Competing for Endogenous Information in an Irreversible Environmental Resource Problem: a Game-theoretic Analysis

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Abstract The paper analyzes strategic behavior in a two-stage environmental choice problem under different information scenarios. Given uncertainty about environmental cost and irreversibility of development, “learning without destroying” emerges from strategic competition when information is endogenous and publicly available. This happens since agents trade off the higher payoff of being the first-mover against the potentially free acquisition of endogenous information without developing their own environmental endowment. We prove that in a 2X2 dynamic environmental game with payoff uncertainty and irreversibility publicly available endogenous information could lead players to destroy less in aggregate terms with respect to the case in which information is exogenous.

JEL references: C72; D81; Q32.

Key Words: Public Endogenous Information; Irreversibility; Testing Value.

1. Introduction

The issue of irreversibility and uncertainty in environmental decisions has been studied extensively over the last three decades. Starting with the first definition of the Quasi-Option Value by Arrow and Fisher (1974), the key concepts of this field have been developed and refined in several articles. Arrow and Fisher’s (1974) idea of the quasi-option value was originally tied to the optimal level of development of natural resources. The concept emerged from a two-period model of choice (develop or preserve), where development is irreversible and the expected net benefits of preservation in the future periods are conditional upon the choice in the original period. Fisher and Hanemann (1987) use a similar theoretical framework as Arrow and Fisher (1974). The main assumptions are the risk neutrality of the Decision Maker (henceforth DM), irreversibility of the action “development”, uncertainty about future profits and costs (of development and preservation) and independent learning (exogenous

information): the DM can receive new information about the future economic profits and the environmental costs of his action only by letting time pass; the acquisition of information about profits and costs in the second period is thus independent from the choice made in the first period, i.e. it is exogenous. Almost all other theoretical papers in the environmental literature analyzing decision problems share these basic features. Each of them mainly identifies the quasi-option value in different environmental problems and studies its role in increasing the level of environmental preservation.

Following the intuition of Epstein (1980) and Miller and Lad (1984), Attanasi and Montesano (2006) depart from Arrow and Fisher’s model by introducing a second type of option value - the Testing Value - to the analysis. The testing value emerges in all those situations in which the level of information concerning future economic profits of development and/or its future environmental costs depends on the level of development carried out by the DM, i.e. the possibility of acquiring new information is endogenous. Assuming that the DM’s choice set is continuous, uncertainty can be solved by developing a percentage between 0% and 100% of the environmental resource, given that the level of information obtained is inversely related to the level of preservation of the environmental resource. Attanasi and Montesano (2006) show that the inclusion of the testing value in the Arrow and Fisher’s (1974) two-period model of choice generally pushes the DM towards a higher level of preservation of the environmental resource with respect to the case in which information is only exogenous. This is the case since endogenous information leads the DM to develop only a certain amount of the environmental asset in the current period (internal solutions). On the contrary, exogenous information frequently leads to corner solutions in the current period (preserve everything or destroy everything). However, if the choice set is dichotomous, the irreversibility makes the information obtained through development irrelevant.

In this paper we extend the basic idea of Attanasi and Montesano (2006) to interactive strategic settings. We show that in such settings endogenous information can play a role in leading players to preserve their own environmental asset even in the case each player’s set of possible actions is restricted to preserve or destroy the entire environmental resource. The tendency to preserve in the current period occurs when endogenous information, once revealed, is publicly available, so that a player can obtain endogenous information even preserving his own resources, on condition that his opponent chooses to develop.\footnote{As an example, consider the case of two tropical islands. They are very similar from a morphological point of view and the distance between them is only a few miles. Thus, both of them can constantly observe the consequences of the environmental and economic choices of their neighbor. Suppose that one of them undergoes some kind of touristic development, while the other chooses to preserve its original environmental features. Suppose also that after some years the former island realizes at its own expenses (hence endogenously) that, as a consequence of the touristic development, has lost a significant share of its natural value. The latter observes the other island’s environmental cost linked to the undertaken development and thereby chooses to continue to preserve its environmental endowment.} The main aim of this
paper is to analyze the role that publicly available endogenous information could have on environmental preservation. More specifically, we want to state a precise set of conditions under which, in a 2X2 dynamic environmental game with payoff uncertainty and irreversibility, publicly available endogenous information could lead players to destroy less with respect to the case in which information is exogenous. The underlying idea is that the possibility of publicly available endogenous information leads one of the two players to preserve its own environmental resource in the first period, while, if information is exogenous, both players can choose to fully exploit their environmental resources in the first period.

