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### “TOURISM INVESTMENTS UNDER UNCERTAINTY: AN ECONOMIC ANALYSIS OF “ECO-MONSTERS””

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# Tourism Investments Under Uncertainty: an Economic Analysis of “Eco-monsters”<sup>•</sup>

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## *Abstract*

“Ecological monsters” (“eco-monsters”) can be the bizarre, but legal, outcome of rational choices made by two agents: (i) a firm whose investments depend on Governmental permits; (ii) a policy maker having the discretionary power on the permits. This paper will determine the existence conditions which create a legal “eco-monster”. The model consists of a sequential noncooperative game with equilibrium in terms of positive expected firm profits and policy maker net balance ending up with a non-zero-sum game and a double failure: (i) a market failure, when the firm interrupts and abandons the investment, and (ii) a public failure, when the policy maker can not avoid the creation of “eco-monsters”. Policy implications and partisan party effects are explored: for certain parameters values, the economic policy can be ineffective in decreasing the “eco-monsters” frequency as a paradoxical, but rational, outcome in a stochastic framework, with real options and environmental externalities.

**JEL Classification:** C72-D62-D73

**Keywords:** Noncooperative Games, Externalities, Real Options.

## 1. Introduction

This paper will determine the conditions which create a legal “eco-monster” as a consequence of the rational choices of two agents: (i) an agent (e.g. a firm) that asks the local policy maker for a building permit to begin a plan; (ii) a policy maker with the discretionary authority to grant the permit<sup>1</sup>.

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<sup>1</sup> The reasons “eco-monsters” occur can also be found in a different framework, but the analytical structure of the corresponding model would not be significantly different from our model structure. For example, the firm could begin on  $T = 0$  the investment without the Government permit (illegal “eco-monster”), but then would pay on  $T = 1$  an exogenous penalty  $P$ , which is a random variable whose realization causes the investment interruption or completion (depending on the investment’s net present value). This model, even if very close to reality, does not correspond with our intention to find the economic *rationale* of “eco-monsters” in a framework of rational agents, with symmetric and complete information.

From an economic point of view, an “eco-monster” can be defined as either an investment not carried out until the complete accumulation of capital (incomplete investment) or an unproductive intermediate good, which is merely an eyesore on the landscape of a resort. Some examples of “eco-monsters” are: a factory initiated but not completed; an incomplete structure without walls; a tourism harbor abandoned before receiving the moorings; a hotel on the beach without rooms; an amusement park without attractions; a tourism park without accommodation facilities; a golf course without holes. An “eco-monster” seems to be the outcome of wrong decisions made both by the private decision maker – i.e. when a firm pays the costs of an investment without earning a profit from an incomplete capital accumulation – and by the public policy maker, who failed to look after the environmental integrity of the site by permitting private incomplete investment.

In order to examine the causes of the problem and to find the solution, the simplest possible model will be used: two risk-neutral agents (firm and policy maker), complete and symmetric information, limited time horizon, discrete time, zero interest rate, environmental damages with monetary value, final goods and factors of production markets which are independent and in perfect competition.

To tackle the problem the following complications are indispensable: (i) a stochastic framework, for costs and prices; (ii) a specific investment of the firm, which is undertaken at different phases of construction and capital accumulation; (iii) taking up real options on the investment delay or completion is possible; (iv) sequential noncooperative game with four stages; (v) one shot game for the policy maker. These assumptions will also be kept at the simplest level: game timing on three periods, discrete deterministic variables and binary random variables (Grenadier, 2000).

A “real option” is the right, but not the obligation, to make a capital investment decision. For example, the opportunity to invest in the realization of a tourist facility is a real option. In the field of finance, two types of financial options can be applied to capital decisions: “call option”<sup>2</sup> and “put option”<sup>3</sup> (Campbell, 2002). In contrast to financial options a real option is not tradable: e.g. a tourism firm cannot sell the option to another firm, it can only exercise the option.

The real option theory is applied in several economic field and in the literature there are many models for natural resources evaluation in environmental economics (Pindyck, 1980; Brennan and Schwartz, 1985; Paddock *et al.*, 1988; Trigeoris, 1990). This approach, recently, has also been applied in real estate economics to evaluate the price of real capital (Titman, 1985; Quigg, 1993; Capozza and Li, 1994; Grenadier, 1996). Moreover, there are various applications of the real option theory to R&D projects evaluation in industrial organization (Copeland and Weiner, 1990; Hamilton and Mitchell, 1990; Lint and Pennings, 1997; Weeds, 2002).

The institutional framework where real options are found is the legislation for urban planning, at local, regional or national level. A building permit (or construction permit) must be granted by the policy maker in order for the firm to undertake the investment. A building permit is required in most jurisdictions for new constructions, additions to pre-existing structures, and in some cases for major renovations<sup>4</sup>. From an economic point of view, the building permit can be tradable/not tradable and

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<sup>2</sup> A “call option” is a financial contract between two parties, the buyer and the seller of this type of option. The buyer of the option has the right, but not the obligation to buy an agreed quantity of a particular good or financial instrument (the underlying instrument) from the seller of the option at a certain time (the expiration date) for a certain price (the strike price). The seller is obligated to sell the good or financial instrument should the buyer so decide. The buyer pays a fee for this right. With “real options” the call option is the right, but not the obligation, of a firm to undertake an investment subject to a permit to be granted by the policy maker, for which it is necessary to pay *ex-ante* an exogenous lump sum tax.

<sup>3</sup> A “put option” is a financial contract between two parties, the buyer and the seller of the option. The put option allows the seller the right but not the obligation to sell a good or financial instrument to the buyer of the option at a certain time for a certain price. The buyer has the obligation to purchase the underlying asset at that strike price, if the seller exercises the option. With “real options”, the put option is the right, but not the obligation, of a firm to interrupt an investment during its lifetime (abandonment or termination option) and to sell the remainder of the investment (i.e. the net present value of the future cash flows) for a salvage value.

