Why Firms Invest in Natural Capital: Private Incentives and the Role of Public Conservation

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Abstract

Firms exploit natural capital, but they also have incentives to preserve it. We develop a theory in which natural capital is a productive asset that firms invest in to sustain future production while also generating welfare beyond the marketplace. The model predicts that private conservation emerges endogenously but remains below the social optimum because firms cannot appropriate the full value of biodiversity. Public conservation therefore complements private incentives rather than replacing them, increasing long-run growth at the expense of current consumption. We provide evidence consistent with these predictions using region-level data on forest biodiversity from 582 regions in 44 countries.

JEL classification: N5, O4, Q5.

Keywords: Natural capital, biodiversity, private incentives, public policy, endogenous growth

*Andrej Ceglar: European Central Bank. Ivan Jaccard: European Central Bank. Miles Parker: European Central Bank. Alexander Popov: European Central Bank, CERGE-EI, and CEPR. Francesca Zucchi: European Central Bank and CEPR. This article is dedicated to the memory of Ivan Jaccard. We thank Ghasanne Benmir, Gabriel Chodorow-Reich, Michael Ehrmann, Michaela Elfsbacka-Schmoeller, Philipp Hartmann, Peter Karadi, Luc Laeven, Justus Meyer, Kalin Nikolov, Isabel Schnabel, Romano Tarsia, and seminar participants at the ECB for valuable comments. The opinions expressed herein are those of the authors and do not necessarily reflect those of the ECB or the Eurosystem.

1 Introduction

Human activity has transformed natural ecosystems for millennia, yet natural capital has not disappeared. This presents a puzzle. On the one hand, researchers in both the natural and the social sciences document a steep decline in biodiversity since the 1970s (e.g. Dasgupta, 2024; Ceglar et al., 2023; Flammer et al., 2025). Soil biodiversity differs markedly across regions of the world, with particularly low levels in much of the industrialized world (Tahat et al., 2020), while historical evidence indicates that biodiversity loss long predates the Anthropocene, with 85% of wetlands disappearing between 1700 and 2000 (Ceglar et al., 2023). On the other hand, natural ecosystems continue to support production and human welfare on a vast scale.

This apparent contradiction is not unique to the modern economy. Humans have altered and exploited nature for tens of thousands of years. Approximately 80% of the megafauna disappeared following the spread of Homo sapiens across the Americas more than 10,000 years ago, and Europe's primeval forests had already been extensively cleared for construction and energy long before the Industrial Revolution (Harari, 2015). Indeed, one fifth of temperate Europe's forest-cover loss occurred before the late Bronze Age (Roberts et al., 2018). Yet despite this long history of exploitation, natural capital has persisted as an essential input into economic activity.

These observations suggest that the relationship between economic activity and nature is more nuanced than a simple narrative of progressive depletion. While biodiversity has declined substantially over time, several regions—including parts of Europe, North America, and East Asia—have recently experienced net increases in forest area as regrowth has outpaced deforestation (Wilson et al., 2017), accompanied by modest improvements in biodiversity (Maes et al., 2023). This raises a fundamental economic question: if firms continuously exploit natural capital in production, why is it not exhausted? Have modern economies developed an equilibrium in which the incentives to exploit natural capital are partly offset by incentives to preserve it?

In this paper, we attempt to answer these questions through the lens of both economic theory and empirical evidence. While economists have increasingly recognized the importance of natural capital, it remains largely absent from standard models of production and growth despite providing essential inputs and ecosystem services.[1] Recent efforts by both academics and policymakers suggest that its economic contribution is substantial (e.g. Frank and Sudarshan, 2024; Joint Research Council, 2021; World Bank, 2021; Cardenas Rodriguez et al., 2023). For example, Ceglar et al. (2025) show that

[1] Examples include the provision of tangible goods (such as food, medicine, timber, and freshwater), regulating air quality, offering protection against floods and droughts, controlling the climate, and providing recreational and tourism benefits.

72% of euro area nonfinancial firms depend heavily on at least one ecosystem service, to the point that production would be severely impaired if that service were disrupted.[2] Moreover, recent work argues that biodiversity conservation increasingly depends on creating mechanisms through which private actors can monetize investments in biodiversity (Flammer et al., 2025). Yet existing economic frameworks say relatively little about why firms should have incentives to conserve the natural capital on which their own production depends. As sustainability challenges increasingly require action by both firms and governments, understanding the incentives that shape private conservation decisions has become a central research question (Loch, 2024).

