

Moretto, Michele; Panteghini, Paolo M.; Scarpa, Carlo

Working Paper

Investment Size and Firm's Value Under Profit Sharing Regulation

Nota di Lavoro, No. 80.2003

Provided in Cooperation with:

Fondazione Eni Enrico Mattei (FEEM)

Suggested Citation: Moretto, Michele; Panteghini, Paolo M.; Scarpa, Carlo (2003) : Investment Size and Firm's Value Under Profit Sharing Regulation, Nota di Lavoro, No. 80.2003, Fondazione Eni Enrico Mattei (FEEM), Milano

This Version is available at:

<https://hdl.handle.net/10419/118116>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Investment Size and Firm's Value Under Profit Sharing Regulation

Michele Moretto, Paolo M. Panteghini and
Carlo Scarpa

NOTA DI LAVORO 80.2003

SEPTEMBER 2003

ETA – Economic Theory and Applications

Michele Moretto, Paolo M. Panteghini and Carlo Scarpa
Economics Department, University of Brescia

This paper can be downloaded without charge at:

The Fondazione Eni Enrico Mattei Note di Lavoro Series Index:
http://www.feem.it/web/attiv/_wp.html

Social Science Research Network Electronic Paper Collection:
http://papers.ssrn.com/abstract_id=XXXXXX

The opinions expressed in this paper do not necessarily reflect the position of
Fondazione Eni Enrico Mattei

Investment Size and Firm's Value Under Profit Sharing Regulation

Summary

In this article we analyse the effects of different regulatory schemes (price cap and profit sharing) on a firm's investment of endogenous size. Using a real option approach in continuous time, we show that profit sharing does not affect a firm's start-up decision relative to a pure price cap scheme. Unless the threshold after which profit sharing intervenes is very high, however, introducing a profit sharing element delays further investments: this decreases the present value of total investment. We also evaluate the reduction in the firm's value due to profit sharing, linking this reduction to the option value of future investments.

Keywords: Regulation, Investment, Profit sharing, Real options, RPI-x

JEL: L51, D81, D92, G31

Address for correspondence:

Michele Moretto
Dipartimento di Scienze Economiche
Università di Brescia
Via S. Faustino, 74b
25122 Brescia
Italy
E-mail: moretto@eco.unibs.it

1 Introduction

The performance of regulated public utilities has raised concern about how to reconcile consumers' protection and the incentive to invest. A popular solution among regulators is the (by now traditional¹) $RPI - x$ scheme, which is supposed to provide the regulated firm appropriate incentives to invest, making the regulated price insensitive to cost-reducing investments: in this way, firms which reduce their costs are not penalized. However, sometimes this rule allows the firm to keep huge profits, and this has lead to proposals to force firms to share their "excess" profit with the consumers (among others, Sappington and Weisman, 1996; Burns, Turvey and Weyman Jones, 1998). As documented for instance by Sappington (2002) there are now many cases where price cap regulation is modified with an earnings sharing clause, whereby if profits are too high there is an automatic mechanism which riveses prices, to the benefit of consumers. But - although the evidence is mixed - the blanket seems to be too short: a redistribution of benefits from the firms to the consumers may decrease the incentive to invest².

This paper analyses and assesses the above concern, in order to understand whether profit sharing schemes actually penalize investment decisions, relative to a pure price cap. This is done on the basis of modern investment theory³, which stresses how investment is irreversible, and calls for a set-up where investment timing and uncertainty play a substantial role. Along these lines, Panteghini and Scarpa (2003a) use a simple framework to show that modifying a price cap with an element of profit sharing does not affect the incentive to make an investment of given amount: the timing and probability of such an investment are the same, independently of the presence of profit sharing.

In this paper we consider the - more plausible - set-up where time is a *continuous* variable and uncertainty never disappears from the market. Moreover, and more important, investment size is *endogenous*: the firm can

¹According to this scheme, the regulated price should start from a given level, and then increase at a rate equal to the difference between the expected inflation rate (the Retail Price Index, RPI) and an exogenously given component (x). See Beesley and Littlechild (1989).

²On this point, among others, see Mayer and Vickers (1996) and Weisman (2002). See Ai and Sappington (2002) on the evidence, which lends some (but limited) support to this fear.

³In particular, we will use the concept real option; see for instance Dixit and Pindyck (1994).

make an initial investment and then has the option to expand the plant, so that total investment size depends on several subsequent decisions. In this set-up, we can show that the initial investment does not depend on whether or not the price cap rule has a profit sharing element. The reason is that the introduction of the profit ceiling into a $RPI - x$ scheme decreases the net present value of the investment, but also decreases the value of waiting (i.e., the option value) by exactly the same amount⁴.

Profit sharing matters only if the threshold after which profits are passed on to consumers is low, and in this case we have an underinvestment result. When the firm reaches the threshold profit level, beyond which the price cap becomes tighter in order to transfer part of the benefits to the consumers, it faces a problem. Any increase in (profitable) investment will be self defeating, unless market profitability is so high to more than compensate profit sharing. Therefore, the firm waits until market conditions are substantially more favorable, and investment is delayed and possibly never carried out.

This paper is linked to two streams of literature. The first one is the traditional theory of investment under regulation, where investment ("effort") is fully reversible and is modelled in a static framework where the firm perfectly knows the return from its investment (e.g., Laffont and Tirole, 1986). The same approach was taken by several papers which analyze the debate on price cap and profit sharing rules. In general this literature claims that a pure $RPI - x$ system is preferable to a price cap with profit sharing, on the ground of technical efficiency (e.g., Lyon, 1996). Weisman (1993) shows that when price cap rules incorporate an element of profit sharing, price caps may represent a worsening relative to a pure cost based regulation, a notoriously inefficient set-up.

These models are perfectly suitable to tackle reversible investment. When irreversibility matters, however, the decision to invest should consider the option value of investment. As an irreversible choice entails giving up an opportunity, the value of waiting should be considered. Introducing these elements in the model necessarily requires one to analyze a dynamic model (where the timing of investment can be modelled) and to explicitly consider uncertainty, so that waiting is valuable as the information available to the firm changes over time. This change in viewpoint is also reflected in the

⁴This is an application of the "bad news principle" (Bernanke, 1983), which indicates that, under investment irreversibility, uncertainty acts asymmetrically since only the unfavorable events affect the current propensity to invest. If, thus, profit sharing (i.e., the change in the x factor) occurs only in the good state, investment decisions are not affected.

result, which is considerably less negative for profit sharing, which interferes with investment decisions only under certain conditions. Notice that this is in line with several empirical analyses, which point out that the supposed superiority of pure price cap schemes in providing incentives to investment is not based on any clear empirical evidence⁵.

The second stream of literature is the one on investment and irreversibility. In that framework (see e.g., Dixit and Pindyck, 1994) the case of unregulated firms is widely considered, while less attention has been paid to firms who are constrained in their pricing decisions. A notable exception is Dixit (1991), who studies the effects of price ceilings in a competitive industry. In particular, he shows that the price ceiling affects one-off investment strategies only if it is low enough. Although consistent with our result, Dixit's finding does not refer to a monopoly and especially it does not include an earnings sharing clause in the price constraint.

The next section introduces the basic continuous time model. Section 3 analyses the effects of regulation with an investment of given size. Section 4, by introducing the possibility to expand the initial investment, considers an investment of endogenous size, and contains our main result. Section 5 summarizes the results and discusses their implications.

2 The model

In this section we present a continuous time model of investment for a firm, subject to a regulatory constraint on its price. The firm has both an option to delay initial investment and an option to expand it. The following assumptions hold:

1. Market demand $q(t)$ follows a geometric Brownian motion

$$dq(t) = \alpha_q q(t)dt + \sigma_q q(t)dz(t) \quad (1)$$

where t is time, α_q and σ_q are the (constant) growth rate and variance parameter, respectively and $dz(t)$ is the increment of a standard Wiener process satisfying the conditions that $E(dz) = 0$ and $E(dz^2) = dt$.

2. Only one firm operates in this market. Its payoff is

$$\Pi(t) = \Psi(K(t))p(t)q(t) \equiv \Psi(K(t))\Theta(t) \quad (2)$$

⁵For instance, Ai and Sappington (2002) show extremely mixed results.

where $p(t)$ is the regulated price, net of costs and $\Psi(K(t))$ describes the effects of capital accumulation on the firm's profitability. This term can be thought of as a mark up. According to the above assumption, investment can be cost-reducing (namely it can lead to an increase in the firm's mark up).

3. $\Psi(0) = 0$; $\Psi_K > 0$; $\Psi_{KK} > 0$ if and only if $K \in [0, K^*]$; $\Psi_{KK} < 0$ thereafter.

Assumption 3 has a Marshallian flavor, as it assumes the existence of increasing returns when K does not exceed K^* . When, instead, $K \geq K^*$, capacity expansion is subject to diminishing marginal returns. In this case, Dixit (1995) shows that there exists an optimal starting level of capital, say \underline{K} : if the firm decides to invest, it will never invest less than \underline{K} . This level is characterized by $\Psi_K(\underline{K}) = \frac{\Psi(\underline{K})}{\underline{K}}$ and $\Psi_{KK}(\underline{K}) < 0$; this implies that $\underline{K} > K^*$. Once the start-up decision is made, investment decisions follow an incremental strategy⁶.

Let us next turn to the regulatory schemes. The basic one is an $RPI - x$ scheme, whereby price follows a pre-set dynamics given by the x factor. If the firm starts producing at time zero, the initial price $p_0 > 0$ is given, and its dynamics are defined by the difference between the inflation rate (changes in the retail price index, RPI) and an exogenous factor x_l :

$$p(t) = p_0 e^{(RPI - x_l)t} \quad (3)$$

When profit sharing is introduced to complement the basic price cap formula, this entails an upper bound to the profit level, $\tilde{\Pi}$, after which a higher x factor applies⁷. Profit sharing is therefore defined as a modification of (3), as follows

$$p(t) = p_0 e^{(RPI - x_j)t} \quad \text{where } x_j = \begin{cases} x_l & \text{if } \Pi[K(t), \Theta(t)] < \tilde{\Pi} \\ x_h & \text{if } \Pi[K(t), \Theta(t)] > \tilde{\Pi} \end{cases} \quad (4)$$

with $x_l < x_h$. These parameters are known in advance by all market participants, and they are set irreversibly.

⁶It is worth noting that the quality of our results would not change if we assumed that the start-up level of capital were given exogenously. In this case, if \underline{K} were such that $\Psi_K(\underline{K}) > \frac{\Psi(\underline{K})}{\underline{K}}$, the firm would anyway choose a higher level of K (such that $\Psi_K(K) = \frac{\Psi(K)}{K}$). The only relevant case would be one in which $\Psi_K(\underline{K}) < \frac{\Psi(\underline{K})}{\underline{K}}$.

⁷There are other possibilities to model profit sharing; see Sappington and Weisman (1996) and Schmalensee (1979) for (qualitatively analogous) formulations.

Given (2) and (4), for any value of $K(t)$ there exists an upper value $\tilde{\Theta}(K(t))$ beyond which the regulator switches from x_l to x_h . To compute the switch level, set

$$\Psi(K(t))\Theta(t) = \tilde{\Pi}$$

and solve for $\Theta(K(t))$, so as to obtain the switch level $\tilde{\Theta}(K(t)) = \frac{\tilde{\Pi}}{\Psi(K(t))}$. It is easy to ascertain that by assumption 3 $\frac{d\tilde{\Theta}(K(t))}{dK(t)} < 0$ for all $K(t)$.

In order to determine the dynamics of profit, we need to compute the risk-adjusted rate of return or the net “cost of carry” ($r - \delta$), where r is the risk-free interest rate and δ is the dividend rate⁸. If the shareholders are risk-neutral, under equilibrium the equality $r - \delta = \alpha \geq 0$ holds⁹.

Given the above equality, we have $r - \delta = RPI - x_j + \alpha_q$, with $j = l, h$. Solving for the dividend rate we thus obtain

$$\delta(x_j) = r - RPI + x_j - \alpha_q, \text{ with } j = l, h. \quad (5)$$

Using equations (1), (2) and (3), and applying Itô’s lemma we can obtain the profits’ dynamics

$$\begin{aligned} d\Pi(t) &= \Psi_K(K(t))\Theta(t)dK + \Psi(K(t))d\Theta(t) \\ &= \Gamma(K(t))\Pi(t)dK + \Pi(t)[\alpha_j dt + \sigma dz(t)], \text{ with } j = l, h. \end{aligned} \quad (6)$$

where $\alpha_j \equiv RPI - x_j + \alpha_q$ is the expected growth rate of per-period profits, $\sigma = \sigma_q$ is the standard deviation, and $\Gamma(K(t)) \equiv \Psi_K(K(t))/\Psi(K(t)) > 0$ captures the direct effect of investment. From (6), we can see that investment affects the level of profit through its effect on the marginal product of capital which depends on the initial stock of capital. In particular if no new investments are undertaken, $dK = 0$ profits and are driven only by exogenous shocks.