<sup>4</sup> Generally, new constructions must be inspected during construction and after completion to ensure compliance with national, regional, and local building codes. Failure to obtain a permit can result in significant fines and penalties, and

renewable/not renewable. This paper assumes that the building permit lasts for three periods<sup>5</sup>, is renewable and not tradable<sup>6</sup>. The firm always has the option to exercise a “call option” (i.e. to begin the investment) or not (i.e. not to begin the investment at all). When a firm exercises a call option, it can still decide to exercise a “put option” (i.e. to abandon the investment) or not (i.e. to complete the investment).

It is now necessary to define two concepts of reversibility: environmental resilience vs. economic recoverability. Regarding the first concept, an incomplete investment is defined as “irreversible” if its environmental resilience property<sup>7</sup> can not reverse the environmental damage effects in the short run. On the contrary, an incomplete investment is defined as “reversible” if its environmental resilience can progressively reverse the negative effects in the short run. An uncompleted hotel with sea access (visible from the sea) is clearly an irreversible investment, while an abandoned, uncompleted golf course or park will be recovered by natural reforestation and is therefore reversible. Economic recoverability refers instead to the standard concept of specific/unspecific investment, which is linked to the notion of “sunk costs”<sup>8</sup>.

Differently from standard economic literature the following terms will be therefore used with distinct meanings (Pindyck, 1988): (i) “specific/unspecific” investment references an investment’s property of economic recoverability/unrecoverability; (ii) “reversible/irreversible” investment references an investment’s environmental resilience property<sup>9</sup>.

Finally, the term Nature is defined as the *Environment* while the moves it makes produce the different *States of Nature*.

## 2. The Model

The following assumptions are made. The times of the game are  $T = 0, 1, 2, 3$  (three periods): the firm chooses on  $T = 0$  to ask the policy maker for a building permit<sup>10</sup> for which the firm must pay *ex-ante* an exogenous lump sum tax (guarantee deposit)  $S > 0$ . The firm asks for a building permit only at three period intervals, i.e. at time  $T = 0, 3, 6, \dots$  such that each sub-game is independent and self contained in the game<sup>11</sup>, before the actual costs and revenues observation and only if the investment Net Present Value is positive. Moreover, the call option’s expiration date is the end of the first period<sup>12</sup>, such that the firm can begin the investment only at time  $T = 1, 4, 7, \dots$

The investment is completed in two periods:

- on  $T = 1$  the firm observes the starting costs and decides either to begin the investment and pay the costs (i.e. to exercise a call option), or not to begin the investment at all (i.e. not to exercise a call option);

even demolition of unauthorized construction if it cannot meet code.

<sup>5</sup> As we shall see, three periods is our model time horizon.

<sup>6</sup> If it is assumed that the building permit is tradable, then the firm has the option to sell the permit itself to another agent before its expiration date. In this case the “call option” is tradable and has a market value. In the Italian jurisdiction a building permit (and therefore the corresponding real options) is inseparable from the real estate for which it has been granted. Therefore real options can only be sold together with the real estate and not separately.

<sup>7</sup> In biology and ecology the “resilience” property is the capability of a living organism, or of the environment, to self-repair after having suffered damage.

<sup>8</sup> Sunk costs are costs that have already been incurred and which cannot be recovered to any significant degree. An example of sunk costs may be an investment into a tourist facility that now has a lower value or no value whatsoever because it is incomplete (and no sale or recovery is feasible). The facility can be completed for an additional investment or abandoned. See Sutton (1991).

<sup>9</sup> For more details about the four possible combinations, see Table 1.

<sup>10</sup> At the beginning of the investment the firm is not subject to the competition of other firms. Removing this simplifying assumption represents one of the possible extensions of this model.

<sup>11</sup> Except when the firm exercises a real option to delay the beginning of the investment to the following three-year period. The example is taken from Travaglini (1999). For an analysis of the delay option, see also Trigeoris (1996).

<sup>12</sup> In the Italian jurisdiction, after receiving a building permit, a firm must begin the construction within a given expiration date.

- on  $T = 2$  the firm observes the final costs and “news” (i.e. new information) about the completed capital price and decides either to complete the investment (i.e. not to exercise a put option), or to abandon the investment (i.e. to exercise a put option);
- on  $T = 3$  the capital accumulation is completed and the completed capital is tradable at a certain price.

The investment costs  $I_T$  are a stochastic process with two possible realizations “high” and “low” on time  $T = 1, 2$ :  $I_T^H > I_T^L$ . The completed capital price (building price)  $\Pi$  is a discrete random variable which on  $T = 2$  can have two possible realizations “high” and “low” because of an exogenous shock:  $\Pi^H > \Pi^L$ . The probabilities are common knowledge and the investments can be specific/unspecific. The environmental effects of the private investment depend on the capital accumulation and on the environmental resilience assumption:

- if the capital accumulation is completed, it can produce/non produce negative environmental externalities  $C \geq 0$  (only if  $C = 0$  there are not externalities);
- if the capital accumulation is not completed and the investment is irreversible because of the environmental resilience property, an “eco-monster” will exist with an environmental monetary damage  $c \geq 0$  (only if  $c = 0$  the investment is reversible and there will not be an “eco-monster”)<sup>13</sup>.