In the next section, we introduce a game-theoretic framework to formally describe and analyze environmental strategic situations where uncertainty and irreversibility play a relevant role. In Section 3, we analyze players’ optimal behavior under different information scenarios. Section 4 provides an economic interpretation to our theoretical results and concludes.

2. The Model

There are two players \( i = A, B \) holding a similar environmental resource. They have to decide simultaneously if to preserve (entirely) or destroy (entirely) their own environmental resource in each of two periods of choice \( (t = 1, 2) \). Benefits from the resource development in each period are common knowledge among players: if only one player chooses to develop his own environmental resource in \( t \), his current profit from development is \( x > 0 \) (and the current profit from development of his co-player is obviously \( 0 \)); if instead both players choose to develop in \( t \), each of them obtains an individual current profit from development equal to \( y \in (0, x) \). We call \( x \) the one-side development profit and \( y \) the two-side development profit.

The irreversibility assumption implies that the set of possible actions in \( t = 2 \) conditional on having chosen to develop in \( t = 1 \) is represented by the singleton \( \{ \text{Develop} \} \). Hence, if only one player chooses to develop in \( t = 1 \), his total profit from development is \( 2x \) in case the other player will continue to preserve in \( t = 2 \) and \( x + y \) in case the other player will choose to develop in \( t = 2 \). Moreover, if both players choose to develop in \( t = 1 \), each of them obtains a total profit from development equal to \( 2y \).

Suppose also that the environmental costs of developing one’s own resource are uncertain in each period of choice, i.e. they are represented by a random variable \( \tilde{c} = (c_l, p_l; c_h, 1 - p_l) \), with \( c_l < c_h \) (\( l = \text{low}, h = \text{high} \)). The environmental costs stem from development, which is an irreversible process. Therefore, if a player decides to develop his own environmental resource in period \( t \), he will be affected by the environmental costs both in \( t \) and in the following period (if some). We assume that the realized value of the environmental costs is the same in each of

\[ c^A_j = c^B_j = c_j \quad \forall j = l, h. \]
the two periods. Therefore, if a player develops his own resource in $t = 1$, he will undergo a total environmental cost of $2c_j$, with $j = l, h$; if he preserves his own environmental resource in $t = 1$ and develops it in $t = 2$, he will undergo a total environmental cost of $c_j$.

3. Optimal behavior under different information settings

When concentrating on the possible resolution of uncertainty (about the environmental costs) after $t = 1$, we specify four different information scenarios.

In the first one, (additional) information is not available (and it is common knowledge that it will be not available) at the end of $t = 1$, in sufficient time to be incorporated into the second period’s choice.

In the second scenario, (only) exogenous information about the environmental costs of development is available (and it is common knowledge that will be available) with a given probability $q \in (0, 1]$ at the end of $t = 1$, in sufficient time to be incorporated into the second period’s choice. Since the two environmental resources are similar, the two players receive at the end of $t = 1$ the same kind and amount of exogenous information, i.e. they both know the same realized value of $\tilde{c}$ with the same probability $q$ at the end of $t = 1$.