Let us now use these results in the two cases we consider. For simplicity, hereafter, we will omit the time variable t .

⁸Notice that the dividend rate must be positive for the net value of the firm to have an upper bound.

⁹If shareholder are risk-averse, the difference $r - \delta$ takes account of a the risk premium. However, the quality of results is unaffected. For further details see McDonald and Siegel (1986).

3 The start-up decision

Let us first analyze the start-up decision. Given Assumption 3, \underline{K} is given by technological conditions. We therefore concentrate on profit maximization given this level of capital.

It is known from investment theory that investment will take place if current profit goes beyond a certain "trigger" level. If $\tilde{\Pi}$ is below this trigger point, the price scheme would start with $x_j = x_h$. In this case, the x factor would remain constant, exactly like in pure price cap case. Therefore, to have a real alternative to price cap, we must assume that $\tilde{\Pi}$ is greater than the trigger point; in this way, regulation starts with a value of $x_j = x_l$, which is made more stringent at a later stage, in case profit goes beyond $\tilde{\Pi}$.

Given (2) we can express this trigger point in terms of Θ . As there are two logical steps (start-up (S) and expansion(E)) we can think of the optimal investment policy as a function $\Theta^*(K)$, as follows

$$\Theta^*(K) \equiv \begin{cases} \Theta_S^*(K) & \text{for } K = \underline{K} \\ \Theta_E^*(K) & \text{for } K > \underline{K} \end{cases} \quad (7)$$

Let us start characterizing the start-up decision, i.e. $\Theta_S^*(K)$. The firm decides whether and when to start the project of dimension \underline{K} , by solving a standard optimal stopping time problem. In other words, it chooses the investment timing which maximizes

$$O(\underline{K}, \Theta) = \max_T E_0 \{ [V(\underline{K}, \Theta(T)) - p_K \underline{K}] e^{-rT} \mid \Theta_0 = \Theta \} \quad (8)$$

where $E_0 \{ \cdot \}$ denotes the expectation operator with the information available at time zero, $V(\cdot)$ is the project value, i.e. the NPV of the project at time T , and p_K is the price of capital. Thus, $O(\cdot)$ represents the value of the option to delay the start-up decision.

Given the above assumptions, therefore, one obtains the following

Proposition 1 *The candidate policy for optimal start-up is described by the following upper threshold:*

$$\Theta_S^*(\underline{K}) \equiv \frac{\beta_1(x_l)}{\beta_1(x_l) - 1} \delta(x_l) \frac{p_K \underline{K}}{\Psi(\underline{K})} \quad (9)$$

Proof. See Appendix. ■

The optimal time of investments will be defined as $T^* = \inf(t > 0 \mid \Theta = \Theta_S^*(\underline{K}))$. Proposition 1 shows that the optimal start-up threshold depends only on the factor x_l . In particular, $\Theta_S^*(\underline{K})$ does not depend on the switch point $\tilde{\Pi}$: as profit sharing does not affect the start-up decision, the neutrality result found in Panteghini and Scarpa (2003a) is confirmed. Proposition 1 also shows that this threshold depends on the *average* productivity of capital, $\frac{\Psi(\underline{K})}{\underline{K}}$.

4 The option to expand: profit sharing and the size of investment

In order to analyze how regulatory constraints affect how much a firm invests, we assume that once the firm decides to make an initial investment, it has the possibility to invest further. Again, subsequent expansions will be decided if and when the current profit level reaches different thresholds.

These expansions are assumed to be irreversible. Technically, this means that, by exercising the option to delay, the firm acquires a compound option to expand, which consists of a continuum of American call options, each for any dK . For any given starting value of capital the firm can exercise a call option to expand production. After the exercise of such an option the firm obtains another American call option allowing it to undertake a further increment.

In most real-world settings, the ability to expand capacity is limited. In particular, firms operating in regulated markets face both institutional and technological limits, which prevent their production to go beyond a maximum level¹⁰. Therefore, we assume that a maximum quantity of capital \bar{K} exists. The compound option is completely exercised when the firm reaches this level.

The first thing to check is whether the trigger point $\Theta_S^*(\underline{K})$ depends on this possibility to expand the initial investment. To see whether this is the case, let us rewrite (9) as

$$\frac{\Psi(\underline{K})\Theta_S^*(\underline{K})}{\delta(x_l)} \equiv \frac{\beta_1(x_l)}{\beta_1(x_l) - 1} p_K \underline{K} = p_K \underline{K} + \frac{p_K \underline{K}}{\beta_1(x_l) - 1} \quad (10)$$

¹⁰For a discussion on limited expandability, see Dixit and Pindyck (2000).

According to (10), the firm will make the initial investment when the present value of the project at entry, $\frac{\Psi(K)\Theta_S^*(K)}{\delta(x_l)}$, equals the cost of the investment $p_K \underline{K}$ multiplied by a coefficient $\frac{\beta_1}{\beta_1 - 1} > 1$. This coefficient accounts for the option value effect: by waiting a little, the firm obtains new information about market profitability, and this reduces its downside risk. When the firm makes the initial investment, the firm exercises an option to delay and therefore loses some flexibility. The cost of the net loss of flexibility (i.e. the effective opportunity cost) is given by

$$\frac{p_K \underline{K}}{\beta_1(x_l) - 1}. \quad (11)$$

When after the start up the firm may expand its capital, the start-up investment has two effects. On the one hand, it reduces the firm's flexibility (as above), but on the other hand it entails the acquisition of an option to expand production. In this case, it is straightforward to show the following

Corollary 1 *The net loss of flexibility for the firm is the same, whether or not one considers an option to expand.*

Proof. See Appendix. ■

The reason is that what matters is the difference between the value of the option to delay and the value of the option to expand. If there is no possibility to expand the initial project, the value of the latter is obviously zero. If the possibility to expand the project exists, the value of the option to expand is positive, but the value of the option to delay increases by an equal amount.

We can now study the firm's investment strategies after the start-up. To this end, the following Lemma is necessary.

Lemma 1 *If $x_l < x_h$, then $\frac{\beta_1(x_l)}{\beta_1(x_l) - 1} \delta(x_l) < \frac{\beta_1(x_h)}{\beta_1(x_h) - 1} \delta(x_h)$.*

Proof. See Appendix. ■

Determining how much capital the firm decides to accumulate and the timing of this process allows us to determine how the firm's investment decisions are linked to the regulatory scheme. After the initial start-up decision, investment size becomes endogenous. The following Proposition can be proven:

Proposition 2 *Let define \tilde{K} the amount of capital such that*

$$\frac{\beta_1(x_l)}{\beta_1(x_l) - 1} \delta(x_l) \frac{p_K}{\Psi_K(\tilde{K})} = \frac{\tilde{\Pi}}{\Psi(\tilde{K})}. \quad (12)$$

If $\tilde{K} \in (\underline{K}, \overline{K}]$, the candidate policy for optimal investment is described by the following upper threshold:

$$\Theta_E^*(K) \equiv \begin{cases} \Theta_{PC}^*(K) \equiv \frac{\beta_1(x_l)}{\beta_1(x_l) - 1} \delta(x_l) \frac{p_K}{\Psi_K(K)}, & \text{for } K \in (\underline{K}, \tilde{K}], \\ \Theta_{PS}^*(K) \equiv \frac{\beta_1(x_h)}{\beta_1(x_h) - 1} \delta(x_h) \frac{p_K}{\Psi_K(K)}, & \text{for } K \in (\tilde{K}, \overline{K}]. \end{cases} \quad (13)$$

Proof. See Appendix. ■

According to Proposition 2, as long as $K < \tilde{K}$, profit sharing (namely x_h) does not affect investment. Only when $K \geq \tilde{K}$ does profit sharing affect capital accumulation.

With a pure price cap scheme, $\Theta^*(K) = \Theta_{PC}^*(K)$ for any value of K (namely, we do not have a threshold value \tilde{K}). With profit sharing, if $\tilde{K} \in (\underline{K}, \overline{K}]$ the function has two parts; the first one coincides with $\Theta_{PC}^*(K)$, while the second one differs. As shown in the Appendix (see (34)), for $K \geq \tilde{K}$ we have $\Theta^*(K) > \tilde{\Theta}(K)$. In this case, the profit sharing constraint is binding and the relevant trigger point is $\Theta_{PS}^*(K)$. By Lemma 1, it is straightforward to show that under profit sharing, $\Theta_{PS}^*(K) > \Theta_{PC}^*(K)$ for any given $K \geq \tilde{K}$. This means that profit sharing increases the threshold value, beyond which the firm decides to expand its plant, and thus discourages further investment.

Corollary 2 $\Theta_{PC}^*(\underline{K}) = \Theta_S^*(\underline{K})$ as long as $\Psi_K(\underline{K}) = \frac{\Psi(\underline{K})}{\underline{K}}$.

This Corollary confirms that when \underline{K} is chosen optimally, i.e., when $\Psi_K(\underline{K}) = \frac{\Psi(\underline{K})}{\underline{K}}$, $\Theta_S^*(\underline{K})$ characterizes optimal investment policy even when we consider the option to expand. The investment function $\Theta^*(K)$ is therefore continuous for $K = \underline{K}$. If we compare (9) with (13), given assumption 3 we can write

$$\Theta_S^*(\underline{K}) = \Theta_E^*(\underline{K}) = \lim_{dK \rightarrow 0} \Theta_{PC}^*(\underline{K} + dK)$$

In other words, the trigger point for the start-up decision is equal to the trigger point above which investing $\underline{K} + dK$ is profitable. This implies that

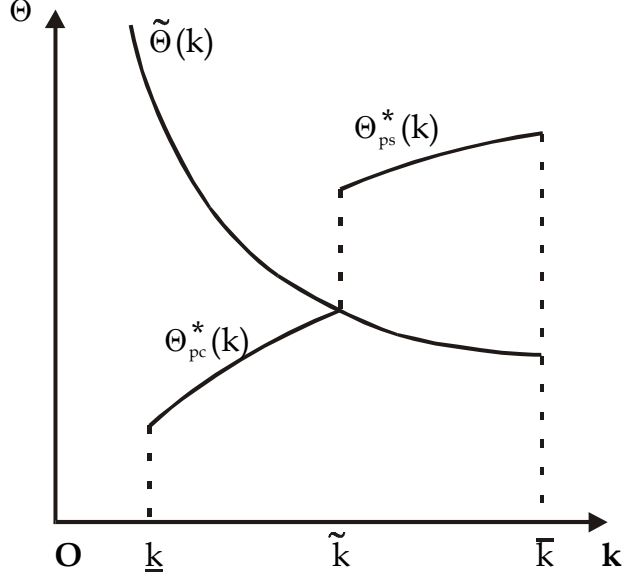


Figure 1:

there do not exist jumps in the trigger point¹¹.

The optimal investment policy can be represented in Figure 1 above, which depicts Θ^* as a function of K .

The profit sharing threshold $\tilde{\Theta}(K)$ is a decreasing function of K : it is like an iso-profit curve, where a high value of Θ must be compensated by a low value of K . Since $\Psi_K(K)$ is decreasing in the region $(\underline{K}, \bar{K}]$, the optimal investment policy $\Theta^*(K)$ is instead upward-sloping. When $\Theta^*(K) = \tilde{\Theta}(K)$, the profit sharing constraint intervenes, x_j jumps from x_l to x_h and therefore $\Theta^*(K)$ has a discontinuity (see (13)). This happens for $K = \tilde{K}$, which is by assumption larger than \underline{K} .

When $\Theta < \Theta_{PC}^*(K)$, the optimal policy is inaction (keeping K constant). The firm waits until the stochastic process moves Θ above $\Theta_{PC}^*(K)$, and at this point it will be optimal to invest (to increase K). When $\Theta_{PC}^*(K) < \Theta < \Theta_{PC}^*(\tilde{K})$, a discrete investment will occur in a lump, to move the capital

¹¹If we had assumed that the start-up level of capital were given exogenously, as already pointed out, \underline{K} would be such that $\Psi_K(\underline{K}) < \frac{\Psi(\underline{K})}{\underline{K}}$. Therefore, an exogenous jump would take place after the start-up, i.e. $\Theta_S^*(\underline{K}) < \Theta_{PC}^*(\underline{K} + dK)$. However, the Θ^* schedule would not change for $K > \underline{K}$, and the qualitative nature of the result would not change.

level immediately to the optimal policy curve, as long as the profit sharing constraint is not binding (i.e., as long as $K \leq \tilde{K}$). When $\Theta_{PC}^*(\tilde{K}) < \Theta < \Theta_{PS}^*(\tilde{K})$ the firm cannot increase capital beyond the level \tilde{K} : further investments would push the firm beyond the threshold where profit sharing intervenes, and would thus tighten the regulatory constraint.