If the firm has exercised the call option on  $T = 1$  and not exercised the put option on  $T = 2$ , then the cost of the completed capital (on  $T = 3$ ) is therefore given by the constant  $K = S + I_1^L + I_2^L$  (minimum cost): in other words, only when the most favorable conditions in terms of prices/costs are realized, the investment is completed by the firm. The firm’s loss for the possible investment interruption on  $T = 2$  is equal to  $D = S + I_1^L > 0$ . The resulting payoff depends on the potential investment salvage value  $D \geq D' \geq 0$ , and is equal to  $(D' - D) \leq 0$ :

- if the investment is unspecific and can be recovered by shifting it to another project, then  $D' > 0$  and at the most the loss can be completely offset by the salvage value, such that  $(D' - D) = 0$ ;
- if the investment is specific and can not be shifted to another alternative project, then  $D' = 0$  and therefore  $(D' - D) = -D < 0$ .

Figure 1 describes the timing of the model, where the operator  $E_T(x; \Phi_T)$  stands for the expectation on the random variable  $x$ , expressed on time  $T$ , and  $\Phi_T$  is the information set at time  $T$ . Due to the crucial assumption of “news” (on  $T = 2$ ) existing only about completed capital price, with expectations  $E_2(\Pi)$ , then  $\Pi^H = E_0(\Pi) = E_1(\Pi) \neq E_2(\Pi)$ , where  $E_2(\Pi)$  can be equal to  $\Pi^L$  or  $\Pi^H$  since  $\Phi_0 = \Phi_1 \neq \Phi_2$ ; on the contrary, since there are not “news” about investment costs, then  $E_T(I) \equiv E(I)$ <sup>14</sup>.

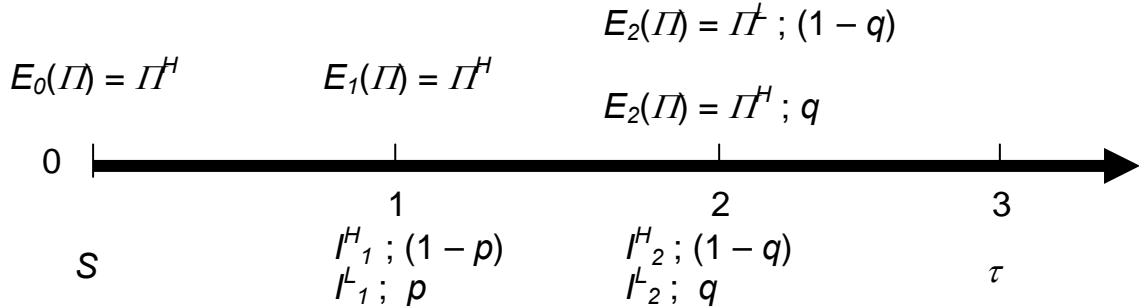
Moreover, Figure 1 shows the assumptions on the random variables, the investment costs probabilities of the first and second period (respectively  $p$  and  $q$ ) and the time at which the expectations are formulated. It must be stressed that on  $T = 2$  the probabilities of investment costs  $I_2$ , and of expected capital price  $E_2(\Pi)$  are assumed to be perfectly negatively correlated, only in two states of nature: (i) “bad times”  $\Phi_T^H$ , with high investment costs and low expected capital price, and

<sup>13</sup> Note that both the “eco-monster” and the complete capital accumulation can cause environmental damage, respectively for the monetary values  $C$  and  $c$ , which are not necessarily different. Nevertheless, the environmental damage  $C$  can be canceled through the taxes collected on the completed capital, while the damage  $c$  caused by the irreversible “eco-monster” can be canceled only by utilizing other budget resources (since there is not any tax). For example, the Government can utilize the tax collected to cover up the view of a hotel on the beach, while it has no resources to cover up an uncompleted facility which therefore remains visible to the natural habitat.

<sup>14</sup> This assumption is strictly connected to the stylized fact that tourism product is a typical contingent good, which has an asymmetric information on costs (investment costs) and revenues (completed capital price), because the “news” affecting the revenues may not affect the costs. For example, a climatic event or a terroristic attack can affect the final market price of the tourism good but not necessarily its production costs.

(ii) “good times”  $\Phi_T^L$ , with low investment costs and high expected capital price. This assumption considerably simplifies the model solutions, without reducing the economic interpretation<sup>15</sup>.

**Figure 1.** Timing.



From Figure 1, it is possible to compute the firm’s expected profit:

$$Y_T^e(\tau; \Phi_T) > 0 \quad [1]$$

where  $0 < \tau < 1$  is the rate of the building tax (exogenous proportional tax) which is levied *una tantum ex-post* (on  $T = 3$ ), but decided *ex-ante* (on  $T = 0$ ), by the policy maker on the completed capital value<sup>16</sup>.

To develop the analysis, the expected values of the firm’s profit and the policy maker’s objective function in all the different states of nature (“good times” and “bad times”) and on all the times  $T = 0, 1, 2$ , will be computed. In this way, the economic *rationale* behind all the firm’s possible real options decisions (to begin, to complete or to abandon the investment) and policies (given  $S$  and  $\tau$ ) can be explored and then the agents’ pay-offs and therefore the values relevant to solve the problem (game equilibrium) can be computed.

The firm’s expected profit on  $T = 0$  is therefore<sup>17</sup>:

$$Y_0^e(\tau; \Phi_0) = E_0(\Pi)(1 - \tau) - S - E(I_1) - E(I_2) = \Pi^H(1 - \tau) - S - E(I_1) - E(I_2) > 0 \quad [2]$$

If the policy maker gives the permit, on  $T = 1$  the firm observes the starting investment costs and its expected profit can therefore be:

$$Y_1^e(\tau; \Phi_1^H) = Y_1^e(\tau; I_1^H) = E_1(\Pi)(1 - \tau) - S - I_1^H - E(I_2) = \Pi^H(1 - \tau) - S - I_1^H - E(I_2) \quad [3]$$

$$Y_1^e(\tau; \Phi_1^L) = Y_1^e(\tau; I_1^L) = E_1(\Pi)(1 - \tau) - S - I_1^L - E(I_2) = \Pi^H(1 - \tau) - S - I_1^L - E(I_2) \quad [4]$$

<sup>15</sup> In general, the events can be dependent or independent and their probabilities correlated or uncorrelated. In this paper it is studied the case in which the correlation coefficient is equal to  $-1$ , but it is possible to generalize the model by assuming any value between  $-1$  and  $+1$ . For example, with a correlation coefficient equal to zero on  $T = 2$  there are four combinations:  $[I^H; I^H]$ ,  $[I^H; I^L]$ ,  $[I^L; I^H]$  and  $[I^L; I^L]$ . Taking into consideration only the most significant cases, with correlation coefficient equal to  $-1$ , is sufficient to find the existence conditions for an “eco-monster”. See Dixit and Pindyck (1994).