Our paper contributes to a growing literature documenting the economic and financial consequences of biodiversity loss and natural capital degradation (see, e.g., Ranger et al., 2023; Dasgupta, 2024). This literature has shown that environmental degradation can impose large and persistent economic costs. For example, Hornbeck (2012) document that the American Dust Bowl of the 1930s—caused by a combination of drought and the destruction of native vegetation—led to substantial and long-lasting economic losses.[3] Recent theoretical work has also highlighted the macroeconomic importance of natural capital. Benmir et al. (2025) show that incorporating natural capital dynamics into an integrated assessment model amplifies the social cost of carbon by 12% relative to a model that captures only the direct effects of climate change on economic activity. At the same time, financial markets have begun to recognize biodiversity as an economically relevant risk, with Garel et al. (2024) documenting increasing investor attention to firms' biodiversity impacts.[4] Our contribution is complementary. Rather than studying the consequences of biodiversity loss for the economy or financial markets, we explain why firms have incentives to conserve natural capital in the first place, and why these incentives, while economically meaningful, remain below the social optimum.

We develop a growth model in which natural capital is simultaneously a productive asset and a source of household welfare. Our framework delivers one central mechanism. Because natural capital increases future productive capacity, firms have incentives to conserve it even in the absence of regulation. However, these incentives remain incomplete because firms cannot monetize the recreational and public-good value of biodiversity. The model formalizes this mechanism by allowing natural capital to serve simultaneously as a productive input and a source of household welfare.

[2] As another relevant example, three-quarters of global food crops, including fruit, vegetables, and important food commodities such as cocoa and coffee, rely on animal pollination (IPBES (2019)).

[3] Specifically, agricultural revenues declined by 27% in high-erosion counties and by 16% in medium-erosion counties relative to low-erosion counties, with these relative declines persisting for several decades.

[4] They show that the average monthly stock returns of listed firms were little affected by biodiversity exposure over 2019–2022. However, following the signing of the Kunming Declaration at COP15 in 2021, firms with a high biodiversity impact experienced an average stock price decline of 1.14% over the subsequent three trading days, with divergent pricing persisting over the following year.

Output is produced using three forms of capital: labor ('human capital'); manufactured inputs ('produced capital'); and ecosystem inputs ('natural capital'). Our paper therefore departs from the conventional treatment of nature as an externality by modeling natural capital as productive capital. This approach is flexible and can capture both natural capital's quantitative aspects (e.g., the volume of lumber needed to manufacture a piece of furniture) and its qualitative aspects (e.g., the variety of species in a forest). Economic activity depletes natural capital through exploitation, but natural capital can regenerate. The rate of natural capital regeneration can be increased through investment in conservation. Such conservation can be carried out both by firms and by a public authority. At the same time, conservation is costly, and the cost of conservation increases as natural capital is depleted.[5] Finally, in addition to an economic value, nature also has an enjoyment component to households who derive utility from, e.g., a walk in the forest or a visit to a wild reserve.

Firms conserve nature precisely because they exploit it. Since future production depends on natural capital, profit maximization generates endogenous conservation incentives. This overturns the conventional view that exploitation and conservation are necessarily opposing forces. Yet those incentives remain too weak because firms ignore the welfare value of biodiversity that lies outside production.

Our first result formalizes this intuition. Once nature is recognized as productive capital, profit-maximizing firms optimally conserve it to sustain future production. Long-standing agricultural practices consistent with this idea include – but are not limited to – fallowing, agroforestry, and managed grazing.

Our second result is that market incentives generate conservation but not enough of it. Firms conserve natural capital because it raises future profits, yet they underinvest because they cannot capture the recreational and broader societal benefits generated by biodiversity. As a result, public conservation is needed to top up private conservation, shifting focus from current consumption to future growth. Examples of such public conservation efforts include, for example, urban parks, natural reserves and wildlife sanctuaries, and green corridors.

The model yields two predictions that are directly observable in the data. We evaluate these predictions by using unique region-level data on the biodiversity intactness of the forest in 582 regions across 44 countries. We show that publicly owned forests exhibit higher biodiversity intactness than privately owned ones, confirming the "overuse" – from a social point of view – of natural capital in economic activity. At the same time, even within the same country the index of biodiversity intactness

[5] This assumption captures the idea that it is cheaper to maintain nature at higher levels of natural capital, similar to Giglio et al. (2024).

in fully publicly owned forests is only 9% higher than in fully privately owned ones. Although the evidence is not causal, it is strikingly consistent with the theory: privately owned forests retain substantial biodiversity, while publicly owned forests preserve even more.