The firm will increase its capital level beyond \tilde{K} only when $\Theta > \Theta_{PS}^*(\tilde{K})$. At such high levels of revenue, the firm finds it optimal to accept a tightening of the price rule: forgiving market opportunities would be too expensive. When K reaches its maximum level \bar{K} , further investments are impossible and the firm can only produce at the regulated price.

We therefore see that profit sharing is neutral for low levels of investment ($K < \tilde{K}$) and in particular for the start up decision. Moreover, profit sharing is neutral if it intervenes for large enough levels of profit (such that $\tilde{K} > \bar{K}$), while it is distortionary otherwise, delaying - possibly, for an indefinite amount of time - large increments of the initial investment.

Let us now analyze the effect of these regulatory schemes on the firm's value. It is straightforward to show that

Proposition 3 *The firm's value at time zero is*

$$V(K, \Theta) = \frac{\Pi(K, \Theta)}{\delta(x_l)} + A_1(K, x_l)\Theta^{\beta_1(x_l)}$$

where

$$\begin{aligned} A_1(K, x_l) &= \int_{z=K}^{\bar{K}} -a_1(z, x_l) dz = \\ &= \left(\frac{\beta_1(x_l)-1}{p_K} \right)^{\beta_1(x_l)-1} \left(\frac{1}{\beta_1(x_l)\delta(x_l)} \right)^{\beta_1(x_l)} \int_{z=K}^{\bar{K}} (\Psi_K(z))^{\beta_1(x_l)} dz + \\ &\quad + \frac{(\delta(x_l)-\delta(x_h))}{\delta(x_l)\delta(x_h)} \int_{z=K}^{\bar{K}} \Psi_K(z) \left(\frac{\Psi(z)}{\Pi} \right)^{\beta_1(x_l)-1} dz. \end{aligned}$$

Proof. See Appendix. ■

The firm's value consists of the sum of the static net present value ($\frac{\Pi(K, \Theta)}{\delta(x_l)}$) and the option values ($A_1(K, x_l)\Theta^{\beta_1(x_l)}$). The first part of $A_1(K, x_l)$ measures the value of the option to expand under pure price cap, and indeed it only depends on x_l . The second term is the expected loss (given that $\delta(x_l) < \delta(x_h)$) due to a tighter regulation, which intervenes as Θ reaches the threshold $\tilde{\Theta}(K)$. The formula shows that this loss is proportional to the expected value

of the incremental investments which are delayed by the firm because of profit sharing.

This means that the value of the firm is negatively affected by profit sharing, relative to a pure price cap. To some extent, this is desirable: the very notion of profit sharing comes from the idea that a scheme which yields an excessively imbalanced distribution of rents is undesirable¹². Thus, one of the regulators' main targets is the rent extraction *per se*, with as little distortion as possible. However, unlike Panteghini and Scarpa (2003a), here total investment size is endogenous, and profit sharing may generate a distortion in investment decisions and therefore an inefficiency. A more complete welfare evaluation of this would require a full specification of a welfare function, which is beyond the scope of the paper.

5 Extensions and conclusion

Despite its apparent complexity, necessary to incorporate uncertainty and time in a satisfactory way, the model still lies on certain assumptions. However, it is easy to show how the model can accommodate at least two additional factors.

Regulatory risk. We have explicitly modeled market uncertainty, while regulatory risk - the possibility that the regulator committed to a price cap mechanism betrays expectations and changes the x factor because observed profits are very high - raises different issues. If revenues may be revised downwards because profits are “too high”, then firm's choices will be affected. But does the introduction of earnings sharing provisions change? Panteghini and Scarpa (2003b) tackle this issue with an investment of given size, showing how uncertainty which intervenes in good states of the world (the risk that high profits will partially be shared) does not affect investment decisions. In the framework we analyze here, it would be easy to show that the same conclusion applies to the initial (start-up) investment. However, regulatory risk may affect the size of total investment, and therefore the expansion decisions. Would earnings sharing be a good way to neutralize this effect? Every decision to expand the initial investment is taken, looking at the future expected value of that expansion. In that moment, the logic governing the decision is the same which underlies the start-up. Therefore, regulatory risk

¹²Note that also the rate-of-return regulation scheme, still prevailing in a large part of the US, is based on the idea that restraining monopoly rents is a goal by itself.

linked to high profits does not modify the comparison between profit sharing and pure price cap that we have developed in the previous section.

Two-sided profit sharing. Many schemes with profit sharing do not only intervene when profits are too high, but when profits are low as well. In this way, the x factor could be adjusted downwards if demand or cost conditions worsen¹³ and profits fall below a given threshold. This provides the firm a form of insurance against market risks and - relative to a pure price cap scheme - this gives the firm an additional incentive to invest¹⁴. Therefore, Proposition 1 would be modified in that a two-sided earning sharing scheme encourages the firm to invest sooner than with a pure price cap. Expansion investments would equally be encouraged, so that the underinvestment result of Proposition 2 should be qualified: profit sharing leads to underinvestment (in the sense of Proposition 2) if it is one-sided, while the analysis with two-sided profit sharing would lead to a more ambiguous result.

The empirical analyses of the effects of earnings sharing schemes on investments lead to ambiguous conclusions, and our analysis indicates good reasons why that may be so. However, further extensions could be considered, in particular as some of the parameters of this model could be considered endogenous. In particular, the values of x factors and of the thresholds for profit sharing are decided by the regulator and an explicit model taking this into account would be a very valuable extension of the present framework.

¹³Weisman (2002) stresses how important it would be to distinguish between these sources of low profitability. We agree with his point, which is anyway beyond the scope of these remarks.

¹⁴A provision of this type would make “bad news” less “bad” and is therefore not neutral to investment decisions.

6 Appendix

6.1 Proof of Proposition 1

Using dynamic programming, the firm's value $V(\underline{K}, \Theta)$ can be written as

$$V(\underline{K}, \Theta) = \Pi(\underline{K}, \Theta) dt + e^{-r dt} E_0 [V(\underline{K}, \Theta + d\Theta)]$$

Expanding the right-hand side and using Itô's lemma one obtains

$$rV(\underline{K}, \Theta) = \Pi(\underline{K}, \Theta) + (r - \delta(x_l))\Theta V_\Theta(\underline{K}, \Theta) + \frac{\sigma^2}{2}\Theta^2 V_{\Theta\Theta}(\underline{K}, \Theta) \quad (14)$$

where $V_\Theta(\underline{K}, \Theta) = \partial V(\underline{K}, \Theta) / \partial \Theta$ and $V_{\Theta\Theta}(\underline{K}, \Theta) = \partial^2 V(\underline{K}, \Theta) / \partial \Theta^2$, respectively. The differential equation (14) has a standard closed-form solution

$$V(\underline{K}, \Theta) = \frac{\Pi(\underline{K}, \Theta)}{\delta(x_l)} + \sum_{i=1}^2 A_i(\underline{K}, x_l) \Theta^{\beta_i(x_l)}, \quad (15)$$

where $\beta_1(x_l) > 1$ and $\beta_2(x_l) < 0$ are the roots of the following characteristic equation¹⁵:

$$\frac{\sigma^2}{2}\beta(\beta - 1) + (r - \delta(x_l))\beta - r = 0.$$

To compute the value function, we use the boundary condition $V(\underline{K}, 0) = 0$. Namely, when Θ goes to zero, the value function becomes worthless¹⁶. This implies that $A_2(\underline{K}, x_l) = 0$. Notice that starting with the initial capacity \underline{K} , at each instant t the firm has two possibilities: it may decide to add capital, or it can decide not to make further investment. Installing an additional unit of capital dK entails the exercise of an option to expand. The value of the option to expand capital depends on the stock accumulated so far. Thus term $A_1(\underline{K}, x_l)\Theta^{\beta_1(x_l)}$ is the sum of the marginal options to increase, allowing the accumulation from the current amount of capital \underline{K} .

¹⁵The roots are

$$\beta_{1,2}(x) = \frac{1}{2} - \frac{r - \delta(x)}{\sigma^2} \pm \sqrt{\left(\frac{r - \delta(x)}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}}.$$

It is easy to ascertain that $\frac{\partial \beta_1(x)}{\partial x} > 0$.

¹⁶For further details on the boundary conditions see Dixit and Pindyck (1994, Ch. 5 and 6).

Let's now turn to the option value $O(\underline{K}, \Theta)$. As in (8), we can write

$$O(\underline{K}, \Theta) = e^{-r dt} E_0 [O(\underline{K}, \Theta + d\Theta)]$$

which has the following solution

$$O(\underline{K}, \Theta) = \sum_{i=1}^2 B_i(\underline{K}, x_l) \Theta^{\beta_i(x_l)}$$

As mentioned above, the initial regulatory regime is the pure price cap (with profit sharing possibly intervening only at a later stage). Thus, $B_i(\underline{K}, x_l)$ and $\beta_i(x_l)$ do not depend on x_h . Using the boundary condition $O(\underline{K}, 0) = 0$, one obtains

$$O(\underline{K}, \Theta) = B_1(\underline{K}, x_l) \Theta^{\beta_1(x_l)} \quad (16)$$

where $B_1(\underline{K}, x_l)$ is a constant to be determined. The optimal investment timing can be computed using the Value Matching Condition (VMC) and the Smooth Pasting Condition (SPC). The former condition requires the net present value of the project to be equal to the option value to defer investment, namely

$$V(\underline{K}, \Theta^*) - p_K \underline{K} = O(\underline{K}, \Theta^*). \quad (\text{VMC})$$

The second condition requires the slopes of the functions $[V(\underline{K}, \Theta) - p_K \underline{K}]$ and $O(\underline{K}, \Theta)$ to match

$$V_\Theta(\underline{K}, \Theta^*) = O_\Theta(\underline{K}, \Theta^*). \quad (\text{SPC})$$

Conditions *VMC* and *SPC* characterize optimal investment time. Given (6), this value can be associated to a level $\Theta^*(\underline{K})$: whenever current profit reaches $\Pi(\underline{K}, \Theta^*(\underline{K}))$, the firm invests. To solve the optimal stopping time problem, let us substitute (15) and (16) into the *VMC* and the *SPC*. We thus obtain a two-equation system with two unknowns: the trigger point of Θ , above which investment is profitable, i.e.

$$\Theta^*(\underline{K}) \equiv \Theta_S^*(\underline{K}) \equiv \frac{\beta_1(x_l)}{\beta_1(x_l) - 1} \delta(x_l) \frac{p_K \underline{K}}{\Psi(\underline{K})}, \quad (17)$$

and the difference

$$[B_1(\underline{K}, x_l) - A_1(\underline{K}, x_l)] \Theta_S^*(\underline{K})^{\beta_1(x_l)} = \frac{p_K \underline{K}}{\beta_1(x_l) - 1}. \quad (18)$$

Term $[B_1(\underline{K}, x_l) - A_1(\underline{K}, x_l)] \Theta_S^*(\underline{K})^{\beta_1(x_l)}$ measures the value of the option to delay, net of the option to expand. By undertaking the initial investment the firm gets an option to expand production. When the firm starts production, i.e. at $\Theta_S^*(\underline{K})$, the net loss of flexibility is $\frac{p_K \underline{K}}{\beta_1(x_l) - 1}$. ■

6.2 Proof of Corollary 1

Let us recall (18) and let us rewrite it as

$$B_1(\underline{K}, x_l) \Theta_S^*(\underline{K})^{\beta_1(x_l)} = \frac{p_K \underline{K}}{\beta_1(x_l) - 1} + A_1(\underline{K}, x_l) \Theta_S^*(\underline{K})^{\beta_1(x_l)}. \quad (19)$$

If now we assume that the firm does not have any option to expand, then $A_1(\underline{K}, x_l) = 0$. Therefore, (19) boils down to

$$B_1(\underline{K}, x_l) \Theta_S^*(\underline{K})^{\beta_1(x_l)} = \frac{p_K \underline{K}}{\beta_1(x_l) - 1}. \quad (20)$$

which implies that the net loss of flexibility is the same whether or not the option to expand exists. ■

6.3 Proof of Lemma 1

Let us recall the positive root

$$\beta_1(x_j) = \frac{1}{2} - \frac{r - \delta(x_j)}{\sigma^2} + \sqrt{\left(\frac{r - \delta(x_j)}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}}, \quad j = l, h,$$

which can be rewritten as

$$\beta_1(x_j) + \left(\frac{r - \delta(x_j)}{\sigma^2} - \frac{1}{2}\right) = \sqrt{\left(\frac{r - \delta(x_j)}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2r}{\sigma^2}} > 0. \quad (21)$$

