :

$$(10) \quad I = i(\underset{-}{c}, \underset{+}{e}).$$

Heiner argues that as the C-D gap widens, the agent is increasingly likely to follow a rule-governed behavior, which produces observed regularities in economic behavior. According to Heiner, we will apply the C-D gap theory to explain "*switching between buying and selling strategies in financial markets, resulting in sudden movement in stock prices*"[1].

Therefore, an agent will buy whenever the expected gain from buying exceeds the expected loss. Let π denote the share of viable orange trees and $(1-\pi)$ the share of unproductive orange trees. The probability that an agent will buy an orange tree when the orange tree is viable, is represented by r with consequent gain g. Similarly, the conditional probability of an agent buying an orange tree when the orange tree is unproductive, is represented by w with consequent loss l.

An agent will buy an orange tree whenever the gains from buying a viable tree will cumulate faster than the losses from buying an unproductive tree, that is

$$(11) \quad r g \pi > w l (1-\pi)$$

or

$$(12) \quad \frac{r}{w} > \frac{l}{g}\frac{1-\pi}{\pi}$$

Heiner (1983) define this expression as the *Reliability Condition*. The left-hand side of the inequality is a *reliability ratio*, which measures the probability of correctly responding under the right circumstances relative to the probability of mistakenly responding under the wrong circumstances. The right-hand side of the inequality represents a *tolerance limit*, which a reliability ratio must satisfy.

Let ψ_t denote the reliability ratio at the date *t*. This ratio represents agents confidence degree towards their own competency. The reliability ratio assesses the subjective probability to recognize a viable tree relative to the subjective probability not to recognize an unproductive tree. In your model, the reliability ratio is determined by the dynamic of market prices:

$$(13) \quad \psi_t = \psi_{t-1}\left(\frac{P_{t-1}}{P_{t-2}}\right)^{\alpha} \qquad \text{with } \alpha \in [0,1],$$

[1] p.582.

where α is the likelihood degree that agents accord to the information contained in the market price. We introduce a "herd behavior" in the reliability ratio since agents refer to market prices thinking that other agents hold more information.

The gain received by an agent who has bought a viable tree and the loss sustained by one who has bought an unproductive tree are notified:

$$(14) \quad g_t = \frac{\overline{P_{z,t}}}{P_{z,t}} \qquad \text{and} \qquad (15) \quad l_t = \frac{1}{P_{z,t}},$$

where $P_{z,t}$ is the market price of orange trees at the date t and $\overline{P_{z,t}}$ is the fundamental value of orange trees at the date t. The value of unproductive trees is supposed null. Consequently, the fundamental value of orange trees is equal to the dividends of viable trees from date T_2:

$$(15) \quad \overline{P_{z,t}} = \sum_{j=T_2-t}^{\infty} \beta^j \frac{U'(y')}{U'(y_t)} \frac{\delta F}{\delta z}(x,z)z$$

The price equation is composed of two expressions. The first represents the determination of the price under uncertainty according to Heiner's model (1983) in equation 12. However, this expression is slightly different of the Heiner's seminal model in order to be continuous for a market price determination. The larger inequality between the reliability ratio and tolerance limit is, the more confident towards their own competency the agents are. Then, they will be able to pay to receive stream of future dividends. This expression plays fully when uncertainty is maximal that is no information is available apart from market price.

The second expression represents a "fundamentalist reverting" who appears in the orange tree pricing with the uncertainty reduction and the arrival of fundamentalist information. This information permits agents to recognize viable trees:

$$(16) \quad P_{z,t} = \left[\frac{\frac{\psi_t}{1-\pi}}{\pi} \frac{g_t}{l_t} \right]^{1-\eta_t} \overline{P_{z,t}}^{\eta_t} = \left[\frac{\frac{\psi_t}{1-\pi}}{\pi} \right]^{1-\eta_t} \overline{P_{z,t}},$$

where η_t represents the degree of fundamentalist information that agents possess. The uncertainty reduces with time and follow a logistic process define by:

$$(17)\quad \eta_t = \frac{1}{1+b\gamma^{t}} \quad \text{with } b>0 \text{ and } \gamma \in [0,1],$$

where b is a parameter of Y-axis and $\frac{1}{\gamma}$ is the rate of diffusion of fundamentalist information, i.e. the rate of uncertainty reduction.