The paper proceeds as follows. In Section 2, we develop and solve an endogenous growth model with natural capital. In Section 3, we present empirical evidence consistent with the main predictions of the model. Section 4 concludes with a discussion of the policy implications of our work.

2 The model

2.1 Assumptions

Time is continuous, and the horizon is infinite. We consider an economy that admits a representative agent with logarithmic preferences and discount rate ρ:

$$\int_0^\infty e^{-\rho t} \ln \mathcal{C}_t dt \tag{1}$$

where $\mathcal{C}_t$ denotes consumption at time t. The representative agent is endowed with one unit of labor, which is supplied inelastically and yields a competitive wage denoted by W_t. Population size is constant at L, which we normalize to one for simplicity.

There is a unique consumption (or final) good serving as the numeraire of the economy, whose output is denoted by Y_t. The consumption good is produced competitively by the final good sector using labor and a continuum of intermediate inputs $j \in [0, 1]$ according to the following technology:[6]

$$Y_t = \frac{L^\beta}{1-\beta} \int_0^1 X_{jt}^{1-\beta} B_{jt}^\beta dj, \quad \beta \in (0, 1). \tag{2}$$

Each intermediate input j is produced by a firm, which acts as a monopolist.[7] In the following, we refer to these firms as intermediate goods (or inputs) producers. For simplicity, we normalize the marginal cost of production to one. Both the inputs X_{jt} as well as the variety/quality of the natural capital B_{jt} supporting (or serving to produce) each of these inputs matters in the production of the final good.

This modeling is consistent with the World Bank's framework (see World Bank, 2021), which estimates national wealth as stemming from produced capital (our X_{jt}), human capital (our L) and

[6]In a previous version of the model, we adopted a different (linear) formulation of the production function. The main model implications continue to hold in that alternative version. Also, because L is normalized to one, we omit to report L when it causes no confusion.

[7]This assumption is standard in this class of models of endogenous growth.

natural capital (our B_{jt}) – which are the inputs we consider in Equation (2).[8] It is also consistent with the empirical evidence of Garel et al. (2025), who document substantial reliance on nature for a wide range of firms in a panel of 31,772 firms in 117 countries.

The natural capital supporting each input j deteriorates with the associated output X_j by a factor δ. Thus, a greater output implies a greater exploitation of natural capital. Nonetheless, we allow natural capital to be improved by investment in conservation. Investment in conservation can be undertaken by the producer of input j – in which case we denote it by I_{jt} – or by a public authority – in which case we denote it by S_{jt}. For each j, the dynamics of dB_{jt} then satisfy:

$$dB_{jt} = (I_{jt} + S_{jt} - \delta X_{jt} + \gamma B_{jt})\, dt. \tag{3}$$

The first two terms on the right-hand side represent private and public investment in conservation, respectively, which both increase natural capital. The third term represents the exploitation rate of natural capital due to production – notably, the idea that production leads to a deterioration of natural capital is consistent, for instance, with Martins Cardoso and Parker (2024) and the OECD framework to assess environmentally-adjusted productivity (Cardenas Rodriguez et al., 2023). The last term in this equation indicates the regeneration rate of natural capital, i.e., the natural recovery capacity of the ecosystem.[9] In general, Equation (3) implies that an intermediate producer can alternatively preserve natural capital by reducing its output (then slowing down exploitation) or by investing in conservation.

Because the natural capital associated with intermediate inputs enters the production of the final consumption good – and, thus, demand by the final-good sector – input producers may have incentives to invest in conservation, as we will show. Conservation is costly, however, and we assume that the investment cost is $\frac{\theta}{2}\frac{I^2}{B}$. This formulation implies that: (1) the cost is convex in I; (2) conservation is less costly when B is larger. To ease comparability, we also assume that investment in conservation pursued by the central authority has a similar functional form but a different cost coefficient, i.e., $\frac{\zeta}{2}\frac{S^2}{B}$.[10] That is, we emphasize that the conservation technology available to private firms and the public authority has the same impact on the dynamics of natural capital (as per equation (3)) and, in the case $\theta = \zeta$, it also has the same cost.

At any time, the consumption flow of the representative agent is given by the competitive labor wage, the net dividends from the input producers and public transfers (e.g., public investment in

[8] The World Bank framework also considers net foreign assets, which is beyond the scope of our model.