In the third and in the fourth scenarios, information about the environmental costs of development is (only) endogenous, i.e. a player knows the realized value of $\tilde{c}$ at the end of $t = 1$ if he decides to develop his own resources in that period. In the third scenario endogenous information is private, so the only way for a player to know the realized value of the environmental cost at the end of $t = 1$ is to choose to develop his own resources in that period. That means that every time he decides to receive (endogenous) information at the end of $t = 1$ he knows he cannot “choose” again in $t = 2$, because of the irreversibility of development. In the fourth scenario, instead, endogenous information, once coming out, is publicly available, so a player could know the realized value of the environmental cost even preserving his own resources, if his opponent chooses to develop the one he holds. Therefore, in the last information scenario there are two ways through which one can obtain information at the end of $t = 1$ about the (present and future) environmental costs of development: by either developing one’s own resource in $t = 1$ or “waiting” that the co-player develops her own in $t = 1$. In the latter case, one can choose between preservation and development in $t = 2$ after knowing the realized value of the environmental cost.

In the next subsections we analyze the 2-period environmental dynamic game under the different information scenarios described above. Each information scenario leads to a different

\footnote{Notice that the strategic setting described above cannot be represented as a symmetric 2-period repeated game between two risk-neutral players, where the constituent game is simultaneous. Because of irreversibility, every time a player chooses Develop in $t = 1$, his set of possible actions in $t = 2$ is “restricted” to \{Develop\}, in that way being different from the set of possible actions in $t = 1$. Therefore, the game is not “repeated” in...}
dynamic game (with imperfect information), with a specific set of terminal histories. We find the set of Subgame Perfect Nash Equilibria (henceforth SPNE) of the four dynamic games. Then we’ll make a comparison among them, along the dimension of the parameters of the environmental problem.

3.1 No Information

The environmental dynamic game under the “no information” scenario is described in Figure 1. At the end of \( t = 1 \), no information is revealed (neither exogenously nor endogenously), hence no player knows the realized value of the environmental cost before the end of the game.

Players’ optimal behavior in \( t = 2 \) (and so also in \( t = 1 \)) depends on the expected value of the environmental cost, \( EV(\tilde{c}) \).

When it is low, i.e. \( EV(\tilde{c}) \in (0, y) \), development is a dominant action for both players in \( t = 2 \) (in the subgames in which they are still allowed to choose). Since the simultaneous interaction in \( t = 1 \) has the same payoff structure of the one played in \( t = 2 \), going backward, both players develop also in \( t = 1 \). Hence, in the unique SPNE, both players develop \( \forall t = 1, 2 \).

For the interested reader, details of the calculation of each SPNE in the four different information scenarios can be found at http://www.giuseppeattanasi.com/appendix.pdf.
When the expected value of the environmental cost is high, i.e. $EV(\tilde{c}) \in (x, +\infty)$, preservation is a dominant action for both players in $t = 2$ (in the subgames in which they are still allowed to choose). Therefore, each of them preserves his own environmental resource in $t = 2$ if he has preserved it in $t = 1$. Since the simultaneous interaction in $t = 1$ has the same payoff structure of the one played in $t = 2$, going backward, they both preserve also in $t = 1$. Hence, in the unique $SPNE$, both players preserve $\forall t = 1, 2$.

When the expected value of the environmental cost is between the one-side and the two-side development profit, i.e. $EV(\tilde{c}) \in (y, x)$, there are not dominant actions in each of the proper subgames of the decision tree. In particular, in each subgame reached after only one of the two players has developed in $t = 1$, the other player continues to preserve, because the two-side development profit is lower than $EV(\tilde{c})$. For the same reason, in each subgame reached after both players have preserved in $t = 1$, only one of them turns into development. Going backward to $t = 1$, we realize that there are several $SPNE$, both in pure and in mixed strategies. Nonetheless, in each of them there is one player preserving his own resources in both periods and the other developing his own in $t = 1$ (and so also in $t = 2$).