Differentiating $\beta_1(x_j)$ with respect to $\delta(x_j)$ and using (21) yields

$$\begin{aligned}
\frac{\partial \beta_1(x_j)}{\partial \delta(x_j)} &= \frac{1}{\sigma^2} \left\{ 1 - \frac{\frac{r-\delta(x_j)}{\sigma^2} - \frac{1}{2}}{\beta_1(x_j) - \left(\frac{1}{2} - \frac{r-\delta(x_j)}{\sigma^2}\right)} \right\} = \\
&= \frac{1}{\sigma^2} \frac{\beta_1(x_j) + \left(\frac{r-\delta(x_j)}{\sigma^2} - \frac{1}{2}\right) - \left(\frac{r-\delta(x_j)}{\sigma^2} - \frac{1}{2}\right)}{\beta_1(x_j) - \left(\frac{1}{2} - \frac{r-\delta(x_j)}{\sigma^2}\right)} = \\
&= \frac{1}{\sigma^2} \frac{\beta_1(x_j)}{\beta_1(x_j) - \left(\frac{1}{2} - \frac{r-\delta(x_j)}{\sigma^2}\right)}. \\
\frac{\partial}{\partial \beta_1(x_j)} \left(\frac{\beta_1(x_j)}{\beta_1(x_j) - 1} \right) &= -\frac{1}{[\beta_1(x_j) - 1]^2} < 0 \\
\frac{\partial}{\partial \delta(x_j)} \left(\frac{\beta_1(x_j)}{\beta_1(x_j) - 1} \delta(x_j) \right) &= \\
&= \left[\frac{\partial}{\partial \beta_1(x_j)} \left(\frac{\beta_1(x_j)}{\beta_1(x_j) - 1} \right) \right] \delta(x_j) \frac{\partial \beta_1(x_j)}{\partial \delta(x_j)} + \frac{\beta_1(x_j)}{\beta_1(x_j) - 1} = \\
&= -\frac{\delta(x_j)}{[\beta_1(x_j) - 1]^2} \frac{1}{\sigma^2} \frac{\beta_1(x_j)}{\beta_1(x_j) - \left(\frac{1}{2} - \frac{r-\delta(x_j)}{\sigma^2}\right)} + \frac{\beta_1(x_j)}{\beta_1(x_j) - 1} = \\
&= \frac{\beta_1(x_j)}{\beta_1(x_j) - 1} \left\{ 1 - \frac{\delta(x_j)}{\sigma^2} \frac{1}{[\beta_1(x_j) - 1] \left[\beta_1(x_j) - \left(\frac{1}{2} - \frac{r-\delta(x_j)}{\sigma^2}\right) \right]} \right\} = \\
&= \frac{\beta_1(x_j)}{\beta_1(x_j) - 1} \frac{f(\delta(x_j))}{[\beta_1(x_j) - 1] \left[\beta_1(x_j) - \left(\frac{1}{2} - \frac{r-\delta(x_j)}{\sigma^2}\right) \right]},
\end{aligned}$$

where

$$f(\delta(x_j)) \equiv [\beta_1(x_j) - 1] \left[\beta_1(x_j) - \left(\frac{1}{2} - \frac{r - \delta(x_j)}{\sigma^2} \right) \right] - \frac{\delta(x_j)}{\sigma^2}.$$

This implies that

$$\frac{\partial}{\partial \delta(x_j)} \left(\frac{\beta_1(x_j)}{\beta_1(x_j) - 1} \delta(x_j) \right) \propto f(\delta(x_j)).$$

It is easy to ascertain that

$$\lim_{\delta(x_j) \rightarrow 0^+} f(\delta(x_j)) > 0 \quad (22)$$

Moreover, we have

$$\frac{\partial f(\delta(x_j))}{\partial \delta(x_j)} = \frac{\beta_1(x_j)}{\sigma^2} \frac{\beta_1(x_j) - 1}{\beta_1(x_j) - \left(\frac{1}{2} - \frac{r-\delta(x_j)}{\sigma^2}\right)} > 0, \text{ for } \delta(x_j) \in (0, r]. \quad (23)$$

Let us next recall equation (5):

$$\delta(x_j) = r - RPI + x_j - \alpha_q.$$

Obviously, $\frac{\partial \delta(x_j)}{\partial x_j} = 1$. Thus conditions (22) and (23) are sufficient to conclude that

$$\frac{\partial}{\partial x_j} \left(\frac{\beta_1(x_j)}{\beta_1(x_j) - 1} \delta(x_j) \right) > 0.$$

This proves Lemma 1. ■

6.4 Proof of Proposition 2

To show that system (13) provides the optimal triggers for the incremental decision, let us first define the firm's value at time zero. This is the expected discounted stream of profits $\Pi(K, \Theta) \equiv \Psi(K)\Theta$, taking into account both profit sharing regulation as well as the value of \bar{K} . Without loss of generality, let us assume that $\Pi \leq \tilde{\Pi}$. The firm's problem is

$$V(K, \Theta) = \max_K E_0 \left[\int_0^\infty e^{-rt} [\Pi(K, \Theta) - p_K dK] dt \mid K_0 = K, \Theta_0 = \Theta \right] \quad (24)$$

such that $dK \geq 0$, $K \leq \bar{K}$ and (6) for all t . Absent installation costs, the rate of growth of capital is unbounded where dK is the investment process. The expectation in equation (24) is taken with respect to the joint distribution of K and Θ , with Θ driven by (6), conditional on the information available at time zero and taking into account the profit sharing constraint and the irreversibility constraint.

Assuming that V is twice continuously differentiable, a solution can be obtained starting within a time interval where no new investment occurs. From (24), the firm's value can be written as

$$V(K, \Theta) = \Pi(K, \Theta) dt + e^{-rdt} E_0 [V(K, \Theta + d\Theta)],$$

Expanding the right-hand side and using Itô's lemma one obtains

$$rV(K, \Theta) = \Pi(K, \Theta) + (r - \delta(x_l))\Theta V_\Theta(K, \Theta) + \frac{\sigma^2}{2} \Theta^2 V_{\Theta\Theta}(K, \Theta) \quad (25)$$

Differentiating (25) with respect to K , and defining by $v(K, \Theta) \equiv V_K(K, \Theta)$ the contribution of the K th unit of capital to the firm's value, we obtain the following differential equation

$$rv(K, \Theta) = \Pi_K(K, \Theta) + (r - \delta(x_l))\Theta v_\Theta(K, \Theta) + \frac{\sigma^2}{2}\Theta^2 v_{\Theta\Theta}(K, \Theta) \quad (26)$$

which has the following closed-form solution

$$v(K, \Theta) = f(K, \Theta) + \sum_{i=1}^2 a_i(K, x_l)\Theta^{\beta_i(x_l)}. \quad (27)$$

The index l in $a_i(K, x_l)$ indicates that $x = x_l$, i.e. that profit sharing is not in place. The interpretation of equation (27) is then transparent. The contribution of the K th unit of capital to the profit flow, when the existing stock of capital is K , is given by $\Pi_K(K, \Theta) = \Psi_K(K)\Theta$. Since Θ is expected to grow at the rate α_l until the profit sharing threshold $\tilde{\Pi}$ is reached, and at rate α_h afterwards, the expected present value of this contribution is

$$\begin{aligned} f(K, \Theta) &= E_0 \left[\int_0^T e^{-rt} \Pi_K(K, \Theta; \alpha_l) dt + \int_T^\infty e^{-rt} \Pi_K(K, \Theta; \alpha_h) dt \mid K_0 = K, \Theta_0 = \Theta \right] \\ &= E_0 \left[\int_0^T e^{-rt} \Pi_K(K, \Theta; \alpha_l) dt + e^{-rT} \int_T^\infty e^{-r(t-T)} \Pi_K(K, \Theta; \alpha_l) dt \mid K_0 = K, \Theta_0 = \Theta \right] \\ &= E_0 \left[\int_0^T e^{-rt} \Pi_K(K, \Theta; \alpha_l) dt + e^{-rT} f(K, \tilde{\Theta}; \alpha_h) \mid K_0 = K, \Theta_0 = \Theta \right] \\ &= E_0 \left[\int_0^\infty e^{-rt} \Pi_K(K, \Theta; \alpha_l) dt + e^{-rT} [f(K, \tilde{\Theta}; \alpha_h) - f(K, \tilde{\Theta}; \alpha_l)] \mid K_0 = K, \Theta_0 = \Theta \right] \\ &= \frac{\Pi_K(K, \Theta)}{\delta(x_l)} + \frac{(\delta(x_l) - \delta(x_h)) \Pi_K(K, \tilde{\Theta})}{\delta(x_l)\delta(x_h)} \left(\frac{\Theta}{\tilde{\Theta}} \right)^{\beta_1(x_l)}, \end{aligned}$$

where T indicates the first value of t such that Θ reaches the trigger $\tilde{\Theta}$.

The boundary conditions for (27) are:

$$v(K, \Theta^*) = p_K, \quad (28)$$

$$v_\Theta(K, \Theta^*) = 0, \quad (29)$$

$$a_2(K, x_l) = 0, \quad (30)$$

$$a_1(\bar{K}, x_l) = 0. \quad (31)$$

As usual (28) and (29) are the VMC and SPC for the firm's optimal policy. Moreover, (30) imposes the irreversibility constraint on capital $dK \geq 0$ ¹⁷. The last condition (31) imposes that $K \leq \bar{K}$.

Substituting (27) into (28) and (29), we have

$$\begin{aligned} \frac{\Psi_K(K)\Theta^*}{\delta(x_l)} + \frac{(\delta(x_l)-\delta(x_h))\Psi_K(K)\tilde{\Theta}}{\delta(x_l)\delta(x_h)} \left(\frac{\Theta^*}{\tilde{\Theta}}\right)^{\beta_1(x_l)} + a_1(K, x_l)(\Theta^*)^{\beta_1(x_l)} &= p_K, \\ \frac{\Psi_K(K)\Theta^*}{\delta(x_l)} + \beta_1(x_l) \frac{(\delta(x_l)-\delta(x_h))\Psi_K(K)\tilde{\Theta}}{\delta(x_l)\delta(x_h)} \left(\frac{\Theta^*}{\tilde{\Theta}}\right)^{\beta_1(x_l)} + \beta_1(x_l)a_1(K, x_l)(\Theta^*)^{\beta_1(x_l)} &= 0. \end{aligned}$$

Easy computation yields

$$\Theta^*(K) \equiv \Theta_{PC}^*(K) \equiv \frac{\beta_1(x_l)}{\beta_1(x_l) - 1} \delta(x_l) \frac{p_K}{\Psi_K(K)}. \quad (32)$$

Since $\Psi_K(K)$ is decreasing in K , this identifies an upward-sloping curve. From conditions (28) and (29) we also obtain

$$\begin{aligned} a_1(K, x_l) = - \left(\frac{\beta_1(x_l)-1}{p_K} \right)^{\beta_1(x_l)-1} \left(\frac{\Psi_K(K)}{\beta_1(x_l)\delta(x_l)} \right)^{\beta_1(x_l)} \\ - \frac{(\delta(x_l)-\delta(x_h))\Psi_K(K)}{\delta(x_l)\delta(x_h)} \left(\frac{\Psi(K)}{\tilde{\Pi}} \right)^{\beta_1(x_l)-1}. \end{aligned} \quad (33)$$

Finally, we need to show that the investment policy (32) is viable and optimal at $\tilde{\Pi}$. On the latter point, it must be that $\tilde{\Theta}$ and Θ^* coincide when the constraint is binding. Now, define \tilde{K} as the largest $K \leq \bar{K}$ that satisfies

$$\tilde{\Theta}(\tilde{K}) \equiv \frac{\tilde{\Pi}}{\Psi(\tilde{K})} = \frac{\beta_1(x_l)}{\beta_1(x_l) - 1} \delta(x_l) \frac{p_K}{\Psi_K(\tilde{K})} \equiv \Theta^*(\tilde{K}). \quad (34)$$

Given decreasing returns to scale, it easy to show that \tilde{K} exists and is unique. Furthermore, for all $K \leq \tilde{K}$ it turns out that $\Theta^*(K) \leq \tilde{\Theta}(K)$ which concludes the first part of the proof.