Uncertainty is fully when $\eta = 0$; no fundamentalist information is available. The environment is certain when $\eta = 1$; agents are able to distinguish viable tree with the information from the environment and their competence. The rate of uncertainty reduction is determined by the uncertainty structure of the technological shock:

$$(19)\quad \gamma = \gamma(\underset{+}{I}).$$

The function η_t with different values of γ appears in figure 1. Then, the more limited agents competence is and the more complex environment is, the longer time uncertainty reduction will take.

4. Dynamic of price

Let B_t denote the valuation ratio at the date t , defined by:

$$(20)\quad B_t = P_{z,t}\overline{P_{z,t}}^{-1} = \left[\frac{\psi_t}{\frac{1-\pi}{\pi}}\right]^{1-\eta_t}.$$

Market valuation is equal to the fundamental value when $B = 1$. This state corresponds to the mechanism of pricing in a certain environment that is $\eta = 1$. $B < 1$ correspond to an undervaluation of orange trees and $B > 1$ to an overvaluation. In the case of misvaluation, the transversality condition of Lucas model is satisfied since the bubble is transitory. In fact, $\lim_{\tau \to \infty} E_t \left[\beta^{\tau} P_{z,t+\tau} \frac{U'(y_{t+\tau})}{U'(y_t)} \right] = 0$ with $B_t \neq 1$ for $t \in [T_0, T_2 - 1]$.

The reliability ratio is rewritten :

$$(21) \quad \psi_t = \psi_{t-1} \left(\frac{P_{z,t-1}}{P_{z,t-2}} \right)^{\alpha} = \beta^{-\alpha} \left(\psi_{t-1} \right)^{1+\alpha(1-\eta_{t-1})} (\psi_{t-2})^{-\alpha(1-\eta_{t-2})} \left(\frac{\pi}{1-\pi} \right)^{\alpha(\eta_{t-2}-\eta_{t-1})},$$

and appears under the guise of second order recurrent series: $U_{n+1} = f(U_n, U_{n-1})$. Then, it is necessary to solve this equation system, to settle U_o and U_1, that is the initial level of the reliability ratio.

Market price of orange trees is then :

$$(22) \quad P_{z,t} = \begin{cases} 0 & \text{for } t \leq T_1 - 1 \\ B \overline{P_{z,t}} & \text{for } T_1 \leq t \leq T_2 - 1 \\ \overline{P_{z,t}} & \text{for } t \geq T_2 \end{cases}$$

with

$$(23) \quad \overline{P_{z,t}} = \begin{cases} \frac{\beta^{T_2 - t}}{1-\beta} \left(\frac{U'(y')}{U'(y)} \right) \frac{\delta F}{\delta z}(x,z) z & \text{for } t \leq T_2 - 1 \\ \frac{1}{1-\beta} \frac{\delta F}{\delta z}(x,z) z & \text{for } t \geq T_2 \end{cases}$$

When $t \leq T_1 - 1$, there is no available fundamentalist information (η =0) and π is equal to 0. ψ_{t_i} represents the initial reliability ratio. The reliability ratio for following periods is:

$$(24) \quad \psi_{t_i+1} = \beta^{-\alpha} \psi_{t_i}.$$

The valuation ratio, B_t, is equal to 0 for any n:

(25) $B_{t_i+n} = \dfrac{\beta^{-\alpha n}\psi_{t_i}}{\dfrac{1-\pi}{\pi}} = 0$ for $\pi = 0$.

At date T_1, there is a shock on π. Then, fundamentalist information appears depending on the process defined by the function η_t. This shock leads to an increase of B_t and $\dfrac{P_{z,T_1}}{P_{z,T_1-1}}$ depending on α, the likelihood degree that agents accord to the information contained in the market price.

Fundamentalist information, η, at first periods is too small to exert a sufficient tension on price formation. Market price of orange trees increases and each agent interpret this movement as information over the viability of each tree. Then, each agent thinks that his own competence allows him to identify correctly viable trees. In the case there is no "fundamentalist reverting" ($\eta = 0$), ψ_t follows a "myopic disaster" dynamic where confidence agents is fully determined by movement of market price at the precedent period. The reversal appears when objective and fundamentalist information is taller than weight that agents accord to the information contained in the market price.