### 3.2 Exogenous Information

In the exogenous information scenario, at the end of the first period, with probability $q \in (0, 1]$, players find out the realized value of the environmental cost in both periods of choice, independently of the action profile played in $t = 1$. Hence exogenous information arrival is not “certain”: it is revealed with a given probability, which is common knowledge among players. We graphically represent this situation in Figure 2, by supposing that after $t = 1$ there are two consecutive moves of “Nature”\(^6\). The first move determines whether information is revealed or not. If information is revealed, there is a second move of $Nature$, indicating to both players the realized value of the environmental cost. Therefore, for each action profile in $t = 1$ there are two proper subgames. In the first one, players interact without knowing the true state of the world ($Nature$ plays only once); in the second one, $Nature$ moves first by indicating the true state of the world. After this move, we have other two subgames: in each of them both players know the realized value of $\tilde{c}$. In each of the subgames where no new information is revealed, players’ optimal behavior is similar to that under the “no information scenario”. In each of the subgames following the revelation of new information, players’ choice depends on

\(^6\)In the decision tree in Figure 2, players’ choices are represented by squares, while nature moves are represented by circles.
the realized value of the environmental cost, which they can observe before choosing in \( t = 2 \).
Several SPNE (in both pure and mixed strategies) exist. We report only the subcases that differ with respect to the “no information” scenario in terms of players’ behavior in $t = 1$. When $EV(\bar{c}) \in (0, y)$ and $c_h \in (y, x)$, it is possible that, for low values of $p_l$, i.e. $p_l \in \left[0, \frac{(1+q)(c_l-y)}{(1+q)c_h-qy-c_l}\right]$, at least one player preserves his own resources in $t = 1$, while under the “no information” scenario both players would develop in $t = 1$. This is reasonable: now players have the possibility to observe (without any effort) the realized value of the environmental cost before choosing in $t = 2$. Hence, even though the expected value of the environmental cost is very low, they prefer preserving in $t = 1$, because the “bad” state of the world is highly likely and the environmental cost in that case would be quite large, since it is higher than the two-side development profit.

When $EV(\bar{c}) \in (y, x)$, $c_l \in (0, y)$ and $c_h \in (x, +\infty)$, it is possible that, for low values of $p_l$, i.e. $p_l \in \left[0, \frac{2(c_h-x)}{2c_h-qx-(2-q)c_l}\right]$, both players preserve their own resources in $t = 1$, while under the “no information” scenario only one player would preserve in $t = 1$. This is again reasonable: even though the low environmental cost is even lower than the one-side development profit, it is really unlikely to realize. The high environmental cost, which in this case is even higher than the one-side development profit, is instead highly likely. Hence, both players prefer “waiting” in $t = 1$, in order to know the realized value of the environmental cost before $t = 2$. Then, in case exogenous information arrives before that period, they would both preserve when they observe that the realized value is $c_h$ and they would both develop otherwise.

### 3.3 Endogenous “Private” Information

Similarly to the previous case, it is not possible to represent the strategic setting as a 2-period repeated game. This is so not only because of irreversibility, but also because the payoffs of the simultaneous game in $t = 2$ are endogenous due to their dependence on the choices made by the two players in $t = 1$. In particular, looking at Figure 3, since endogenous information is available to a player only if he chooses to develop in $t = 1$, there will be asymmetric information in two of the four proper subgames of the dynamic game, i.e. in those where one player has developed in $t = 1$ and the other has preserved in $t = 1$. These are the only proper subgames in which players’ strategic situation is different from the “no information” scenario. However, due to the irreversibility assumption, in these two subgames the player who has developed in $t = 1$ cannot “exploit” the additional information about $\bar{c}$ in order to make a better choice with respect to the “no information” scenario. The other player (the one who has preserved in $t = 1$) has in $t = 2$ the same information he had in $t = 1$, hence he acts

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*Ceteris paribus, when $c_h$ is also higher than the one-side development profit $x$, then it is also possible that for very low values of $p_l$, i.e. $p_l \in \left[0, \frac{(1+q)(c_h-x)}{(1+q)c_h-qx-c_l}\right]$, both players preserve their own resource in $t = 1$. "\(n\)" indicates that the subgame is not a proper subgame of the dynamic game."
as in the “no information” scenario. Therefore, players’ optimal behavior under the “private endogenous information” scenario is similar to that under the “no information” one.