Let us now turn to the case where $\tilde{K} \leq K \leq \bar{K}$. Notice that now it may well happen that, for given $K > \tilde{K}$, profit first goes beyond $\tilde{\Pi}$ (i.e. $\Theta \geq \tilde{\Theta}$), while at a later stage $\Pi \leq \tilde{\Pi}$ (i.e. $\Theta \leq \tilde{\Theta}$). In this case, in line with the

¹⁷In other words, when Θ is very small the expected present value of the last unit of capital installed is close to zero. Therefore, the value of the marginal option to scrap it is almost infinite. For further details on the boundary conditions see Dixit and Pindyck (1994, Ch. 5 and 6).

spirit of the mechanism at stake, the price cap goes back to its original level. Recalling (24), the Bellman equations will be

$$\begin{aligned} rV(K, \Theta) &= \\ &= \Pi(K, \Theta) + (r - \delta(x_l))\Theta V_\Theta(K, \Theta) + \frac{\sigma^2}{2}\Theta^2 V_{\Theta\Theta}(K, \Theta) \\ &\quad \text{for } \Theta \leq \tilde{\Theta} \end{aligned} \quad (35)$$

and

$$\begin{aligned} rV(K, \Theta) &= \\ &= \Pi(K, \Theta) + (r - \delta(x_h))\Theta V_\Theta(K, \Theta) + \frac{\sigma^2}{2}\Theta^2 V_{\Theta\Theta}(K, \Theta) \\ &\quad \text{for } \Theta \geq \tilde{\Theta} \end{aligned} \quad (36)$$

Therefore, by the same line of reasoning, the contribution of the K th unit of capital to the firm's value can be evaluated using (27)-(31) for $\Theta \leq \tilde{\Theta}$ with (32) as optimal policy. On the other hand, eliminating the dependence on $\tilde{\Pi}$ for the case $\Theta \geq \tilde{\Theta}$, yields

$$v(K, \Theta) = \frac{\Pi_K(K, \Theta)}{\delta(x_h)} + \sum_{i=1}^2 a_i(K, x_h) \Theta^{\beta_i(x_h)}. \quad (37)$$

The boundary conditions are

$$v(K, \Theta^*) = p_K \quad (38)$$

$$v_\Theta(K, \Theta^*) = 0 \quad (39)$$

$$a_2(K, x_h) = 0 \quad (40)$$

$$a_1(\bar{K}, x_h) = 0 \quad (41)$$

The optimal policy and the integration constant are

$$\Theta^*(K) \equiv \Theta_{PS}^*(K) \equiv \frac{\beta_1(x_h)}{\beta_1(x_h) - 1} \delta(x_h) \frac{p_K}{\Psi_K(K)}, \quad \text{for } \Theta \geq \tilde{\Theta} \quad (42)$$

and

$$a_1(K, x_h) = - \left(\frac{\beta_1(x_h) - 1}{p_K} \right)^{\beta_1(x_h) - 1} \left(\frac{\Psi_K(K)}{\beta_1(x_h) \delta(x_h)} \right)^{\beta_1(x_h)} < 0 \quad (43)$$

This concludes the proof. ■

6.5 Proof of Proposition 3

To compute the firm's value let us start with the interval $K \geq \tilde{K}$. Solving (36) for $\Theta \in (\tilde{\Theta}(K), \Theta^*(K) \equiv \Theta_{PS}^*(K))$ yields:

$$V(K, \Theta) = \frac{\Pi(K, \Theta)}{\delta(x_h)} + \sum_{i=1}^2 A_i(K, x_h) \Theta^{\beta_i(x_h)} \text{ for } \Theta \geq \tilde{\Theta}. \quad (44)$$

In equation (44), the first term is the expected value of profit flows if K is held constant at its current level. As for the second term, $A_1(K, x_h) \Theta^{\beta_1(x_h)}$ is the value of the firm's optimal future capacity expansion in response to the evolution of Θ towards the optimal investment policy $\Theta^*(K)$. Therefore $A_1(K, x_h)$ must be positive. On the contrary, the term $A_2(K, x_h) \Theta^{\beta_2(x_h)}$ is the expected present value of returning below the Profit Sharing constraint (i.e. $\Theta \leq \tilde{\Theta}$) in the future: $A_2(K, x_h)$ must be positive as well.

If $\Theta \in (0, \tilde{\Theta}(K))$, solving (35), gives

$$V(K, \Theta) = \frac{\Pi(K, \Theta)}{\delta(x_l)} + \sum_{i=1}^2 A_i(K, x_l) \Theta^{\beta_i(x_l)} \text{ for } \Theta \leq \tilde{\Theta}. \quad (45)$$

To compute the value function, we use the boundary condition $V(K, 0) = 0$, which implies that $A_2(K, x_l) = 0$. The other term $A_1(K, x_l) \Theta^{\beta_1(x_l)}$ represents the consequences of reaching the profit sharing constraint in the future (from above) in case the profit flow is reduced. This implies that $A_1(K, x_l)$ must be negative.

So far we have three constants $A_1(K, x_h)$, $A_2(K, x_h)$ and $A_1(K, x_l)$ to be determined. To this end, we assume that the value function is continuously differentiable at $\tilde{\Theta}(K) = \tilde{\Pi}/\Psi(K)$ where the two regimes meet

$$\begin{aligned} \frac{\Pi(K, \tilde{\Theta}(K))}{\delta(x_h)} + \sum_{i=1}^2 A_i(K, x_h) \tilde{\Theta}(K)^{\beta_i(x_h)} &= \\ &= \frac{\Pi(K, \tilde{\Theta}(K))}{\delta(x_l)} + A_1(K, x_l) (\tilde{\Theta}(K))^{\beta_1(x_l)} \end{aligned} \quad (46)$$

$$\begin{aligned} \frac{\Pi(K, \tilde{\Theta}(K))}{\delta(x_h)} + \sum_{i=1}^2 \beta_i(x_h) A_i(K, x_h) (\tilde{\Theta}(K))^{\beta_i(x_h)} &= \\ = \frac{\Pi(K, \tilde{\Theta}(K))}{\delta(x_l)} + \beta_1(x_l) A_1(K, x_l) (\tilde{\Theta}(K))^{\beta_1(x_l)} \end{aligned} \quad (47)$$

Finally, by integrating $a_1(K, x_h)$, given by (43), we can obtain

$$\begin{aligned}
A_1(K, x_h) &\equiv \int_K^{\bar{K}} -a_1(z, x_h) dz = \\
&= \left(\frac{\beta_1(x_h) - 1}{p_K} \right)^{\beta_1(x_h)-1} \left(\frac{1}{\beta_1(x_h)\delta(x_h)} \right)^{\beta_1(x_h)} \int_K^{\bar{K}} (\Psi_K(z))^{\beta_1(x_h)} dz
\end{aligned} \tag{48}$$

Suppose now that $K \leq \tilde{K}$. In this case the profit sharing constraint is never binding and for the firm's value the only effective threshold is the investment policy $\Theta^*(K) \equiv \Theta_{PC}^*(K)$.

For $\Theta \in (0, \Theta^*(K) \equiv \Theta_{PC}^*(K))$, solving (25), the value function is:

$$V(K, \Theta) = \frac{\Pi(K, \Theta)}{\delta(x_l)} + \sum_{i=1}^2 A_i(K, x_l) \Theta^{\beta_i(x_l)} \text{ for } \Theta \leq \Theta^* \tag{49}$$

Again, to compute (49) we use the boundary condition $V(K, 0) = 0$, which implies that $A_2(K, x_l) = 0$. Differently from (45), the term, $A_1(K, x_l) \Theta^{\beta_1(x_l)}$ represents the value of the firm's optimal future capacity expansion, in response to the evolution of Θ towards the optimal investment policy $\Theta^*(K)$. Yet, differently from (44), here we should take into account the possible switches in the state variable Θ .

By integrating (33) yields $A_1(K, x_l)$ ¹⁸

$$\begin{aligned}
A_1(K, x_l) &\equiv \int_{z=K}^{\bar{K}} -a_1(z, x_l) dz = \\
&= \left(\frac{\beta_1(x_l) - 1}{p_K} \right)^{\beta_1(x_l)-1} \left(\frac{1}{\beta_1(x_l)\delta(x_l)} \right)^{\beta_1(x_l)} \int_{z=K}^{\bar{K}} (\Psi_K(z))^{\beta_1(x_l)} dz + \\
&+ \frac{(\delta(x_l) - \delta(x_h))}{\delta(x_l)\delta(x_h)} \int_{z=K}^{\bar{K}} \Psi_K(z) \left(\frac{\Psi(z)}{\tilde{\Pi}} \right)^{\beta_1(x_l)-1} dz
\end{aligned} \tag{50}$$

This shows that the introduction of a profit sharing threshold $\tilde{\Pi}$ decreases the firm's value.

Finally, by Lemma 1, the comparison of (32) and (42) involves a change in the optimal policy during the period of optimization, i.e. there is a discontinuous jump in the optimal policy at $K = \tilde{K}$. However, we can show that firm's value does not display any discrete jump.

¹⁸Notice that if $\tilde{K} = \bar{K}$ the constraint $\tilde{\Pi}$ disappears.

Defining by (42) $\Theta_{PS}^*(\tilde{K})$ be the state's value immediately after the jump, while by (32) $\Theta_{PC}^*(\tilde{K})$ is the value before the jump, the firm waits until the stochastic process Θ moves it vertically to $\Theta_{PS}^*(\tilde{K})$ before adding a new unit under the Profit Sharing regulation. As the Profit Sharing constraint is exogenously set by the regulator when it is not binding the optimal investment policy is determined by matching and smooth pasting the firm's value function. At the point where the constraint binds, the optimal policy is given by an indifference condition before and after the jump in x . This requires the following necessary condition at $(\tilde{K}, \Theta^*(\tilde{K}))$ (Kamien and Schwartz, 1991, p.247):

$$\begin{aligned} & \frac{\Pi(\tilde{K}, \Theta_{PC}^*(\tilde{K}))}{\delta(x_l)} + A_1(K, x_l)(\Theta_{PC}^*(\tilde{K}))^{\beta_1(x_l)} = \\ & = \frac{\Pi(\tilde{K}, \Theta_{PS}^*(\tilde{K}))}{\delta(x_h)} + \sum_{i=1}^2 A_i(K, x_h)(\Theta_{PS}^*(\tilde{K}))^{\beta_i(x_h)}. \end{aligned} \quad (51)$$

which ensures that regime switches do not cause any discrete change in the firm's value. ■

References

- [1] Ai, C. and D. Sappington (2002), The Impact of State Incentive Regulation on the U.S. Telecommunications Industry, *Journal of Regulatory Economics*, 22, 133-60.
- [2] Armstrong, M., S. Cowan and J. Vickers (1995), *Regulatory Reform. Economic Analysis and British Experience*, MIT Press, Cambridge, Mass.
- [3] Beesley, M. and S. Littlechild (1989), The Regulation of Privatized Monopolies in the United Kingdom, *Rand Journal of Economics*, 20, 454-72.
- [4] Bernanke, B.S. (1983), Irreversibility, Uncertainty, and Cyclical Investment, *Quarterly Journal of Economics*, 98, 85-103.
- [5] Burns, P., R. Turvey and T. G. Weyman-Jones (1998), The Behavior of the Firm under Alternative Regulatory Constraints, *Scottish Journal of Political Economy*, 45(2), 133-57
- [6] Crew, M. and P. Kleindorfer (1996), Incentive Regulation in the United Kingdom and the United States: Some Lessons, *Journal of Regulatory Economics*, 9, 211-25.
- [7] Dixit, A. (1991), Irreversible Investment with Price Ceilings, *Journal of Political Economy*, 99, 541-57.
- [8] Dixit, A. (1995), Irreversible Investment with Uncertainty and Scale Economies, *Journal of Economic Dynamics and Control*, 19, 327-50.
- [9] Dixit, A. and R.S. Pindyck (1994), *Investment under Uncertainty*, Princeton University Press.
- [10] Dixit, A. and R.S. Pindyck (2000), Expandability, Reversibility, and Optimal Capacity Choice, in M.J. Brennan and L. Trigeorgis (eds.) *Project Flexibility, Agency, and Competition*, Oxford University Press.
- [11] Harrison J.M., (1985), *Brownian Motion and Stochastic Flow Systems*, New York: John Wiley & Son.
- [12] Kamien, M.T. and N.L. Schwartz (1991), *Dynamic Optimization*, Amsterdam, North-Holland.