At date T_2, whatever uncertainty degree there is at the date (T_2-1), payment of dividends by viable trees leads to eliminate uncertainty and the environment becomes certain. There is any more bubble.

5. Simulation

Parameters are followers: γ = 0.4; β = 0.96; α = 0.15; ψ_{t_i} = 1; π_{t_i} = 0; π_{T_1} = 1/3; b = 1000; T_0 = -12, T_1 = 0 and T_2 = 30.

Figure 2 and figure 3 show reliability ratio and valuation ratio depending on inverse of the rate of uncertainty reduction. This parameter plays on time extinction of the bubble. The faster fundamentalist information is delivered, the earlier bubble will disappear.

Figure 4 shows the special case of technological shock in certain environment ($\eta_t = 1 \, \forall t$), where the shock on share of viable orange trees is accompanied by all information permitting agents to distinguish viable trees.

Figure 5 and figure 6 show reliability ratio and valuation ratio depending on different values of weight that agents accord to the information contained in the market price (α). This parameter has an influence on the size of the bubble. For high values of α , the bubble is taller than its "rational limit" where each orange tree is considered as viable ($P_{z,t} = \frac{1}{\pi}\overline{P_{z,t}}$).

Initially, we shall normalize ψ_{t_i} to 1 since we suppose that an agent without information is characterized by the probability to recognize a viable tree equal to the probability to not recognize an unproductive tree ($r = w$). But many authors demonstrate than "overconfidence" seems to be a characteristic of personal judgment (DeBondt and Thaler, 1995)[2]. Then, we have simulated the dynamic of price with different values of the initial reliability ratio (ψ_{t_i}). Figure 7 shows this simulation. The initial level of reliability ratio appears as a determinant of the bubble size.

Figure 8 shows the special case where payment of dividends comes before the complete reduction of uncertainty ($T_2 < t$ as $\eta_t = 1$). The adjustment of orange trees price is immediate because the payment of first dividends at the date T_2 permits agents to immediately recognize viable trees. The collapse of the bubble is instant.

6. Aggregate market and « destructive creation »

When news arrive at date T_1 that a share of orange trees will yield *z* oranges per period at date T_2, $P_{x,t}$ falls since dividends beyond date T_2-1 are now discounted at a higher rate, i.e. they are multiplied by the factor ($U'(y')/U'(y) < 1$):

$$(26) \quad P_{x,t} = \begin{cases} \frac{(1-s_n)y}{1-\beta} & \text{for } t \leq T_1 - 1 \\ \frac{1-\beta^{T_2-t}}{1-\beta}(1-s_n)y + \frac{\beta^{T_2-t}}{1-\beta}\left(\frac{U'(y')}{U'(y)}\right)\frac{\delta F}{\delta x}(x,z)x & \text{for } T_1 \leq t \leq T_2 - 1 \\ \frac{1}{1-\beta}\frac{\delta F}{\delta x}(x,z)x & \text{for } t \geq T_2 \end{cases}$$

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[2] See Odean (1998) for a survey litterature on « overconfidence ».

The orange bubble influences the aggregate market capitalization depending on the future cost share of oranges in the production function, s_z:

$$(27)\quad M_t = \begin{cases} \dfrac{(1-s_n)y}{1-\beta} & \text{for } t \le T_1 - 1 \\ \dfrac{1-\beta^{T_2-t}}{1-\beta}(1-s_n)y + \dfrac{\beta^{T_2-t}}{1-\beta}\left(\dfrac{U'(y')}{U'(y)}\right) y'(s_x + B\,s_z) & \text{for } T_1 \le t \le T_2 - 1 \\ \dfrac{(1-s_n)y'}{1-\beta} & \text{for } t \ge T_2 \end{cases}$$

At date T_2, the ratio of market capitalization to GDP recovers its earlier level: $\dfrac{(1-s_n)}{(1-\beta)}$.