[9] For instance, Jones and Schmitz (2009) find that recovery often occurs on decadal time scales, with average recovery times up to around 42 years for forests and up to 56 years for ecosystems affected by multiple disturbances.

[10] This assumption is without loss of generality, as insights do not rely on the magnitude of the cost coefficients to necessarily differ.

conservation, entering negatively if non-zero). In addition, we assume that the representative agent derives a consumption flow from natural capital, which can be interpreted as the public good due to amusement, enjoyment or health associated with the quality/variety of natural capital. This is in line with Dasgupta and Levin (2023) who represent humanity as being embedded in nature, rather than just a consumer of certain purely economic benefits. We denote this benefit as $A_t = \Psi \int_0^1 B_{jt} dj$, which is larger the greater B_{jt} across product lines.

We focus on a balanced growth path equilibrium, in which aggregate quantities grow at the constant endogenous rate g. This unique equilibrium is an allocation such that input producers maximize their value through production and investment in conservation; the final good sector maximizes profits; the representative agent maximizes utility from consumption; the central authority sets public investment in conservation to maximize welfare; all markets clear.

2.2 Model solution

To isolate the economic strengths at play, we solve the model in steps. First, we consider a simpler setting in which there is no public investment to conserve natural capital. Second, we solve the more general case featuring the central authority setting the public investment in conservation so to maximize welfare.

2.2.1 Case with no public investment in conservation

The maximization of the consumption good sector delivers the demand curve for each intermediate input j:

$$X_{jt} = \left(B_{jt}^{\beta}/p_{jt}\right)^{\frac{1}{\beta}} = B_{jt} p_{jt}^{-\frac{1}{\beta}} \;\Rightarrow\; p_{jt} = X_{jt}^{-\beta} B_{jt}^{\beta} \tag{4}$$

where the price p is determined by the profit maximization of the j-th input producer. The higher B_t, the greater the quantity demanded for a given price level (or, equivalently, a greater price for a given quantity). This then generates incentives for private firms to investment in conservation (as we discuss in more detail later).

Given the demand schedule of the final good sector, natural capital matters in the maximization of the input producer. Following standard arguments, the maximization problem of an input producer – whose value is denoted by $V_j(B)$ – satisfies (suppressing the subscript j when it causes no confusion):

$$rV(B) = \max_{X,I} \left(I - \delta X + \gamma B\right) V_B + X(p-1) - \frac{\theta}{2B} I^2. \tag{5}$$

This equation admits the following interpretation. The left-hand side is the return required to invest in the firm, whereas the right-hand side represents the expected change in firm value on each time interval. Specifically, the first term on the right-hand side is the expected change in firm value due to a change in natural capital (due to investment in conservation I, production-driven exploitation δX and natural regeneration γB), the second term represents the revenues net of the cost of production, and the third term represents the cost associated with investing in conservation. To solve the model, we conjecture that the value of an input producer can be expressed as $V(B) = vB$, where v can be interpreted as the marginal value of natural capital from the perspective of the intermediate producer. Using this scaling property, we also define scaled production $x = X/B$ and scaled investment in conservation $i = I/B$ (or investment rate). Maximizing Equation (5) then gives the optimal scale of production x:

$$x = \left(\frac{1-\beta}{1+\delta v}\right)^{\frac{1}{\beta}}. \tag{6}$$

This expression suggests that if production leads to a greater deterioration in natural capital (as captured by the parameter δ), then the optimal scale of production is lower and more so the higher the marginal value of natural capital v. Next, the maximization of (5) with respect to the firm's investment in conservation gives:

$$i = \frac{v}{\theta}. \tag{7}$$

This equation illustrates that the higher the marginal value of natural capital from the firm perspective, the higher its investment in conservation. However, the higher the associated cost, the lower the optimal conservation effort.

Along the balanced growth path, aggregate quantities grow at the equilibrium rate $g = i - \delta x + \gamma$.[11] The relationship between production and growth illustrates the central trade-off in the model. Increased production leads to a greater exploitation – and, thus, deterioration – of natural capital, which then leads to a decline in the growth rate. Yet, firms can support growth by investing in conservation, as captured by the term i entering positively in the expression of g.

Along the balanced growth path, the consumption of the representative agent as well as its components also grow at g.[12] When there is no public investment in conservation, the consumption of the representative agent is given by:

$$\mathcal{C}_t = W_t + D_t + A_t = (W_0 + D_0 + \Psi)e^{gt} \tag{8}$$

being the sum of the competitive equilibrium wage (the first term), the dividend coming from the intermediate good sector (the second term) and the flow coming from the enjoyment of natural capital

[11] Following standard arguments, the Euler equation of the representative agent is then $r = \rho + g$.