<sup>16</sup> The building tax  $\tau$  is paid by the firm on  $T = 3$  only after the investment is completed and it is computed on the completed capital value (revenues), i.e. on the building market price, without taking into consideration the investment costs. In the Italian jurisdiction this tax is analogous to the “property (or land) register tax”.

<sup>17</sup> As usual, the positive profit condition is necessary for the firm to begin the investment.

Since  $Y_1^e(\tau; \Phi_1^H) < Y_0^e(\tau; \Phi_0)$ , if there are high investment costs  $I_1^H$  the firm will choose not to begin the investment at all (Travaglini, 1999), i.e. it will not exercise the call option. In the case of low investment costs  $I_1^L$  then  $Y_1^e(\tau; \Phi_1^L) > Y_0^e(\tau; \Phi_0)$ , such that the firm immediately begins the investment and pays the costs ( $I_1^L$  and  $S$ ), i.e. it will exercise the call option.

On  $T = 2$  the firm observes the final investment costs and the “news” about the completed capital price, such that its profit can be:

$$Y_2^e(\tau; \Phi_2^H) = Y_2^e(\tau; I_1^L; I_2^H) = E_2(\Pi)(1 - \tau) - S - I_1^L - I_2^H = \Pi^L(1 - \tau) - S - I_1^L - I_2^H \quad [5]$$

$$Y_2^e(\tau; \Phi_2^L) = Y_2^e(\tau; I_1^L; I_2^L) = E_2(\Pi)(1 - \tau) - S - I_1^L - I_2^L = \Pi^H(1 - \tau) - S - I_1^L - I_2^L \quad [6]$$

To emphasize the conditions which create an “eco-monster”, it is assumed that with state of nature “bad times” the firm will suffer a loss  $Y_2^e(\tau; \Phi_2^H) < 0$ , such that it is convenient for the firm to exercise the put option, i.e. to abandon the investment, since a future loss would increase the present investment costs. In this case there is an investment salvage value  $D' \geq 0$ , whose value is assumed to be exogenous and null if the incomplete investment is specific, while positive if the investment is unspecific, i.e. totally or partially recoverable (respectively if  $D' = D$  or if  $D' < D$ ). Instead, assuming state of nature “good times”, since  $Y_2^e(\tau; \Phi_2^L) > 0$  then the investment is completed, i.e. the firm does not exercise the put option.

The policy maker’s objective function as a public net balance, is defined as the difference between the expected public revenues (given the instrumental variables  $S$  and  $\tau$ ) and the expected costs (the monetary damage deriving from the negative environmental externalities  $C$  and  $c$ ). Moreover, social preferences (or policy maker’s ideology) are represented through different weights on the “budget variables” (the taxes  $S$  and  $\tau$ ) and the “environmental variables” (the externalities  $C$  and  $c$ ), named respectively  $\alpha > 0$  (preference for the “budget variables”) and  $\beta > 0$  (preference for the “environmental variables”).

The policy maker’s objective function is therefore:

$$W^e = E[\alpha(\tau\Pi + S) - \beta(c + C)] > 0 \quad [7a]$$

This function can also be interpreted as the approximation of a separable and additive social welfare function  $W^e = E[W(\alpha, \beta, \Pi, \tau, S, c, C); \Phi]$  and can be interpreted in terms of a social net monetary benefit. In order to simplify the computation each term is divided by  $\beta$  to obtain:

$$w^e = E[\gamma(\tau\Pi + S) - (c + C)] > 0 \quad [7b]$$

where  $w^e = \frac{W^e}{\beta}$  and  $\gamma = \frac{\alpha}{\beta}$ . Therefore<sup>18</sup>:

- if  $\alpha > \beta$ , then  $\gamma > 1$  and the policy maker attaches more importance to the “budget variables”;
- if  $\alpha < \beta$ , then  $\gamma < 1$  and the policy maker attaches more importance to the “environmental variables”.

<sup>18</sup> As outlined in Section 5 in this model the taxes  $S$  and  $\tau$  are exogenous variables which can be policy instruments, while the variable  $\gamma$  measures the “partisan party effect” on the game equilibrium.

### 3. The Game

The interaction between the agents can be described by the following sequential noncooperative game with four stages (Figure 2), where the policy maker plays a crucial role but the firm is agent who moves first, while Nature moves twice.

On  $T = 0$  the firm has to decide to ask the local policy maker for the building permit: if the permit is not requested or not granted, the agents pay-offs are equal to zero; if the permit is granted then the firm must pay *ex-ante* to the policy maker the exogenous lump sum tax (guarantee deposit)  $S > 0$ .