When the arrival of oranges produces obsolescence of apples, then information that appears at date T_1 could lead to decrease $P_{x,t}$. If we suppose that the two fruits are substitutes in the production of juice, this would decrease the share of apples in the production function as $\dfrac{\delta F(x,z)}{\delta x} < \dfrac{\delta F(x,0)}{\delta x}$.

If the arrival of oranges were to make apples fully obsolete, $\dfrac{\delta F(x,z)}{\delta x} = 0$, the value of apple trees would then be:

$$(28)\quad P_{x,t} = \begin{cases} \dfrac{(1-s_n)y}{1-\beta} & \text{pour } t \le T_1 - 1 \\ \dfrac{1-\beta^{T_2-t}}{1-\beta}(1-s_n)y & \text{pour } T_1 \le t \le T_2 - 1 \\ 0 & \text{pour } t \ge T_2 \end{cases}$$

The impact of the news at date T_1 would be $(1-\beta^{T_2-T_1})$, which would represent a 30% drop in the case of precedent parameters.

The fundamental value of orange trees in the case of fully obsolescence would be:

$$(29)\quad \overline{P_{z,t}} = \begin{cases} \dfrac{\beta^{T_2-t}}{1-\beta}(1-s_n)y & \text{for } t \le T_2 - 1 \\ \dfrac{(1-s_n)y}{1-\beta} & \text{for } t \ge T_2 \end{cases}$$

The market capitalization would become:

$$(30)\quad M_t = \begin{cases} \dfrac{(1-s_n)y}{1-\beta} & \text{for } t \le T_1 - 1 \\ \dfrac{1-\beta^{T_2-t}}{1-\beta}(1-s_n)y + B\dfrac{\beta^{T_2-t}}{1-\beta}(1-s_n)y & \text{for } T_1 \le t \le T_2 - 1 \\ \dfrac{(1-s_n)y}{1-\beta} & \text{for } t \ge T_2 \end{cases}$$

Figure 9 shows the dynamic of fruit trees price in the case of fully obsolescence. When the news arrives at date T_1, agents anticipate the future obsolescence of apples from date T_2, and then the value of apple trees decreases. The orange trees bubble compensates more than this drop. When orange trees are correctly valued (B=1), the ratio market capitalization to GDP recovers its earlier level $\left(\dfrac{1-s_n}{1-\beta}\right)$.

7. Conclusion

In our model, the size of the bubble depends on i) the initial level of the confidence degree that agents allot to their own competence, (ii) the weight that agents accord to the information contained in the market price. The rapidity of the bubble deflation is determined by the rate of diffusion of fundamentalist information, i.e. the rate of reduction of the gap between the complexity of the environment and the cognitive capacities of the agents.

The uncertainty concerning the identification of viable firms which emerge of the technological shock, leads to the emergence of a stock market bubble even though agents have a perfect knowledge of the impact of the shock and date on which it occurs. This type of uncertainty seems to characterize the firms of the ICT industries, which are confronted with a "winners take all" competition.

In this model, uncertainty and incomplete information are determining factors in the emergence of the bubble. Mimetic behavior is rational to agents who follow other participants, who are thought to be better informed. This model suggest that strengthening transparency and expand competencies required by the analysis of complex information are likely to reduce the size and the duration of the bubble. Also, the long time of the bursting

ICT bubble (see table 2) suggests than the reduction of uncertainty about identification of viable firms took time. Finally, the absence of reaction from the Fed board members since the "irrational exuberance" speech in 1996 is likely to increase the weight that agents accord to the information contained in the market price. Therefore increasing margin requirements[3] a little or speak about overvaluation in official speeches would have send a healthy signal for agents.

[3] See discussion about marginal calls by Robert Shiller in the *The Wall Street Journal* (Monday, April 10, 2000).