- [13] Laffont, J. J. and J. Tirole (1986), Using Cost Observations to Regulate Firms, *Journal of Political Economy*, vol.94, 614-41.
- [14] Lyon, T. (1996), A Model of Sliding-Scale Regulation, *Journal of Regulatory Economics*, 9, 227-47.
- [15] Lyon, T. and J. Mayo (2000), Regulatory Opportunism and Investment behavior: Evidence from the U.S. Electricity Utility Industry, *Indiana University Discussion Paper*.
- [16] Mayer, C. and J. Vickers (1996), Profit-Sharing Regulation: An Economic Appraisal, *Fiscal Studies*, 17, 1-18.
- [17] McDonald, R. and D. Siegel (1986), The Value of Waiting to Invest, *Quarterly Journal of Economics*, 101, 707-28.
- [18] Merton, R.C. (1990), *Continuous-Time Finance*, Blackwell's, Cambridge, Mass..
- [19] Panteghini, P.M. and C. Scarpa (2003a), The Distributional Efficiency of Alternative Regulatory Regimes: A Real Option Approach, *International Tax and Public Finance*, forthcoming.
- [20] Panteghini, P.M. and C. Scarpa (2003b), Irreversible Investments and Regulatory Risk, *CES-ifo Working Paper* No. 934
- [21] Sappington, D. and D. Weisman (1996), Revenue Sharing in Incentive Regulation Plans, *Information Economics and Policy*, 8, 229-48.
- [22] Sappington, D. (2002), Price Regulation and Incentives, in M. Cave, S. Majumdar, I. Vogelsang (eds.), *Handbook of Telecommunications*, North-Holland, London.
- [23] Trigeorgis, L. (1996), *Real Options, Managerial Flexibility and Strategy in Resource Allocation*, MIT Press, Cambridge, Mass..
- [24] Weisman, D.L. (1993), Superior Regulatory Regimes in Theory and in Practice, *Journal of Regulatory Economics*, 5, 355-66.
- [25] Weisman, D.L. (2002), Is There "Hope" for Price Cap Regulation?, *Information Economics and Policy*, 14, 349-370.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

Fondazione Eni Enrico Mattei Working Paper Series

Our working papers are available on the Internet at the following addresses:

<http://www.feem.it/Feem/Pub/Publications/WPapers/default.html>

<http://papers.ssrn.com>

SUST	1.2002	<i>K. TANO, M.D. FAMINOW, M. KAMUANGA and B. SWALLOW: <u>Using Conjoint Analysis to Estimate Farmers' Preferences for Cattle Traits in West Africa</u></i>
ETA	2.2002	<i>Efrem CASTELNUOVO and Paolo SURICO: <u>What Does Monetary Policy Reveal about Central Bank's Preferences?</u></i>
WAT	3.2002	<i>Duncan KNOWLER and Edward BARBIER: <u>The Economics of a "Mixed Blessing" Effect: A Case Study of the Black Sea</u></i>
CLIM	4.2002	<i>Andreas LÖSCHEL: <u>Technological Change in Economic Models of Environmental Policy: A Survey</u></i>
VOL	5.2002	<i>Carlo CARRARO and Carmen MARCHIORI: <u>Stable Coalitions</u></i>
CLIM	6.2002	<i>Marzio GALEOTTI, Alessandro LANZA and Matteo MANERA: <u>Rockets and Feathers Revisited: An International Comparison on European Gasoline Markets</u></i>
ETA	7.2002	<i>Effrosyni DIAMANTOUDI and Efthios S. SARTZETAKIS: <u>Stable International Environmental Agreements: An Analytical Approach</u></i>
KNOW	8.2002	<i>Alain DESDOIGTS: <u>Neoclassical Convergence Versus Technological Catch-up: A Contribution for Reaching a Consensus</u></i>
NRM	9.2002	<i>Giuseppe DI VITA: <u>Renewable Resources and Waste Recycling</u></i>
KNOW	10.2002	<i>Giorgio BRUNELLO: <u>Is Training More Frequent when Wage Compression is Higher? Evidence from 11 European Countries</u></i>
ETA	11.2002	<i>Mordecai KURZ, Hehui JIN and Maurizio MOTOLESE: <u>Endogenous Fluctuations and the Role of Monetary Policy</u></i>
KNOW	12.2002	<i>Reyer GERLAGH and Marjan W. HOFKES: <u>Escaping Lock-in: The Scope for a Transition towards Sustainable Growth?</u></i>
NRM	13.2002	<i>Michele MORETTO and Paolo ROSATO: <u>The Use of Common Property Resources: A Dynamic Model</u></i>
CLIM	14.2002	<i>Philippe QUIRION: <u>Macroeconomic Effects of an Energy Saving Policy in the Public Sector</u></i>
CLIM	15.2002	<i>Roberto ROSON: <u>Dynamic and Distributional Effects of Environmental Revenue Recycling Schemes: Simulations with a General Equilibrium Model of the Italian Economy</u></i>
CLIM	16.2002	<i>Francesco RICCI (I): <u>Environmental Policy Growth when Inputs are Differentiated in Pollution Intensity</u></i>
ETA	17.2002	<i>Alberto PETRUCCI: <u>Devaluation (Levels versus Rates) and Balance of Payments in a Cash-in-Advance Economy</u></i>
Coalition Theory Network	18.2002	<i>László Á. KÓCZY (liv): <u>The Core in the Presence of Externalities</u></i>
Coalition Theory Network	19.2002	<i>Steven J. BRAMS, Michael A. JONES and D. Marc KILGOUR (liv): <u>Single-Peakedness and Disconnected Coalitions</u></i>
Coalition Theory Network	20.2002	<i>Guillaume HAERINGER (liv): <u>On the Stability of Cooperation Structures</u></i>
NRM	21.2002	<i>Fausto CAVALLARO and Luigi CIRAULO: <u>Economic and Environmental Sustainability: A Dynamic Approach in Insular Systems</u></i>
CLIM	22.2002	<i>Barbara BUCHNER, Carlo CARRARO, Igor CERSOSIMO and Carmen MARCHIORI: <u>Back to Kyoto? US Participation and the Linkage between R&D and Climate Cooperation</u></i>
CLIM	23.2002	<i>Andreas LÖSCHEL and ZhongXIANG ZHANG: <u>The Economic and Environmental Implications of the US Repudiation of the Kyoto Protocol and the Subsequent Deals in Bonn and Marrakech</u></i>
ETA	24.2002	<i>Marzio GALEOTTI, Louis J. MACCINI and Fabio SCHIANTARELLI: <u>Inventories, Employment and Hours</u></i>
CLIM	25.2002	<i>Hannes EGLI: <u>Are Cross-Country Studies of the Environmental Kuznets Curve Misleading? New Evidence from Time Series Data for Germany</u></i>
ETA	26.2002	<i>Adam B. JAFFE, Richard G. NEWELL and Robert N. STAVINS: <u>Environmental Policy and Technological Change</u></i>
SUST	27.2002	<i>Joseph C. COOPER and Giovanni SIGNORELLO: <u>Farmer Premiums for the Voluntary Adoption of Conservation Plans</u></i>
SUST	28.2002	<i><u>The ANSEA Network: Towards An Analytical Strategic Environmental Assessment</u></i>
KNOW	29.2002	<i>Paolo SURICO: <u>Geographic Concentration and Increasing Returns: a Survey of Evidence</u></i>
ETA	30.2002	<i>Robert N. STAVINS: <u>Lessons from the American Experiment with Market-Based Environmental Policies</u></i>

NRM	31.2002	<i>Carlo GIUPPONI and Paolo ROSATO: <u>Multi-Criteria Analysis and Decision-Support for Water Management at the Catchment Scale: An Application to Diffuse Pollution Control in the Venice Lagoon</u></i>
NRM	32.2002	<i>Robert N. STAVINS: <u>National Environmental Policy During the Clinton Years</u></i>
KNOW	33.2002	<i>A. SOUBEYRAN and H. STAHN : <u>Do Investments in Specialized Knowledge Lead to Composite Good Industries?</u></i>
KNOW	34.2002	<i>G. BRUNELLO, M.L. PARISI and Daniela SONEDDA: <u>Labor Taxes, Wage Setting and the Relative Wage Effect</u></i>
CLIM	35.2002	<i>C. BOEMARE and P. QUIRION (lv): <u>Implementing Greenhouse Gas Trading in Europe: Lessons from Economic Theory and International Experiences</u></i>
CLIM	36.2002	<i>T. TIETENBERG (lv): <u>The Tradable Permits Approach to Protecting the Commons: What Have We Learned?</u></i>
CLIM	37.2002	<i>K. REHDANZ and R.J.S. TOL (lv): <u>On National and International Trade in Greenhouse Gas Emission Permits</u></i>
CLIM	38.2002	<i>C. FISCHER (lv): <u>Multinational Taxation and International Emissions Trading</u></i>
SUST	39.2002	<i>G. SIGNORELLO and G. PAPPALARDO: <u>Farm Animal Biodiversity Conservation Activities in Europe under the Framework of Agenda 2000</u></i>
NRM	40.2002	<i>S.M. CAVANAGH, W. M. HANEMANN and R. N. STAVINS: <u>Muffled Price Signals: Household Water Demand under Increasing-Block Prices</u></i>
NRM	41.2002	<i>A. J. PLANTINGA, R. N. LUBOWSKI and R. N. STAVINS: <u>The Effects of Potential Land Development on Agricultural Land Prices</u></i>
CLIM	42.2002	<i>C. OHL (lvi): <u>Inducing Environmental Co-operation by the Design of Emission Permits</u></i>
CLIM	43.2002	<i>J. EYCKMANS, D. VAN REGEMORTER and V. VAN STEENBERGHE (lvi): <u>Is Kyoto Fatally Flawed? An Analysis with MacGEM</u></i>
CLIM	44.2002	<i>A. ANTOCI and S. BORGHESI (lvi): <u>Working Too Much in a Polluted World: A North-South Evolutionary Model</u></i>
ETA	45.2002	<i>P. G. FREDRIKSSON, Johan A. LIST and Daniel MILLIMET (lvi): <u>Chasing the Smokestack: Strategic Policymaking with Multiple Instruments</u></i>
ETA	46.2002	<i>Z. YU (lvi): <u>A Theory of Strategic Vertical DFI and the Missing Pollution-Haven Effect</u></i>
SUST	47.2002	<i>Y. H. FARZIN: <u>Can an Exhaustible Resource Economy Be Sustainable?</u></i>
SUST	48.2002	<i>Y. H. FARZIN: <u>Sustainability and Hamiltonian Value</u></i>
KNOW	49.2002	<i>C. PIGA and M. VIVARELLI: <u>Cooperation in R&D and Sample Selection</u></i>
Coalition	50.2002	<i>M. SERTEL and A. SLINKO (liv): <u>Ranking Committees, Words or Multisets</u></i>
Theory		
Network		
Coalition	51.2002	<i>Sergio CURRARINI (liv): <u>Stable Organizations with Externalities</u></i>
Theory		
Network		
ETA	52.2002	<i>Robert N. STAVINS: <u>Experience with Market-Based Policy Instruments</u></i>
ETA	53.2002	<i>C.C. JAEGER, M. LEIMBACH, C. CARRARO, K. HASSELMANN, J.C. HOURCADE, A. KEELER and R. KLEIN (liii): <u>Integrated Assessment Modeling: Modules for Cooperation</u></i>
CLIM	54.2002	<i>Scott BARRETT (liii): <u>Towards a Better Climate Treaty</u></i>
ETA	55.2002	<i>Richard G. NEWELL and Robert N. STAVINS: <u>Cost Heterogeneity and the Potential Savings from Market-Based Policies</u></i>
SUST	56.2002	<i>Paolo ROSATO and Edi DEFRANCESCO: <u>Individual Travel Cost Method and Flow Fixed Costs</u></i>
SUST	57.2002	<i>Vladimir KOTOV and Elena NIKITINA (lvii): <u>Reorganisation of Environmental Policy in Russia: The Decade of Success and Failures in Implementation of Perspective Quests</u></i>
SUST	58.2002	<i>Vladimir KOTOV (lvii): <u>Policy in Transition: New Framework for Russia's Climate Policy</u></i>
SUST	59.2002	<i>Fanny MISSFELDT and Arturo VILLAVICENCO (lvii): <u>How Can Economies in Transition Pursue Emissions Trading or Joint Implementation?</u></i>
VOL	60.2002	<i>Giovanni DI BARTOLOMEO, Jacob ENGWERDA, Joseph PLASMANS and Bas VAN AARLE: <u>Staying Together or Breaking Apart: Policy-Makers' Endogenous Coalitions Formation in the European Economic and Monetary Union</u></i>
ETA	61.2002	<i>Robert N. STAVINS, Alexander F. WAGNER and Gernot WAGNER: <u>Interpreting Sustainability in Economic Terms: Dynamic Efficiency Plus Intergenerational Equity</u></i>
PRIV	62.2002	<i>Carlo CAPUANO: <u>Demand Growth, Entry and Collusion Sustainability</u></i>
PRIV	63.2002	<i>Federico MUNARI and Raffaele ORIANI: <u>Privatization and R&D Performance: An Empirical Analysis Based on Tobin's Q</u></i>
PRIV	64.2002	<i>Federico MUNARI and Maurizio SOBRERO: <u>The Effects of Privatization on R&D Investments and Patent Productivity</u></i>
SUST	65.2002	<i>Orley ASHENFELTER and Michael GREENSTONE: <u>Using Mandated Speed Limits to Measure the Value of a Statistical Life</u></i>
ETA	66.2002	<i>Paolo SURICO: <u>US Monetary Policy Rules: the Case for Asymmetric Preferences</u></i>
PRIV	67.2002	<i>Rinaldo BRAU and Massimo FLORIO: <u>Privatisations as Price Reforms: Evaluating Consumers' Welfare Changes in the U.K.</u></i>
CLIM	68.2002	<i>Barbara K. BUCHNER and Roberto ROSON: <u>Conflicting Perspectives in Trade and Environmental Negotiations</u></i>
CLIM	69.2002	<i>Philippe QUIRION: <u>Complying with the Kyoto Protocol under Uncertainty: Taxes or Tradable Permits?</u></i>
SUST	70.2002	<i>Anna ALBERINI, Patrizia RIGANTI and Alberto LONGO: <u>Can People Value the Aesthetic and Use Services of Urban Sites? Evidence from a Survey of Belfast Residents</u></i>
SUST	71.2002	<i>Marco PERCOCO: <u>Discounting Environmental Effects in Project Appraisal</u></i>