On  $T = 1$  Nature moves for the first time and the resulting states of nature are “high” or “low” investment costs, while there is no uncertainty on the present capital price,  $\Pi^H$  :

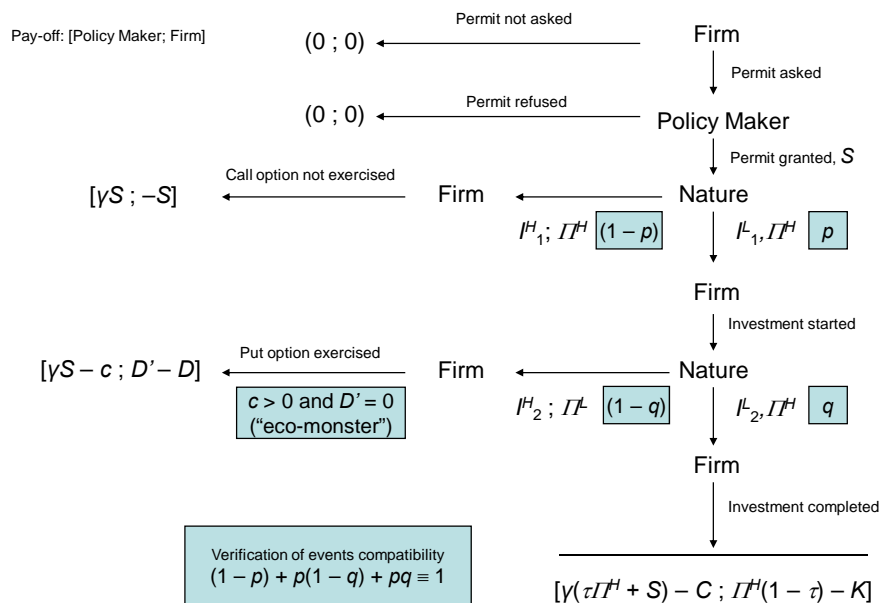
- in the case of low investment costs,  $I_1^L$  with probability  $p$ , the firm begins the investment and pays the corresponding starting costs  $I_1^L$ ;
- in the case of high investment costs,  $I_1^H$  with probability  $(1 - p)$ , the firm does not begin the investment, i.e. it will not exercise the call option, with a pay-off equal to  $-S$ , while the policy maker pay-off is equal to  $\gamma S$ .

On  $T = 2$  Nature moves for the second time and sets the two possible states of nature “bad times” (high investment costs and low expected capital price) and “good times” (with low investment costs and high expected capital price). With respect to  $T = 1$  there is uncertainty also on the capital price because of the assumption of “news” existing only about completed capital price:

- in the case of “good times”, with probability  $q$ , the firm pays the final costs and completes the investment;
- in the case of “bad times”, with probability  $(1 - q)$ , the firm does not complete the investment, i.e. it will exercise the put option, with a pay-off equal to  $(D' - D)$ , while the policy maker pay-off is equal to  $(\gamma S - c)$ .

On  $T = 3$  the capital accumulation is completed and the firm pays the building tax  $\tau$  (exogenous proportional tax) on completed capital value: the firm pay-off is equal to  $[\Pi^H(1 - \tau) - K]$ , while the policy maker pay-off is equal to  $[\gamma(\tau\Pi^H + S) - C]$ .

**Figure 2. The Game.**



The sequential game summarizes every possible parameter value:

- if the investment is undertaken in a deterministic framework with complete information, then  $\Pi^H = \Pi^L$  and  $p = q = 1$ ;
- if the completed investment does not produce externalities with monetary value then  $C = 0$ , while if the investment does then  $C > 0$ ;
- if the incomplete investment is reversible then  $c = 0$ , while if it is irreversible and with a monetary environmental damage then  $c > 0$ ;
- if the investment is unspecific and is completely recoverable then  $(D'-D) = 0$ , while if it is specific then  $(D'-D) < 0$ .

Table 1 shows all the possible combinations between the crucial parameters  $c$  and  $D'$ , including the creation of an “eco-monster”:

**Table 1.** Investments.

	<i>Specific Investment</i>	<i>Unspecific Investment</i>
<i>Reversible Investment</i>	$c = 0; D' = 0$	$c = 0; D' > 0$
<i>Irreversible Investment</i>	$c > 0; D' = 0$ (“eco-monster”)	$c > 0; D' > 0$

In order to find the economic *rationale* behind an “eco-monster”, the game solutions will be shown, i.e. the necessary conditions for the existence of a legal “eco-monster”.

#### 4. The General Solution: Rational “Eco-monsters”

The optimal strategies of the two rational agents, with common knowledge about the sequential game, are:

- in order to begin the game, the firm must have an expected pay-off equal to or greater than zero:

$$Y^e = -S(1-p) + (D'-D)p(1-q) + [\Pi^H(1-\tau) - K]pq \geq 0 \quad [8a]$$

from which (i.e. by solving for  $\Pi^H$ ) the implicit price condition for the firm (*firm's strategy*) is obtained:

$$\Pi_{firm}^H \geq \frac{S(1-p) - (D'-D)p(1-q) + Kpq}{(1-\tau)pq} \quad [9a]$$

- in order to play the game, the policy maker must also have an expected pay-off equal to or greater than zero:

$$\begin{aligned} w^e &= \gamma S(1-p) + (\gamma S - c)p(1-q) + [\gamma(\tau\Pi^H + S) - C]pq \\ &= \gamma S - cp(1-q) + (\gamma\tau\Pi^H - C)pq \geq 0 \end{aligned} \quad [10]$$

from which (i.e. by solving for  $\Pi^H$ ) the implicit price condition for the policy maker (*policy maker's strategy*) is obtained:

$$\Pi_{pm}^H \geq \frac{-\gamma S + cp(1-q) + Cpq}{\gamma \varphi q} \quad [11]$$