**Figure 3. The dynamic environmental game with Private Endogenous Information**

### 3.4 Endogenous “Public” Information

Once again, we cannot represent the strategic setting as a 2-period repeated game, because the payoff profiles in $t = 2$ are endogenous. As it can be seen in *Figure 4*, in case at least one player chooses to develop in $t = 1$, since (endogenous) information is publicly available, it will be symmetric in $t = 2$: both players choose knowing the realized value of $\tilde{c}$ in all proper subgames, apart from the one coming after both players have preserved in $t = 1$. Therefore, in that subgame the strategic situation is similar to that in the “no information” scenario. Because of irreversibility, also in the subgame coming after both players have developed in $t = 1$ the optimal behavior cannot differ with respect to the “no information” scenario.
Instead, in the two proper subgames coming after only one of the two player has developed in $t = 1$, since endogenous information is public, the strategic situation is similar to that under the exogenous information scenario with $q = 1$ (even though payoffs are different). Again, several $SPNE$ (in both pure and mixed strategies) arise. In the next subsection, we analyze only the subcases which differ, in terms of players’ behavior in $t = 1$, with respect to both the “no information” and the “exogenous information” scenario.

Figure 4. The dynamic environmental game with Public Endogenous Information

### 3.5 Comparison among different information scenarios

Let us start by comparing players’ optimal behavior under public endogenous information to that in the “no information” (and so also “private endogenous information”) scenario. When the expected value of the environmental cost is low, i.e. $EV(\tilde{c}) \in (0, y)$ and $c_h$ is at least
greater than \( y \), it is possible that, for low values of \( p_l \), i.e. \( p_l \in \left( 0, \frac{2(c_h - y)}{y - c_l} \right) \), one of the two players chooses to preserve his own resources in \( t = 1 \), while under the “no information” scenario both players would develop in \( t = 1 \). This happens because the player who chooses to preserve in \( t = 1 \) prefers receiving the costless information, when he holds the conjecture that his opponent would develop in \( t = 1 \). In that way, the former can choose in \( t = 2 \) after having learned the realized value of the environmental cost. The latter instead plays on the first-mover advantage, which is able to compensate the potential environmental costs in both periods: the worst it could happen to him is that \( \tilde{c} = c_h \), but in this case he is sure that his total development profit will be \( 2x \), because the other player, having publicly known that \( \tilde{c} = c_h \), does not develop in \( t = 2 \). Moreover, when \( EV(\tilde{c}) \in (y, x) \), \( c_l \in (0, y) \) and \( c_h \in (x, +\infty) \), it is possible that, for low values of \( p_l \), i.e. \( p_l \in \left( 0, \frac{2(c_h - x)}{2c_h - x + y - 2c_l} \right) \), both players preserve their own resources in \( t = 1 \), while under the “no information” scenario only one of them would preserve in \( t = 1 \).