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Tableau 1
Historical comparison of stock market crashes
in the United States

crash	size	period	duration	index
October 1929	-37%	october 11 – november 10	30 days	Dow Jones Industrial
October 1987	-30%	october 2 – october19	17 days	Dow Jones Industrial
« e-crashes » March 2000	-36,5%	march 10 – may 25	45 days	Nasdaq
	-61%	September 1st 2000- april 4, 2001	7 months	

Table 2
e-crashes in the world

		1st crash (10/03/00-25/05/00)	2nd crash (01/10/00-04/04/01)	e-crash (10/03/00-04/04/01)
US	Nasdaq	-36.5%	-61%	-67.5%
	Isdex	-43%	-80%	-85%
France	Nouveau Marché	-49%	-68%	-79.7%
	ITCAC	-37%	-53%	-63.7%
Deutschland	Neuer Market	-26.7%	-35%	-48.8%
Japan	Jasdaq	-31.6%	-24.2%	-51.4%

Figure 1
Process of fundamentalist information diffusion (η)
depending on γ

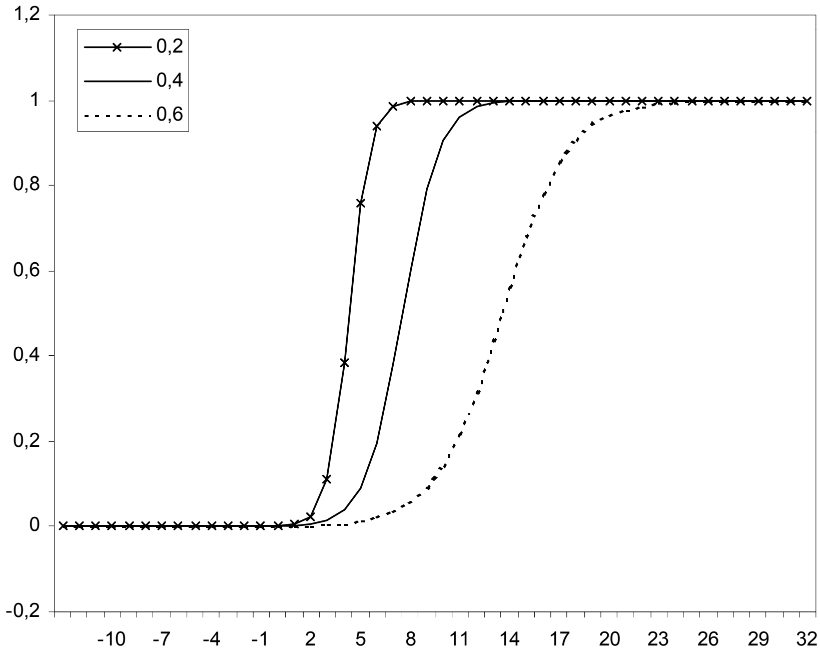

Figure 2
Reliability ratio (ψ) depending on γ

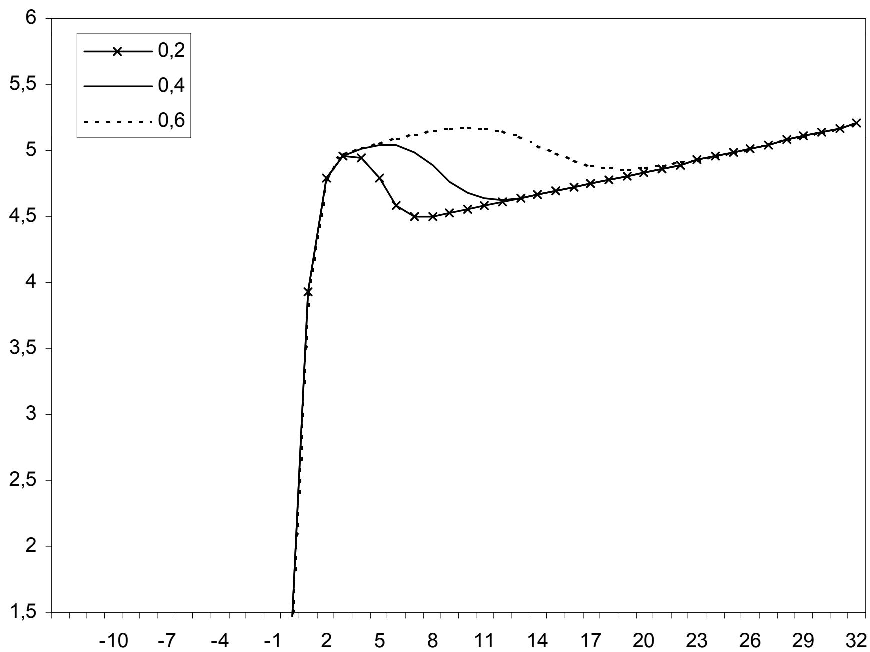

Figure 3
Valuation ratio (B) depending on γ

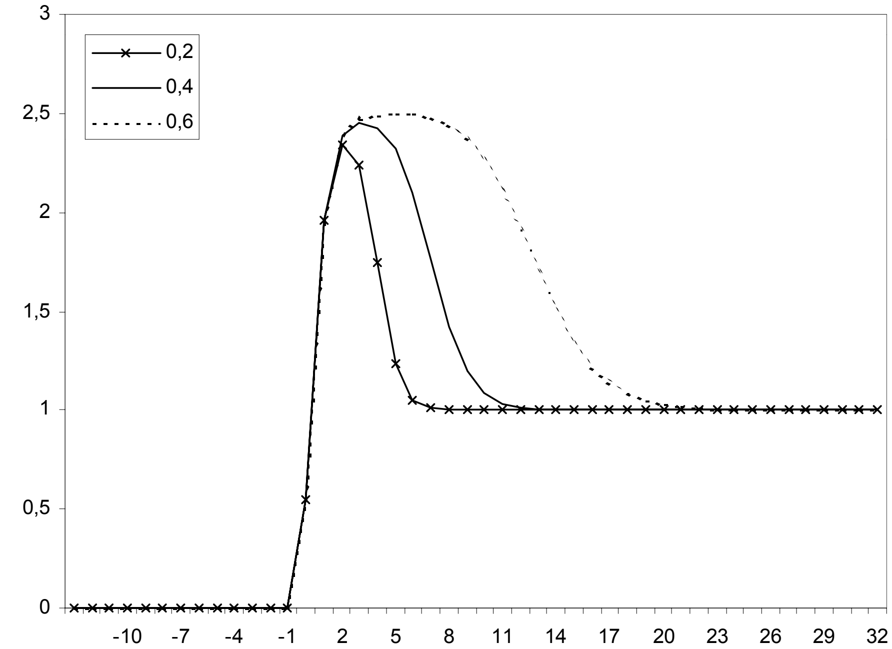

Figure 4
Valuation ratio (B)
and process of fundamentalist information diffusion (η)
in a certain environment ($\eta_t = 1 \forall t$)

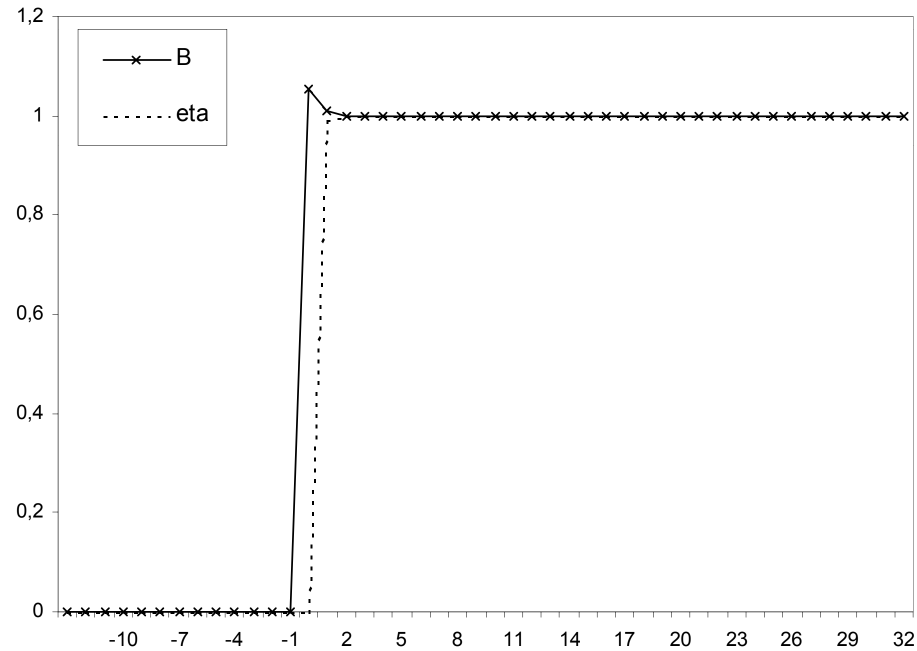

Figure 5
Reliability ratio (ψ) depending on the weight that agents accord to the information contained in the market price (α)