Since the final game equilibrium must satisfy the implicit price conditions for both the firm (such that it will request the permit) and the policy maker (such that it will grant the permit), respectively conditions [9a] and [11], the *equilibrium condition* is therefore:

$$\Pi^* \geq \max[\Pi_{firm}^H; \Pi_{pm}^H] \quad [12]$$

Condition [12] can be solved by the substitution of [9a] and [11], in terms of the variable  $S$  in the following way:

$$\Pi_{pm}^H \geq \Pi_{firm}^H \quad \text{iff} \quad S^*(\tau) \geq \frac{cp(1-q)(1-\tau) + Cpq + (D'-D)p(1-q)\gamma\tau}{\gamma(1-\varphi)} \quad [13a]$$

or, in terms of the variable  $\tau$ :

$$\Pi_{pm}^H \geq \Pi_{firm}^H \quad \text{iff} \quad \tau^*(S) \geq \frac{-\gamma S + cp(1-q) + Cpq}{\gamma S + Cp(1-q)(C - \gamma D' + \gamma D) + Kpq} \quad [13b]$$

Condition [12], in the two possible forms [13a] and [13b], is therefore the general condition in terms of expected pay-offs for the game equilibrium. This general condition contains all the significant variables for the solution of the model and therefore it allows to also determine the conditions which create a legal “eco-monster”, in a framework with stochasticity, real options and environmental damages. In fact, for  $c > 0$  and  $D'=0$ , i.e. in the case of irreversible and specific investment, and with probability  $p(1-q)^{19}$  the final outcome of the game will be the creation of a legal “eco-monster”. For  $D'=0$ , conditions [8a], [9a], [13a] and [13b] become:

$$Y^e = -S(1-p) - Dp(1-q) + [\Pi^H(1-\tau) - K]pq \geq 0 \quad [8b]$$

$$\Pi_{firm}^H \geq \frac{S(1-p) - Dp(1-q) + Kpq}{(1-\tau)pq} \quad [9b]$$

$$\Pi_{pm}^H \geq \Pi_{firm}^H \quad \text{iff} \quad S^{**}(\tau) \geq \frac{cp(1-q)(1-\tau) + Cpq - Dp(1-q)\gamma\tau}{\gamma(1-\varphi)} \quad [13c]$$

$$\Pi_{pm}^H \geq \Pi_{firm}^H \quad \text{iff} \quad \tau^{**}(S) \geq \frac{-\gamma S + cp(1-q) + Cpq}{\gamma S + Cp(1-q)(C + \gamma D) + Kpq} \quad [13d]$$

The rational conditions of a legal “eco-monsters” [13c] and [13d] are also subject to an *existence condition* because a non empty set of the parameters  $S$  and  $\tau$  must exist, such that both the policy maker's and the firm's expected pay-offs are equal to or greater than zero, i.e. such that

<sup>19</sup> If a deterministic framework is assumed, the probabilities  $p$  and  $q$  are equal to 1. In this case, it is impossible that an “eco-monster” occurs and there will not be the corresponding environmental monetary damage (i.e.  $c = 0$ ).

conditions [8b] and [10] are verified. These last conditions therefore reveal that the parameters  $S$  and  $\tau$  must be upper and lower bounded in the following ways<sup>20</sup>:

$$0 < \frac{cp(1-q) + (\gamma d \Pi^H - C)pq}{\gamma} < S < \frac{-Dp(1-q) + [\Pi^H(1-\tau) - K]pq}{1-p} \quad [14]$$

$$0 < \frac{-\gamma S + cp(1-q) + Cpq}{\gamma \Pi^H pq} < \tau < \frac{(\Pi^H - K)pq + S(1-p) + Dp(1-q)}{\Pi^H pq} < 1 \quad [15]$$

To summarize, the equilibrium condition [12], in its two possible forms [13a] or [13b], together with the existence conditions [14] and [15] describe the game solution. This general solution implies the conditions for the creation of a rational and legal “eco-monster”:

- 1) if the firm’s investment is irreversible and specific (sufficient condition), then an “eco-monster” will occur, i.e. the variable  $c > 0$  (environmental monetary damage) must appear in at least one of the equilibrium and existence conditions [12], [14], [15] and  $D'=0$  (zero salvage value);
- 2) the creation of an “eco-monster” requires that (necessary condition) the expected completed capital price verifies both conditions [8b] and [10], i.e. a proportional building tax  $\tau^*(S)$  and a lump-sum tax  $S^*(\tau)$  such that  $Y^e \geq 0$  and  $w^e \geq 0$  must exist.

In conclusion it can be argued that the permit approval is automatic (*per se rule*) if the investment costs are certain (deterministic framework) and the completed capital does not produce environmental damages. In all the other cases the permit approval must be discretionary (*rule of reason*)<sup>21</sup>, i.e. the permit will be granted only if the completed capital price is lower bounded (condition [12]) and only if the taxes  $S$  and  $\tau$  are upper and lower bounded (conditions [14] and [15]). Therefore an “eco-monster” will not occur in the following cases: (i) in a deterministic framework, independently from the completed capital externalities  $C \geq 0$ ; (ii) in a stochastic framework limited to the first period, i.e. if there is no uncertainty in the second period and thus the firm has no incentive to exercise the put option (abandon the investment); (iii) if the investment is unspecific or reversible (independently from the completed capital externalities).

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<sup>20</sup> Since  $S > 0$  and  $0 < \tau < 1$  by assumption, it follows that:  $S > 0$  only if  $q > \frac{c}{C - \gamma d \Pi^H}$  (and since  $0 < q < 1$  by definition,

it is necessary that  $C > \gamma d \Pi^H$ );  $0 < \tau < 1$  only if  $p > \frac{\gamma S}{c(1-q)Cq}$  (always true, since  $p > 0$  by definition) and

$p < \frac{-S}{D(1-q) - kq - S}$  (since  $p < 1$  by definition, it is necessary that  $\frac{q}{1-q} > \frac{D}{K}$ ).

<sup>21</sup> This terminology mirrors literature on competition policies, specifically the debate about the two antitrust intervention rules called (i) “*per se rule*”, enforced by the policy maker when the market reaches or overtakes some critical thresholds, and (ii) “*rule of reason*”, which consists in specific interventions examining the situations case by case. In general, the debate is known in the literature as “*rules vs. discretion*” (see Balducci, Candela and Scorcu 2001).