Let us now compare players’ optimal behavior under public endogenous information to those under exogenous information. One could reasonably expect that, when information is exogenous, since it is not necessary to develop in order to learn, both players would always preserve more with respect to the case in which information is endogenous (and publicly available). What happens instead in our framework is that, for specific values of the size and likelihood of the environmental cost, the aggregate preservation level is higher under public endogenous information than under the exogenous one. More precisely, when the expected value of the environmental cost is low (\( EV(\tilde{c}) \in (0, y) \)) but \( c_h \) is quite high (at least greater than \( y \)) and highly likely, i.e. \( p_l \in \left( \frac{(1+q)(c_h - y)}{1+q(c_h - y) - y - c_l}; \frac{2(c_h - y)}{2c_h - y + c_l} \right) \), we find a unique \( SPNE \) under the exogenous information scenario, where both players develop in \( t = 1 \) (and so also in \( t = 2 \)), while, when information is endogenous and publicly available, in the unique \( SPNE \) only one player develops in \( t = 1 \) and the other preserves in \( t = 1 \) (he develops in \( t = 2 \) only if the realized value of environmental cost is \( c_l \)). This result holds \( \forall q \in (0, 1) \), hence even in case the probability of exogenously receiving new information after \( t = 1 \) is very high. As \( q \) increases, however, the interval of \( p_l \) values for which “public” endogenous information leads to a more “conservative” equilibrium (with respect to exogenous information) does restrict from the left hand side. Let us compare the optimal expected payoff of the two players under the two information scenarios in this subcase. For player \( i \), preserving in \( t = 1 \) under the public endogenous information scenario and developing in \( t = 1 \) under the exogenous information one, we have \( EU_{i|P_{\text{Public Endo}}} = p_l(y - c_l) > 2(y - EV(\tilde{c})) = EU_{i|N_{\text{no Info}}} \) for player \( -i \), who develops in \( t = 1 \) under both information scenarios, we have \( EU_{-i|P_{\text{Public Endo}}} = p_l(x + y - 2c_l) + 2(1 - p_l)c_h > 2(y - EV(\tilde{c})) = EU_{-i|N_{\text{no Info}}} \), where \( i = A, B \) and \( -i = N\setminus i \), with \( N = \{ A, B \} \). Hence, both

\[ \text{However, the constraint that arises from the condition } EV(\tilde{c}) \in (0, y), \text{ i.e. } p_l(c_h - c_l) > c_h - y, \text{ does not restrict the interval of } p_l \text{ values for which the result above holds.} \]
players obtain a higher payoff in the public endogenous information case.

According to Attanasi and Montesano (2006), this increase in players’ optimal payoff measures the *Testing Value* (henceforth *TV*), i.e. the additional gain that a DM obtains when he can receive information regarding future benefits, by developing in the current period (with respect to the case in which he ignores the possibility of receiving information in this way). The *TV* has to be interpreted as the *additional value attached to endogenous information*. Therefore it can be calculated as the difference between the expected benefits in case of *certain* endogenous information and the expected benefits in the “no information” scenario. Notice that in the particular subcase we are analyzing the expected benefits in the no information scenario are equal to those in the exogenous information case. This allows us to interpret the *TV* in this subcase as the value of public endogenous information additional with respect to information exogenously arriving. Given the way in which we identified player *i* and −*i* when we calculated the optimal expected payoff of the two players, we obtain \[ TV_i = 2(1 - p_i)(c_h - y) + p_i(x - c_i) + p_i c_i > 0 \] and \[ TV_{-i} = 2(1 - p_i)(c_h - y) + p_i(x - c_i) + 2(1 - p_i)c_h - p_i y > TV_i. \]

By definition, *TV* is always nonnegative: it is positive when the preservation level is higher with endogenous information with respect to the “no information” (or exogenous information) case; it is null when the preservation level under the two information scenarios is the same; it would be negative if a player would preserve more under the no information scenario with respect to the endogenous one: Attanasi and Montesano (2006), analyzing a similar environmental problem, prove that this cannot happen for any set of parameters. They also prove that when |\(N\)| = 1 and the choice set of the DM is discrete and dichotomous, the *TV* is always null. Nonetheless, they prove that *TV* has to be null for a DM who makes the same choice under the two different information scenarios, when this choice is to develop entirely the environmental resource.

However, in the subcase considered the *TV* is positive for both players and higher for the player who decided to develop in the current period with respect to the one who decided to preserve: the increase in the optimal payoff passing from the “exogenous information” to the “public endogenous information” case is higher for the player who chooses to develop in both periods under both information scenarios. The explanation of the two seemingly counterintuitive results is the following: the *TV* has been defined by Attanasi and Montesano (2006) in a decision theoretic environment, hence without considering interactive strategic situations; by construction, in their model they do not contemplate the possibility that endogenous infor-

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9 Attanasi and Montesano (2006) show that *TV* could be calculated in two ways:
- as an *additional* value of endogenous to exogenous information;
- as a value emerging in the particular information context in which only endogenous information is available.