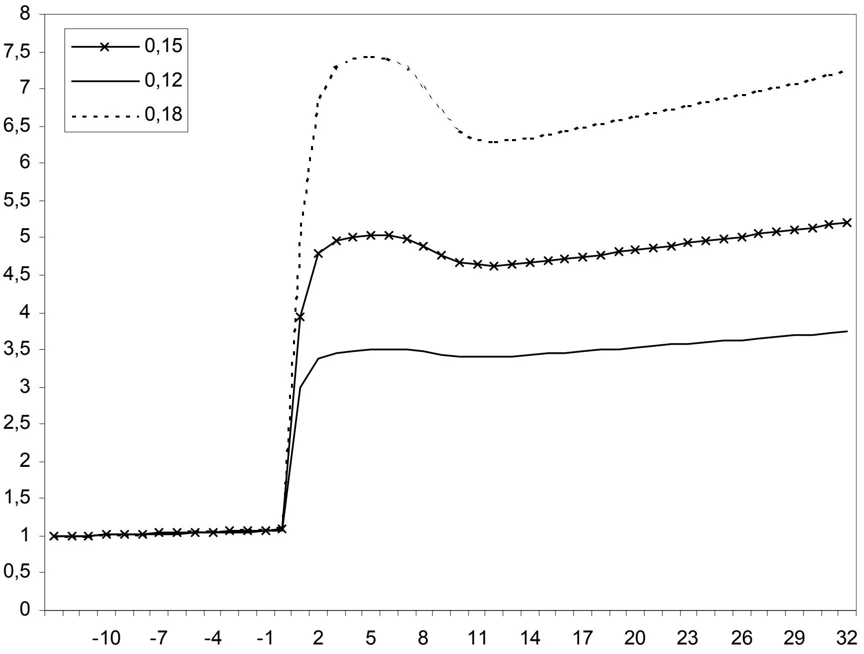

Figure 6
Valuation ratio (B) depending on the weight that agents accord to the information contained in the market price (α)
with ($\frac{1}{\pi} = 3$)

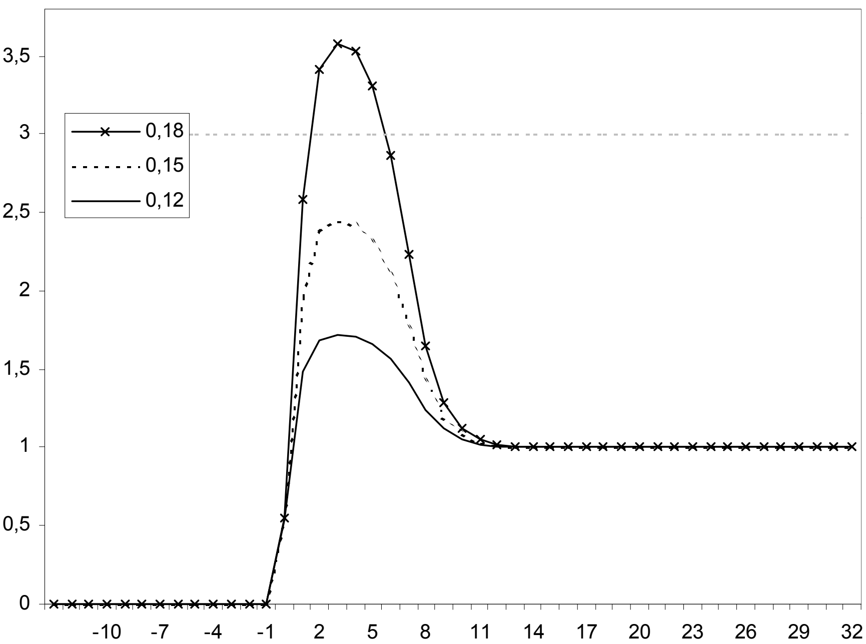

Figure 7
Valuation ratio (B)
Depending on initial reliability ratio (ψ_{ti})