## 5. Comparative Static: some Policy and Partisan Implications

The effects on the game equilibrium of a change, *ceteris paribus*, of the taxes  $S$  or  $\tau$  as possible policy instruments, or of the policy maker's ideology  $\gamma$  (in a "partisan party" framework), can now be computed.

The effects on the implicit price conditions [9b] and [11], respectively for the firm and the policy maker, of a change in the lump sum  $S$  are:

$$\frac{\partial \Pi_{firm}^H}{\partial S} = \frac{1-p}{(1-\tau)pq} > 0 \quad [16]$$

$$\frac{\partial \Pi_{pm}^H}{\partial S} = -\frac{1}{\tau pq} < 0 \quad [17]$$

From [16] it is possible to deduce that an increase in the lump sum tax  $S$  causes an increase in the firm's implicit price  $\Pi_{firm}^H$  which is the necessary condition for the firm to begin the game, i.e. to request the building permit. Instead, from [17] it is possible to deduce that an increase in  $S$  causes a decrease in the policy maker's implicit price  $\Pi_{pm}^H$  which is the necessary condition for the policy maker to play the game, i.e. to grant the building permit. In the case of a decrease of  $S$ , *mutatis mutandis*, the opposite results are obtained.

On the other hand, the effects, on the same implicit price conditions, of a change in the proportional tax  $\tau$  are:

$$\frac{\partial \Pi_{firm}^H}{\partial \tau} = \frac{\Pi_{firm}^H}{1-\tau} > 0 \quad [18]$$

$$\frac{\partial \Pi_{pm}^H}{\partial \tau} = -\frac{\Pi_{pm}^H}{\tau} < 0 \quad [19]$$

From [18] and [19] the same effects from a change in  $S$  are obtained, but with different effectiveness. Furthermore, when  $\Pi_{firm}^H > \Pi_{pm}^H$  only [16] and [18] hold, because they affect the binding constraint, while [17] and [19] do not hold, because they affect the non-binding constraint (and the economic policy is ineffective), *mutatis mutandis* in the opposite case.

Figure 3 shows the effect of an increase/decrease of the agents' implicit price  $\Pi^*$  (only when  $\Pi_{firm}^H > \Pi_{pm}^H$ ) on expected "eco-monsters".

**Figure 3.** Comparative static.

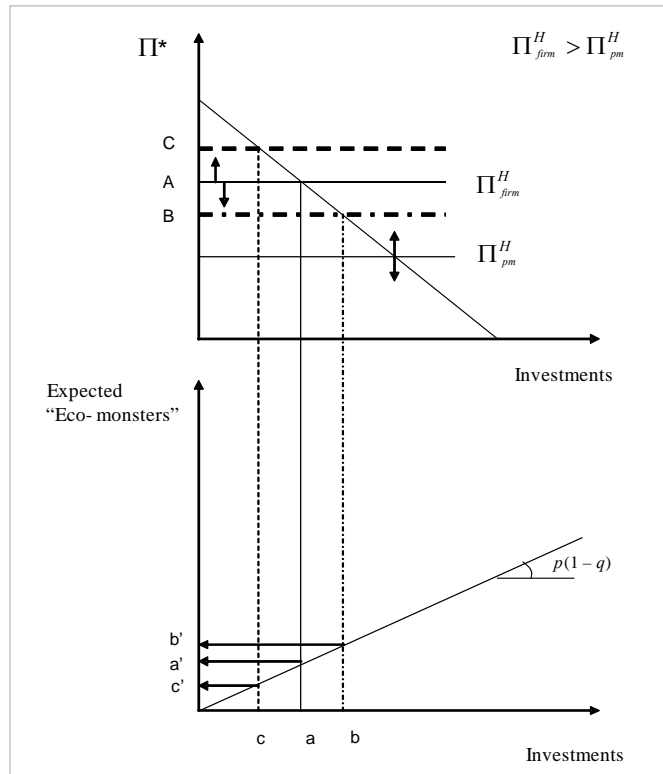


Figure 3 is composed of two graphs. The upper graph depicts the agents' implicit price  $\Pi^*$  ranked in a decreasing way with respect to investment frequency, while the graph below depicts how investment frequency will transform into expected "eco-monsters". A taxes increase causes a shift of the firm's implicit price  $\Pi_{firm}^H$  from the point "A" to point "C", while the approved investments shift from the point "a" to point "c" and, as a consequence, the expected "eco-monsters" shift from point "a" to point "c". *Mutatis mutandis* in the case of a taxes decrease. Obviously, only when  $\Pi_{firm}^H > \Pi_{pm}^H$ , does a shift in the policy maker's implicit price  $\Pi_{pm}^H$  not have any effect (ineffectiveness of the economic policy).

Tables 2 and 3 summarize the corresponding policy implications of an increase (Table 2) or decrease (Table 3) of the taxes.