They prove that in case the utility function is linear (and in our case it is), the two definitions of the *TV* coincide.
mation could be costlessly “transferred” to another player once acquired. This transmission could prevent the “receiving” player from developing in $t = 1$, thus “leaving” the other with the (higher) one-side development profit in the same period.

4. Conclusions

In this paper we have studied the role of publicly available endogenous information in motivating risk neutral decision makers towards preservation of their own environmental resource in an interactive strategic setting. More specifically, we have analyzed strategic behavior in a two-stage environmental choice problem with uncertainty about the environmental cost and irreversibility of development. In order to correctly understand the effects of the possible resolution of uncertainty (about the environmental cost) after $t = 1$ on players’ economic and environmental choices, we have specified four different information scenarios. In two of them, we assigned a specific role to information endogenously acquired.

First of all, we have shown that endogenous information, if only privately available to the player choosing to develop his own resources in the current period, has no effects in terms of players’ behavior with respect to the standard case where no new information is disclosed between the two choice periods. This is because the player who endogenously obtains information, once developed in $t = 1$, cannot “exploit” this new information in $t = 2$, because he is constrained to develop also in $t = 2$.

When instead endogenous information is publicly available (i.e. both players receive new information if at least one of them has chosen to develop in $t = 1$) “learning without destroying” emerges from strategic competition. This happens since agents trade off the higher payoff of being the first-mover against the potentially free acquisition of endogenous information without developing their own environmental endowment.

When the environmental cost is highly likely but its expected value is low, one player chooses to preserve his own resources in the current period under the “public endogenous information” scenario, while under the “no information” scenario (and so also under the

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10 For example, in our framework, the TV coming from private endogenous information is always equal to 0, since for both players the optimal “preservation level” under this information scenario is always equal to the one obtained when information is not available.

11 There is another subcase in which the aggregate level of preservation in $t = 1$ under the public endogenous information scenario is higher than that under the exogenous information one. When $\text{EV}(\tilde{c}) \in (y, x)$, $c_l \in (0, y)$, $c_h \in (x, +\infty)$ and $p_l \in \left(\frac{2(c_h - x)}{2c_h - y}, \frac{2(c_h - x)}{2c_h - x + y - 2c_l}\right)$, with $q \in \left(0, \frac{x-y}{x-c_l}\right)$, both players preserve in $t = 1$ when information is endogenously available, while only one of them preserves in $t = 1$ when information is exogenous. Again a positive TV emerges for both players. The economic intuition is the following: when the environmental cost is highly likely and its expected value is high, the fear of revealing new information endogenously to the opponent prevents both players from developing in $t = 1$. When instead information is exogenous but the probability that it will be disclosed is low, one of the two players decides to develop in $t = 1$, by playing on the first-mover advantage, thus loosing the flexibility of his decision in $t = 2$.
“private endogenous” one) both players would develop in \( t = 1 \). Moreover, under the same conditions on the size and likelihood of the environmental cost, both players would develop in the current period also under the “exogenous information scenario”. That means we have found a set of conditions under which publicly available endogenous information leads players to destroy less (in aggregate terms) with respect to the case in which information is exogenous. Under these conditions, one of the two players develops in the current period and the other chooses to preserve, thus receiving the new costless information, thanks to his opponent’s choice. In that way, the latter can choose in \( t = 2 \) having learned the realized value of the environmental cost. The former instead plays on the first-mover advantage, which is able to compensate the potential environmental cost in both periods of choice. In that case, given that public endogenous information is “economically convenient”, the increase in the optimal payoff passing from the “exogenous information” to the “public endogenous information” scenario is higher for the player who chooses to develop in the current period under both information scenarios. This increase is precisely measured for both players by the Testing Value, i.e. the conditional value attached to endogenous information, additional with respect to the information exogenously arriving.

References