[12] As a result, we can express all of these quantities as their $t = 0$ value and their path going at rate g.

(the last term). Notably, the dividend from the intermediate good sector decreases with their investment in conservation. However, investment in conservation supports natural capital, then potentially its associated enjoyment.

Lastly, welfare is given by the intertemporal utility of the representative agent:

$$\text{Welfare} = \int_0^\infty e^{-\rho t} \ln \mathcal{C}_t dt = \frac{1}{\rho}\left[\log \mathcal{C}_0 + \frac{g}{\rho}\right]. \tag{9}$$

This expression suggests that both initial consumption as well as its growth rate matter in determining welfare. We will discuss in more details how conservation affects both quantities in our discussion in Section 2.2.3.

2.2.2 Case with public investment in conservation

Consider now the case in which a central authority invests in conservation so to maximize welfare. In this case too, the demand curve for each input continues being as in the case with no public investment (Equation (4)). Following standard arguments and similar to the previous case, the maximization problem of an input producer – whose value is denoted by $V(B)$ – satisfies:[13]

$$rV(B) = \max_{X,I} \left(I + S - \delta X + \gamma B\right) V_B + X(p-1) - \frac{\theta}{2B} I^2. \tag{10}$$

The interpretation of this equation is similar to Equation (5) (i.e., its counterpart in the case with only private investment in conservation), with the main difference being that the first term on the right-hand side reminds that natural capital might also grow thanks to public investment in conservation S.[14] To solve the problem of the input producer, we again conjecture the same scaling property as in the previous case, $V(B) = vB$, where v continues to denote the marginal value of natural capital from the perspective of the intermediate producer. The optimal choices of the intermediate good producer – production and investment in conservation – satisfy the same functional form as before, see Equations (6) and (7). Namely, the firm's production decreases with δ (i.e., the rate at which production deteriorates natural capital) as well as with the marginal value of natural capital v. In turn, investment in conservation increases with the marginal value of natural capital.

In this case too, we focus on a balanced growth path equilibrium, in which all aggregate quantities grow at the equilibrium rate g. Differently, in this case, the equilibrium growth rate is positively affected by the public investment in conservation of the central authority: $g = i + s + \gamma - \delta x$. As in the previous case with no public investment, production leads to a deterioration in natural capital, which in turn has a negative effect on the growth rate. At the same time, the intermediate input

[13]As in the previous case, we omit the subscript j when it causes no confusion.

[14]This will be reflected in endogenous aggregate quantities as well as in the equilibrium interest rate.

producers can counteract the impact of such deterioration by investing in conservation, which has a positive effect on long-term growth. In addition, public investment in conservation further sustains long-run growth in this case.[15]

As in the previous case, aggregate quantities all grow at the rate g along the balanced growth path, and so we can characterize them by their value at $t = 0$ as well as by their balanced growth going forward. When the public authority invests in conservation, the initial consumption of the representative agent (growing at rate g as $\mathcal{C}_t = \mathcal{C}_0 e^{gt}$) is given by

$$\mathcal{C}_0 = \left(D_0 + W_0 - \frac{\zeta}{2} s^2 + \Psi \right)$$

where the third term captures the cost associated with public investment in conservation. While a greater public conservation effort sustains growth (as shown in the expression for g), the above expression illustrates that it nonetheless reduces the initial consumption of the representative agent.

Welfare is given by the intertemporal utility of the representative agent, which again satisfies Equation (9). In this case, however, the central authority chooses the optimal public investment in conservation to maximize welfare with respect to s. This maximization then gives:

$$s = -\rho + \sqrt{\rho^2 + \frac{2(D_0 + W_0 + \Psi)}{\zeta}}$$

where D_0 and W_0 denote the dividend from the intermediate good sector to the representative agent and the equilibrium wage, respectively.

Intuitively, the larger the benefit from natural capital to the representative agent (Ψ), the greater the public investment in conservation.

Thus, public investment in conservation is set to maximize welfare of the representative agent – it therefore takes into account the consumption flow to the representative agent stemming from natural capital.

2.2.3 Discussion

The central implication of the model is that conservation is not solely a regulatory phenomenon. It also emerges as an equilibrium outcome of profit maximization whenever future production depends on natural capital. Thus, natural capital needs to be preserved to support long-term growth. Below we discuss in more detail the tension between exploitation versus conservation as well as the drivers of private versus public investment in conservation.