**Table 2.** Policy implications of a taxes increase.

	$\Delta S > 0$	$\Delta \tau > 0$
$\Pi_{firm}^H > \Pi_{pm}^H$	<i>Virtuous Effect</i> ("eco-monsters" frequency decrease)	<i>Virtuous Effect</i> ("eco-monsters" frequency decrease)
$\Pi_{firm}^H < \Pi_{pm}^H$	<i>Perverse Effect</i> ("eco-monsters" frequency increase)	<i>Perverse Effect</i> ("eco-monsters" frequency increase)

**Table 3.** Policy implications of a taxes decrease.

	$\Delta S < 0$	$\Delta \tau < 0$
$\Pi_{firm}^H > \Pi_{pm}^H$	<i>Perverse Effect</i> (“eco-monsters” frequency increase)	<i>Perverse Effect</i> (“eco-monsters” frequency increase)
$\Pi_{firm}^H < \Pi_{pm}^H$	<i>Virtuous Effect</i> (“eco-monsters” frequency decrease)	<i>Virtuous Effect</i> (“eco-monsters” frequency decrease)

The effects on implicit price conditions [9b] and [11], respectively for the firm and the policy maker, with a change in policy maker ideology  $\gamma$  are:

$$\frac{\partial \Pi_{firm}^H}{\partial \gamma} = 0 \quad [20]$$

$$\frac{\partial \Pi_{pm}^H}{\partial \gamma} = -\frac{\gamma S + \Pi_{pm}^H \tau p q}{\gamma \tau p q} < 0 \quad [21]$$

From [20] it is possible to deduce that any change in the policy maker’s ideology does not affect the firm’s implicit price  $\Pi_{firm}^H$ , while from [21] it is possible to deduce that an increase in the importance attached by the policy maker to the “budget variables” causes a decrease in the policy maker’s implicit price  $\Pi_{pm}^H$  which is the necessary condition for the policy maker to play the game, i.e. to grant the building permit. Obviously, when there is a decrease in  $\gamma$ , *mutatis mutandis*, the opposite effect on the policy maker’s implicit price  $\Pi_{pm}^H$  is obtained. Table 4 summarizes the corresponding partisan party effects.

**Table 4.** Partisan party effects.

	$\Delta \gamma > 0$	$\Delta \gamma < 0$
$\Pi_{firm}^H > \Pi_{pm}^H$	<i>No effect</i>	<i>No effect</i>
$\Pi_{firm}^H < \Pi_{pm}^H$	<i>Perverse effect</i> (“eco-monsters” frequency increase)	<i>Virtuous effect</i> (“eco-monsters” frequency decrease)

From conditions [13c] and [13d] as well as from [18] and [19] partial derivatives, it is possible to note that the *virtuous* and *perverse effects* are greater, *cæteris paribus*, with higher levels of taxes  $S$  and  $\tau$ , i.e. the partisan party effect is more significant when the public policy’s magnitude is relevant.

## 6. Conclusions

A non-zero-sum noncooperative game in a stochastic framework, with real options and environmental externalities, was modeled. The game solution implies a double failure: (i) a market failure, when the firm interrupts and abandons the investment, and (ii) a public failure, when the policy maker can not avoid the creation of “eco-monsters”. The result of this double failure is the creation of “eco-monsters” as the bizarre, but legal, outcome of the rational choices of two agents, a firm and a policy maker.

An “eco-monster” will therefore occur if the following conditions jointly take place: tourism investments under uncertainty, specific and irreversible investments, completed capital prices relatively high (since lower bounded) and building taxes upper and lower bounded.

This simple model allows some policy implications to be drawn. The policies can be of particular relevance for environmental protection and for tourism destinations, where the natural resources are an important input. First of all, the model allows a choice of building taxes ( $S$  and  $\tau$ ) as instrumental variables, in order to monitor the “eco-monsters” frequency (see Tables 2 and 3):

- when the firm’s incentive to begin the game is greater than the policy maker’s incentive to play the game ( $\Pi_{firm}^H > \Pi_{pm}^H$ ), increasing taxes the “eco-monsters” frequency decreases and the economic policy’s effects are virtuous;
- but when ( $\Pi_{firm}^H < \Pi_{pm}^H$ ), increasing taxes the “eco-monsters” frequency increases and the economic policy’s effects are perverse.

In the case of a decrease of  $S$  or  $\tau$ , *mutatis mutandis*, the opposite results are obtained. The taxes also allow a differentiated policy in order to give incentives to only some tourism investments: when ( $\Pi_{firm}^H > \Pi_{pm}^H$ ) the policy maker can affix a low value to the building taxes  $S$  and  $\tau$  for unspecific and reversible investments, and a high value of  $S$  and  $\tau$  for specific and irreversible investments. Recalling the examples in the Introduction, the policy maker can levy a low tax on a golf course or a park plan (since they are reversible investments) or on a tourism village without permanent facilities (since it is an unspecific investment), with the goal of favoring them. At the same time, the policy maker can heavily tax a hotel or an artificial harbor in order to discourage them because they are both specific and irreversible investments.

The model also allows for the evaluation of the effects of the policy maker’s ideology  $\gamma$  on the “eco-monsters” frequency (see Table 4): since  $\gamma$  does not affect the firm’s implicit price  $\Pi_{firm}^H$ , when the policy maker’s incentive to begin the game is greater than the firm’s incentive to play the game ( $\Pi_{firm}^H < \Pi_{pm}^H$ ) then an increase in the importance attached by the policy maker to the “budget variables” causes an increase in the frequency of “eco-monsters”.

Future extensions of this model could be: (i) continuous variables, which allow different solutions about the optimal investment (e.g. the hotel size in terms of rooms); (ii) social welfare functions taking into account the economic development induced by the completed investments; (iii) non linear objective functions; (iv) financing constraints for the firm; (v) a third agent which intermediates between the other agents, like bureaucracy.

Furthermore, an alternative economic policy could be the introduction of Pigou taxes, i.e. taxes lying on the environmental externalities ( $c$  or  $C$ ); the optimal level of Pigou taxes can be then obtained through the maximization of the policy maker’s objective function subject to non-zero firm’s profit<sup>22</sup>. Moreover it can be assumed that the building permit is tradable, i.e. the firm can sell the permit itself to another agent before its expiration date and the real option would have a market price. Finally, different assumptions can be made about the interdependence between inputs and

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<sup>22</sup> Nevertheless if the objective function is a linear function, like in our model, the solution of that problem is trivial because the linear programming technique would yield a corner solution.

outputs markets or about the functional form of investment costs and capital price (e.g. introducing continuous time and a dynamic investment adjustment process).

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