NRM	72.2002	<i>Philippe BONTEMS and Pascal FAVARD: <u>Input Use and Capacity Constraint under Uncertainty: The Case of Irrigation</u></i>
PRIV	73.2002	<i>Mohammed OMRAN: <u>The Performance of State-Owned Enterprises and Newly Privatized Firms: Empirical Evidence from Egypt</u></i>
PRIV	74.2002	<i>Mike BURKART, Fausto PANUNZI and Andrei SHLEIFER: <u>Family Firms</u></i>
PRIV	75.2002	<i>Emmanuelle AURIOL, Pierre M. PICARD: <u>Privatizations in Developing Countries and the Government Budget Constraint</u></i>
PRIV	76.2002	<i>Nichole M. CASTATER: <u>Privatization as a Means to Societal Transformation: An Empirical Study of Privatization in Central and Eastern Europe and the Former Soviet Union</u></i>
PRIV	77.2002	<i>Christoph LÜLSFESMANN: <u>Benevolent Government, Managerial Incentives, and the Virtues of Privatization</u></i>
PRIV	78.2002	<i>Kate BISHOP, Igor FILATOTCHEV and Tomasz MICKIEWICZ: <u>Endogenous Ownership Structure: Factors Affecting the Post-Privatisation Equity in Largest Hungarian Firms</u></i>
PRIV	79.2002	<i>Theodora WELCH and Rick MOLZ: <u>How Does Trade Sale Privatization Work? Evidence from the Fixed-Line Telecommunications Sector in Developing Economies</u></i>
PRIV	80.2002	<i>Alberto R. PETRUCCI: <u>Government Debt, Agent Heterogeneity and Wealth Displacement in a Small Open Economy</u></i>
CLIM	81.2002	<i>Timothy SWANSON and Robin MASON (Ivi): <u>The Impact of International Environmental Agreements: The Case of the Montreal Protocol</u></i>
PRIV	82.2002	<i>George R.G. CLARKE and Lixin Colin XU: <u>Privatization, Competition and Corruption: How Characteristics of Bribe Takers and Payers Affect Bribe Payments to Utilities</u></i>
PRIV	83.2002	<i>Massimo FLORIO and Katuscia MANZONI: <u>The Abnormal Returns of UK Privatisations: From Underpricing to Outperformance</u></i>
NRM	84.2002	<i>Nelson LOURENÇO, Carlos RUSSO MACHADO, Maria do ROSÁRIO JORGE and Luís RODRIGUES: <u>An Integrated Approach to Understand Territory Dynamics. The Coastal Alentejo (Portugal)</u></i>
CLIM	85.2002	<i>Peter ZAPFEL and Matti VAINIO (Iv): <u>Pathways to European Greenhouse Gas Emissions Trading History and Misconceptions</u></i>
CLIM	86.2002	<i>Pierre COURTOIS: <u>Influence Processes in Climate Change Negotiations: Modelling the Rounds</u></i>
ETA	87.2002	<i>Vito FRAGNELLI and Maria Erminia MARINA (Iviii): <u>Environmental Pollution Risk and Insurance</u></i>
ETA	88.2002	<i>Laurent FRANCKX (Iviii): <u>Environmental Enforcement with Endogenous Ambient Monitoring</u></i>
ETA	89.2002	<i>Timo GOESCHL and Timothy M. SWANSON (Iviii): <u>Lost Horizons. The noncooperative management of an evolutionary biological system.</u></i>
ETA	90.2002	<i>Hans KEIDING (Iviii): <u>Environmental Effects of Consumption: An Approach Using DEA and Cost Sharing</u></i>
ETA	91.2002	<i>Wietze LISE (Iviii): <u>A Game Model of People's Participation in Forest Management in Northern India</u></i>
CLIM	92.2002	<i>Jens HORBACH: <u>Structural Change and Environmental Kuznets Curves</u></i>
ETA	93.2002	<i>Martin P. GROSSKOPF: <u>Towards a More Appropriate Method for Determining the Optimal Scale of Production Units</u></i>
VOL	94.2002	<i>Scott BARRETT and Robert STAVINS: <u>Increasing Participation and Compliance in International Climate Change Agreements</u></i>
CLIM	95.2002	<i>Banu BAYRAMOGLU LISE and Wietze LISE: <u>Climate Change, Environmental NGOs and Public Awareness in the Netherlands: Perceptions and Reality</u></i>
CLIM	96.2002	<i>Matthieu GLACHANT: <u>The Political Economy of Emission Tax Design in Environmental Policy</u></i>
KNOW	97.2002	<i>Kenn ARIGA and Giorgio BRUNELLO: <u>Are the More Educated Receiving More Training? Evidence from Thailand</u></i>
ETA	98.2002	<i>Gianfranco FORTE and Matteo MANERA: <u>Forecasting Volatility in European Stock Markets with Non-linear GARCH Models</u></i>
ETA	99.2002	<i>Geoffrey HEAL: <u>Bundling Biodiversity</u></i>
ETA	100.2002	<i>Geoffrey HEAL, Brian WALKER, Simon LEVIN, Kenneth ARROW, Partha DASGUPTA, Gretchen DAILY, Paul EHRLICH, Karl-Goran MALER, Nils KAUTSKY, Jane LUBCHENCO, Steve SCHNEIDER and David STARRETT: <u>Genetic Diversity and Interdependent Crop Choices in Agriculture</u></i>
ETA	101.2002	<i>Geoffrey HEAL: <u>Biodiversity and Globalization</u></i>
VOL	102.2002	<i>Andreas LANGE: <u>Heterogeneous International Agreements – If per capita emission levels matter</u></i>
ETA	103.2002	<i>Pierre-André JOUVET and Walid OUESLATI: <u>Tax Reform and Public Spending Trade-offs in an Endogenous Growth Model with Environmental Externalities</u></i>
ETA	104.2002	<i>Anna BOTTASSO and Alessandro SEMBENELLI: <u>Does Ownership Affect Firms' Efficiency? Panel Data Evidence on Italy</u></i>
PRIV	105.2002	<i>Bernardo BORTOLOTTI, Frank DE JONG, Giovanna NICODANO and Ibolya SCHINDELE: <u>Privatization and Stock Market Liquidity</u></i>
ETA	106.2002	<i>Haruo IMAI and Mayumi HORIE (Iviii): <u>Pre-Negotiation for an International Emission Reduction Game</u></i>
PRIV	107.2002	<i>Sudeshna GHOSH BANERJEE and Michael C. MUNGER: <u>Move to Markets? An Empirical Analysis of Privatisation in Developing Countries</u></i>
PRIV	108.2002	<i>Guillaume GIRMENS and Michel GUILLARD: <u>Privatization and Investment: Crowding-Out Effect vs Financial Diversification</u></i>
PRIV	109.2002	<i>Alberto CHONG and Florencio LÓPEZ-DE-SILANES: <u>Privatization and Labor Force Restructuring Around the World</u></i>
PRIV	110.2002	<i>Nandini GUPTA: <u>Partial Privatization and Firm Performance</u></i>
PRIV	111.2002	<i>François DEGEORGE, Dirk JENTER, Alberto MOEL and Peter TUFANO: <u>Selling Company Shares to Reluctant Employees: France Telecom's Experience</u></i>

PRIV	112.2002	<i>Isaac OTCHERE</i> : <u>Intra-Industry Effects of Privatization Announcements: Evidence from Developed and Developing Countries</u>
PRIV	113.2002	<i>Yannis KATSOULAKOS and Elissavet LIKOYANNI</i> : <u>Fiscal and Other Macroeconomic Effects of Privatization</u>
PRIV	114.2002	<i>Guillaume GIRMENS</i> : <u>Privatization, International Asset Trade and Financial Markets</u>
PRIV	115.2002	<i>D. Teja FLOTHO</i> : <u>A Note on Consumption Correlations and European Financial Integration</u>
PRIV	116.2002	<i>Ibolya SCHINDELE and Enrico C. PEROTTI</i> : <u>Pricing Initial Public Offerings in Premature Capital Markets: The Case of Hungary</u>
PRIV	1.2003	<i>Gabriella CHIESA and Giovanna NICODANO</i> : <u>Privatization and Financial Market Development: Theoretical Issues</u>
PRIV	2.2003	<i>Ibolya SCHINDELE</i> : <u>Theory of Privatization in Eastern Europe: Literature Review</u>
PRIV	3.2003	<i>Wietze LISE, Claudia KEMFERT and Richard S.J. TOL</i> : <u>Strategic Action in the Liberalised German Electricity Market</u>
CLIM	4.2003	<i>Laura MARSILLANI and Thomas I. RENSTRÖM</i> : <u>Environmental Policy and Capital Movements: The Role of Government Commitment</u>
KNOW	5.2003	<i>Reyer GERLAGH</i> : <u>Induced Technological Change under Technological Competition</u>
ETA	6.2003	<i>Efrem CASTELNUOVO</i> : <u>Squeezing the Interest Rate Smoothing Weight with a Hybrid Expectations Model</u>
SIEV	7.2003	<i>Anna ALBERINI, Alberto LONGO, Stefania TONIN, Francesco TROMBETTA and Margherita TURVANI</i> : <u>The Role of Liability, Regulation and Economic Incentives in Brownfield Remediation and Redevelopment: Evidence from Surveys of Developers</u>
NRM	8.2003	<i>Elissaios PAPYRAKIS and Reyner GERLAGH</i> : <u>Natural Resources: A Blessing or a Curse?</u>
CLIM	9.2003	<i>A. CAPARRÓS, J.-C. PEREAU and T. TAZDAÏT</i> : <u>North-South Climate Change Negotiations: a Sequential Game with Asymmetric Information</u>
KNOW	10.2003	<i>Giorgio BRUNELLO and Daniele CHECCHI</i> : <u>School Quality and Family Background in Italy</u>
CLIM	11.2003	<i>Efrem CASTELNUOVO and Marzio GALEOTTI</i> : <u>Learning By Doing vs Learning By Researching in a Model of Climate Change Policy Analysis</u>
KNOW	12.2003	<i>Carole Maignan, Gianmarco OTTAVIANO and Dino PINELLI (eds.)</i> : <u>Economic Growth, Innovation, Cultural Diversity: What are we all talking about? A critical survey of the state-of-the-art</u>
KNOW	13.2003	<i>Carole Maignan, Gianmarco OTTAVIANO, Dino PINELLI and Francesco RULLANI (lix)</i> : <u>Bio-Ecological Diversity vs. Socio-Economic Diversity. A Comparison of Existing Measures</u>
KNOW	14.2003	<i>Maddy JANSSENS and Chris STEYAERT (lix)</i> : <u>Theories of Diversity within Organisation Studies: Debates and Future Trajectories</u>
KNOW	15.2003	<i>Tuzin BAYCAN LEVENT, Enno MASUREL and Peter NIJKAMP (lix)</i> : <u>Diversity in Entrepreneurship: Ethnic and Female Roles in Urban Economic Life</u>
KNOW	16.2003	<i>Alexandra BITUSIKOVA (lix)</i> : <u>Post-Communist City on its Way from Grey to Colourful: The Case Study from Slovakia</u>
KNOW	17.2003	<i>Billy E. VAUGHN and Katarina MLEKOV (lix)</i> : <u>A Stage Model of Developing an Inclusive Community</u>
KNOW	18.2003	<i>Selma van LONDEN and Arie de RUIJTER (lix)</i> : <u>Managing Diversity in a Globalizing World</u>
Coalition Theory Network	19.2003	<i>Sergio CURRARINI</i> : <u>On the Stability of Hierarchies in Games with Externalities</u>
PRIV	20.2003	<i>Giacomo CALZOLARI and Alessandro PAVAN (lx)</i> : <u>Monopoly with Resale</u>
PRIV	21.2003	<i>Claudio MEZZETTI (lx)</i> : <u>Auction Design with Interdependent Valuations: The Generalized Revelation Principle, Efficiency, Full Surplus Extraction and Information Acquisition</u>
PRIV	22.2003	<i>Marco LiCalzi and Alessandro PAVAN (lx)</i> : <u>Tilting the Supply Schedule to Enhance Competition in Uniform-Price Auctions</u>
PRIV	23.2003	<i>David ETTINGER (lx)</i> : <u>Bidding among Friends and Enemies</u>
PRIV	24.2003	<i>Hannu VARTIAINEN (lx)</i> : <u>Auction Design without Commitment</u>
PRIV	25.2003	<i>Matti KELOHARJU, Kjell G. NYBORG and Kristian RYDQVIST (lx)</i> : <u>Strategic Behavior and Underpricing in Uniform Price Auctions: Evidence from Finnish Treasury Auctions</u>
PRIV	26.2003	<i>Christine A. PARLOUR and Uday RAJAN (lx)</i> : <u>Rationing in IPOs</u>
PRIV	27.2003	<i>Kjell G. NYBORG and Ilya A. STREBULAIEV (lx)</i> : <u>Multiple Unit Auctions and Short Squeezes</u>
PRIV	28.2003	<i>Anders LUNANDER and Jan-Eric NILSSON (lx)</i> : <u>Taking the Lab to the Field: Experimental Tests of Alternative Mechanisms to Procure Multiple Contracts</u>
PRIV	29.2003	<i>TangaMcDANIEL and Karsten NEUHOFF (lx)</i> : <u>Use of Long-term Auctions for Network Investment</u>
PRIV	30.2003	<i>Emiel MAASLAND and Sander ONDERSTAL (lx)</i> : <u>Auctions with Financial Externalities</u>
ETA	31.2003	<i>Michael FINUS and Bianca RUNDSHAGEN</i> : <u>A Non-cooperative Foundation of Core-Stability in Positive Externality NTU-Coalition Games</u>
KNOW	32.2003	<i>Michele MORETTO</i> : <u>Competition and Irreversible Investments under Uncertainty</u>
PRIV	33.2003	<i>Philippe QUIRION</i> : <u>Relative Quotas: Correct Answer to Uncertainty or Case of Regulatory Capture?</u>
KNOW	34.2003	<i>Giuseppe MEDA, Claudio PIGA and Donald SIEGEL</i> : <u>On the Relationship between R&D and Productivity: A Treatment Effect Analysis</u>
ETA	35.2003	<i>Alessandra DEL BOCA, Marzio GALEOTTI and Paola ROTA</i> : <u>Non-convexities in the Adjustment of Different Capital Inputs: A Firm-level Investigation</u>