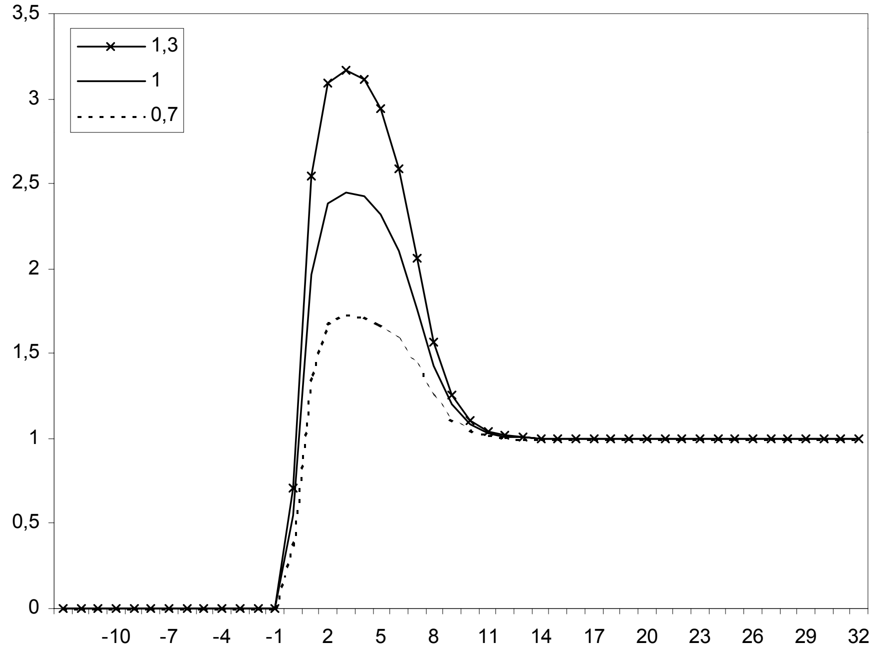

Figure 8
Valuation ratio (B)
when payment of dividends comes before the complete reduction of uncertainty
($T_2 < t$ as $\eta_t = 1$).

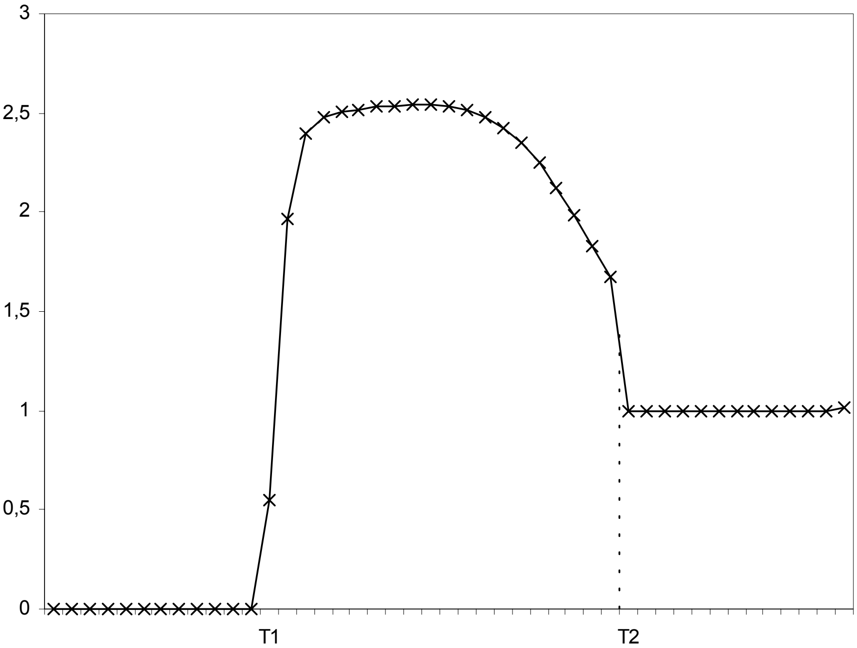

Figure 9
Market capitalization in the case of fully apples obsolescence