GG	36.2003	<i>Matthieu GLACHANT</i> : <u>Voluntary Agreements under Endogenous Legislative Threats</u>
PRIV	37.2003	<i>Narjess BOUBAKRI, Jean-Claude COSSET and Omrane GUEDHAMI</i> : <u>Postprivatization Corporate Governance: the Role of Ownership Structure and Investor Protection</u>
CLIM	38.2003	<i>Rolf GOLOMBEK and Michael HOEL</i> : <u>Climate Policy under Technology Spillovers</u>
KNOW	39.2003	<i>Slim BEN YOUSSEF</i> : <u>Transboundary Pollution, R&D Spillovers and International Trade</u>
CTN	40.2003	<i>Carlo CARRARO and Carmen MARCHIORI</i> : <u>Endogenous Strategic Issue Linkage in International Negotiations</u>
KNOW	41.2003	<i>Sonia OREFFICE</i> : <u>Abortion and Female Power in the Household: Evidence from Labor Supply</u>
KNOW	42.2003	<i>Timo GOESCHL and Timothy SWANSON</i> : <u>On Biology and Technology: The Economics of Managing Biotechnologies</u>
ETA	43.2003	<i>Giorgio Busetti and Matteo MANERA</i> : <u>STAR-GARCH Models for Stock Market Interactions in the Pacific Basin Region, Japan and US</u>
CLIM	44.2003	<i>Katrin MILLOCK and Céline NAUGES</i> : <u>The French Tax on Air Pollution: Some Preliminary Results on its Effectiveness</u>
PRIV	45.2003	<i>Bernardo BORTOLOTTI and Paolo PINOTTI</i> : <u>The Political Economy of Privatization</u>
SIEV	46.2003	<i>Elbert DIJKGRAAF and Herman R.J. VOLLEBERGH</i> : <u>Burn or Bury? A Social Cost Comparison of Final Waste Disposal Methods</u>
ETA	47.2003	<i>Jens HORBACH</i> : <u>Employment and Innovations in the Environmental Sector: Determinants and Econometrical Results for Germany</u>
CLIM	48.2003	<i>Lori SNYDER, Nolan MILLER and Robert STAVINS</i> : <u>The Effects of Environmental Regulation on Technology Diffusion: The Case of Chlorine Manufacturing</u>
CLIM	49.2003	<i>Lori SNYDER, Robert STAVINS and Alexander F. WAGNER</i> : <u>Private Options to Use Public Goods. Exploiting Revealed Preferences to Estimate Environmental Benefits</u>
CTN	50.2003	<i>László Á. KÓCZY and Luc LAUWERS (Ixi)</i> : <u>The Minimal Dominant Set is a Non-Empty Core-Extension</u>
CTN	51.2003	<i>Matthew O. JACKSON (Ixi)</i> : <u>Allocation Rules for Network Games</u>
CTN	52.2003	<i>Ana MAULEON and Vincent VANNETELBOSCH (Ixi)</i> : <u>Farsightedness and Cautiousness in Coalition Formation</u>
CTN	53.2003	<i>Fernando VEGA-REDONDO (Ixi)</i> : <u>Building Up Social Capital in a Changing World: a network approach</u>
CTN	54.2003	<i>Matthew HAAG and Roger LAGUNOFF (Ixi)</i> : <u>On the Size and Structure of Group Cooperation</u>
CTN	55.2003	<i>Taiji FURUSAWA and Hideo KONISHI (Ixi)</i> : <u>Free Trade Networks</u>
CTN	56.2003	<i>Halis Murat YILDIZ (Ixi)</i> : <u>National Versus International Mergers and Trade Liberalization</u>
CTN	57.2003	<i>Santiago RUBIO and Alistair ULPH (Ixi)</i> : <u>An Infinite-Horizon Model of Dynamic Membership of International Environmental Agreements</u>
KNOW	58.2003	<i>Carole MAIGNAN, Dino PINELLI and Gianmarco I.P. OTTAVIANO</i> : <u>ICT, Clusters and Regional Cohesion: A Summary of Theoretical and Empirical Research</u>
KNOW	59.2003	<i>Giorgio BELLETTINI and Gianmarco I.P. OTTAVIANO</i> : <u>Special Interests and Technological Change</u>
ETA	60.2003	<i>Ronnie SCHÖB</i> : <u>The Double Dividend Hypothesis of Environmental Taxes: A Survey</u>
CLIM	61.2003	<i>Michael FINUS, Ekko van IERLAND and Robert DELLINK</i> : <u>Stability of Climate Coalitions in a Cartel Formation Game</u>
GG	62.2003	<i>Michael FINUS and Bianca RUNDSHAGEN</i> : <u>How the Rules of Coalition Formation Affect Stability of International Environmental Agreements</u>
SIEV	63.2003	<i>Alberto PETRUCCI</i> : <u>Taxing Land Rent in an Open Economy</u>
CLIM	64.2003	<i>Joseph E. ALDY, Scott BARRETT and Robert N. STAVINS</i> : <u>Thirteen Plus One: A Comparison of Global Climate Policy Architectures</u>
SIEV	65.2003	<i>Edi DEFRANCESCO</i> : <u>The Beginning of Organic Fish Farming in Italy</u>
SIEV	66.2003	<i>Klaus CONRAD</i> : <u>Price Competition and Product Differentiation when Consumers Care for the Environment</u>
SIEV	67.2003	<i>Paulo A.L.D. NUNES, Luca ROSSETTO, Arianne DE BLAEIJ</i> : <u>Monetary Value Assessment of Clam Fishing Management Practices in the Venice Lagoon: Results from a Stated Choice Exercise</u>
CLIM	68.2003	<i>ZhongXiang ZHANG</i> : <u>Open Trade with the U.S. Without Compromising Canada's Ability to Comply with its Kyoto Target</u>
KNOW	69.2003	<i>David FRANTZ (Ixi)</i> : <u>Lorenzo Market between Diversity and Mutation</u>
KNOW	70.2003	<i>Ercole SORI (Ixi)</i> : <u>Mapping Diversity in Social History</u>
KNOW	71.2003	<i>Ljiljana DERU SIMIC (Ixi)</i> : <u>What is Specific about Art/Cultural Projects?</u>
KNOW	72.2003	<i>Natalya V. TARANOVA (Ixi)</i> : <u>The Role of the City in Fostering Intergroup Communication in a Multicultural Environment: Saint-Petersburg's Case</u>
KNOW	73.2003	<i>Kristine CRANE (Ixi)</i> : <u>The City as an Arena for the Expression of Multiple Identities in the Age of Globalisation and Migration</u>
KNOW	74.2003	<i>Kazuma MATOBA (Ixi)</i> : <u>Glocal Dialogue- Transformation through Transcultural Communication</u>
KNOW	75.2003	<i>Catarina REIS OLIVEIRA (Ixi)</i> : <u>Immigrants' Entrepreneurial Opportunities: The Case of the Chinese in Portugal</u>
KNOW	76.2003	<i>Sandra WALLMAN (Ixi)</i> : <u>The Diversity of Diversity - towards a typology of urban systems</u>

KNOW	77.2003	<i>Richard PEARCE</i> (Ixii): <u>A Biologist's View of Individual Cultural Identity for the Study of Cities</u>
KNOW	78.2003	<i>Vincent MERK</i> (Ixii): <u>Communication Across Cultures: from Cultural Awareness to Reconciliation of the Dilemmas</u>
KNOW	79.2003	<i>Giorgio BELLETTINI, Carlotta BERTI CERONI and Gianmarco I.P. OTTAVIANO</i> : <u>Child Labor and Resistance to Change</u>
ETA	80.2003	<i>Michele MORETTO, Paolo M. PANTEGHINI and Carlo SCARPA</i> : <u>Investment Size and Firm's Value under Profit Sharing Regulation</u>

(I) This paper was presented at the Workshop "Growth, Environmental Policies and Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001

(li) This paper was presented at the Fourth Toulouse Conference on Environment and Resource Economics on "Property Rights, Institutions and Management of Environmental and Natural Resources", organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE, Toulouse, May 3-4, 2001

(lii) This paper was presented at the International Conference on "Economic Valuation of Environmental Goods", organised by Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001

(liii) This paper was circulated at the International Conference on "Climate Policy – Do We Need a New Approach?", jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001

(liv) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002

(lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001

(lvi) This paper was presented at the ESF EURESCO Conference on Environmental Policy in a Global Economy "The International Dimension of Environmental Policy", organised with the collaboration of the Fondazione Eni Enrico Mattei, Acquafredda di Maratea, October 6-11, 2001

(lvii) This paper was presented at the First Workshop of "CFEWE – Carbon Flows between Eastern and Western Europe", organised by the Fondazione Eni Enrico Mattei and Zentrum für Europäische Integrationsforschung (ZEI), Milan, July 5-6, 2001

(lviii) This paper was presented at the Workshop on "Game Practice and the Environment", jointly organised by Università del Piemonte Orientale and Fondazione Eni Enrico Mattei, Alessandria, April 12-13, 2002

(lix) This paper was presented at the ENGIME Workshop on "Mapping Diversity", Leuven, May 16-17, 2002

(Ix) This paper was presented at the EuroConference on "Auctions and Market Design: Theory, Evidence and Applications", organised by the Fondazione Eni Enrico Mattei, Milan, September 26-28, 2002

(Ixi) This paper was presented at the Eighth Meeting of the Coalition Theory Network organised by the GREQAM, Aix-en-Provence, France, January 24-25, 2003

(Ixii) This paper was presented at the ENGIME Workshop on "Communication across Cultures in Multicultural Cities", The Hague, November 7-8, 2002

2002 SERIES

CLIM	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
VOL	<i>Voluntary and International Agreements</i> (Editor: Carlo Carraro)
SUST	<i>Sustainability Indicators and Environmental Valuation</i> (Editor: Carlo Carraro)
NRM	<i>Natural Resources Management</i> (Editor: Carlo Giupponi)
KNOW	<i>Knowledge, Technology, Human Capital</i> (Editor: Dino Pinelli)
MGMT	<i>Corporate Sustainable Management</i> (Editor: Andrea Marsanich)
PRIV	<i>Privatisation, Regulation, Antitrust</i> (Editor: Bernardo Bortolotti)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)

2003 SERIES

CLIM	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
GG	<i>Global Governance</i> (Editor: Carlo Carraro)
SIEV	<i>Sustainability Indicators and Environmental Valuation</i> (Editor: Anna Alberini)
NRM	<i>Natural Resources Management</i> (Editor: Carlo Giupponi)
KNOW	<i>Knowledge, Technology, Human Capital</i> (Editor: Gianmarco Ottaviano)
IEM	<i>International Energy Markets</i> (Editor: Anil Markandya)
CSRM	<i>Corporate Social Responsibility and Management</i> (Editor: Sabina Ratti)
PRIV	<i>Privatisation, Regulation, Antitrust</i> (Editor: Bernardo Bortolotti)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)
CTN	<i>Coalition Theory Network</i>