[15] The standard Euler equation continues to deliver the expression for the equilibrium interest rate $r = \rho + g$, which feeds back into the optimal choices of the input producer.

Exploitation versus conservation The model allows for natural capital to expand because: (1) firms exploit less (i.e., reduce their output), (2) firms invest in conservation, (3) a central authority invests in conservation. That is, a firm can positively impact natural capital both by exploiting less (then reducing their output, however) or by investing in conservation (which, nonetheless, is costly).

Resonating the OECD view, overexploitation of natural resources may jeopardize the future – in our model, it leads to lower growth.[16] More specifically, in our model, the extent to which output translates into deterioration of natural capital (i.e., how an unit of output translate into destruction of natural capital) is captured by the parameter δ. The choice of conservation/exploitation then trades off current consumption and future growth. Namely, decreasing exploitation leads to a decrease in output and then in current consumption but, by reducing the pace of deterioration of natural capital, it can sustain long-term growth. Similarly, investment in conservation reduces current consumption but, on the other hand, sustains growth.

Drivers of investment in conservation Our model illustrates that private and public conservation solve different optimization problems. Firms conserve nature because it is productive, while governments conserve nature because it contributes to welfare beyond production. The distinction explains why public conservation complements rather than crowds out private conservation.

Private conservation is driven by production incentives. Because natural capital enters the production of the final consumption good, it affects the demand for intermediate inputs. Our setting (endogenously) delivers that private investment in conservation is driven by the incentive to sustain the demand for intermediate goods – that is, it stems from profit-maximization of the intermediate good producers. This mechanism complements the framework of Flammer et al. (2025). Whereas they emphasize financial mechanisms that enable firms to monetize biodiversity investments, our model identifies an additional source of private incentives: firms conserve natural capital because it directly supports future production.

Additionally, our setting acknowledges that natural capital is associated with non-productive functions too, such as enjoyment. This aspect is only taken into account by public investment in conservation – that is, it falls beyond the scope of the value-maximization of intermediate firms. The larger the benefit to the representative agent from natural capital, the greater the public investment in conservation should be.

An unexpected implication of the model is that public conservation complements rather than substitutes for private conservation. Because firms and governments conserve nature for fundamentally

[16] See. e.g., the OECD Green Growth paper by Cardenas Rodriguez et al. (2023).

different reasons, greater public conservation does not eliminate firms' incentives to preserve productive ecosystems. Yet, in the case without public investment, there is *underinvestment* in conservation, as the non-productive function of natural capital (i.e., enjoyment) is not taken into account, and private firms give more emphasis to current output than to future growth.

It is worth noting that the model implies positive public investment in conservation even when $\Psi = 0$ (i.e., when there is no consumption flow coming from the enjoyment of natural capital) – in fact, the central authority maximizes welfare by investing in conservation.[17] The maximization of welfare of the central authority reduces consumption today but attains a higher growth rate. This implies that the case with solely private investment downplays future growth while allowing for more consumption in the present – thus, it is relatively short-termistic.

Overall, despite sharing a similar conservation technology, public and private investment in conservation address different purposes – precisely because they maximize different objectives. Private investment is driven by firm profit maximization – and, thus, by the perspective to monetise such investment. While useful, this may not be enough. In turn, public investment aims at maximizing welfare. Indeed, with public investment, the balance is moved towards supporting long-term growth to a larger extent although at the cost of reducing consumption in the present. This is even more so when there are enjoyment benefits associated with natural capital, which are not accounted for by private investment.

3 Empirical evaluation

The theory generates two directly testable predictions. First, privately managed ecosystems should retain substantial natural capital because firms have incentives to preserve productive assets. Second, publicly managed ecosystems should exhibit even greater conservation because governments internalize benefits that firms cannot monetize. These mechanisms imply two testable predictions: private interests will maintain natural capital at non-trivial levels which are, however, strictly lower than when natural capital is in the hands of a public entity.

To test these predictions, we turn to data on the forest ecosystems condition in 582 regions across 44 countries from European Forest Institute (Pulla et al. (2013)) and the PBL Netherlands Environmental Assessment Agency.

We take advantage of two pieces of information. First, for each region, data are available on the

[17] This is instead not maximized when there is no central authority. Obviously, however, public investment in conservation is even higher when $\Psi > 0$.

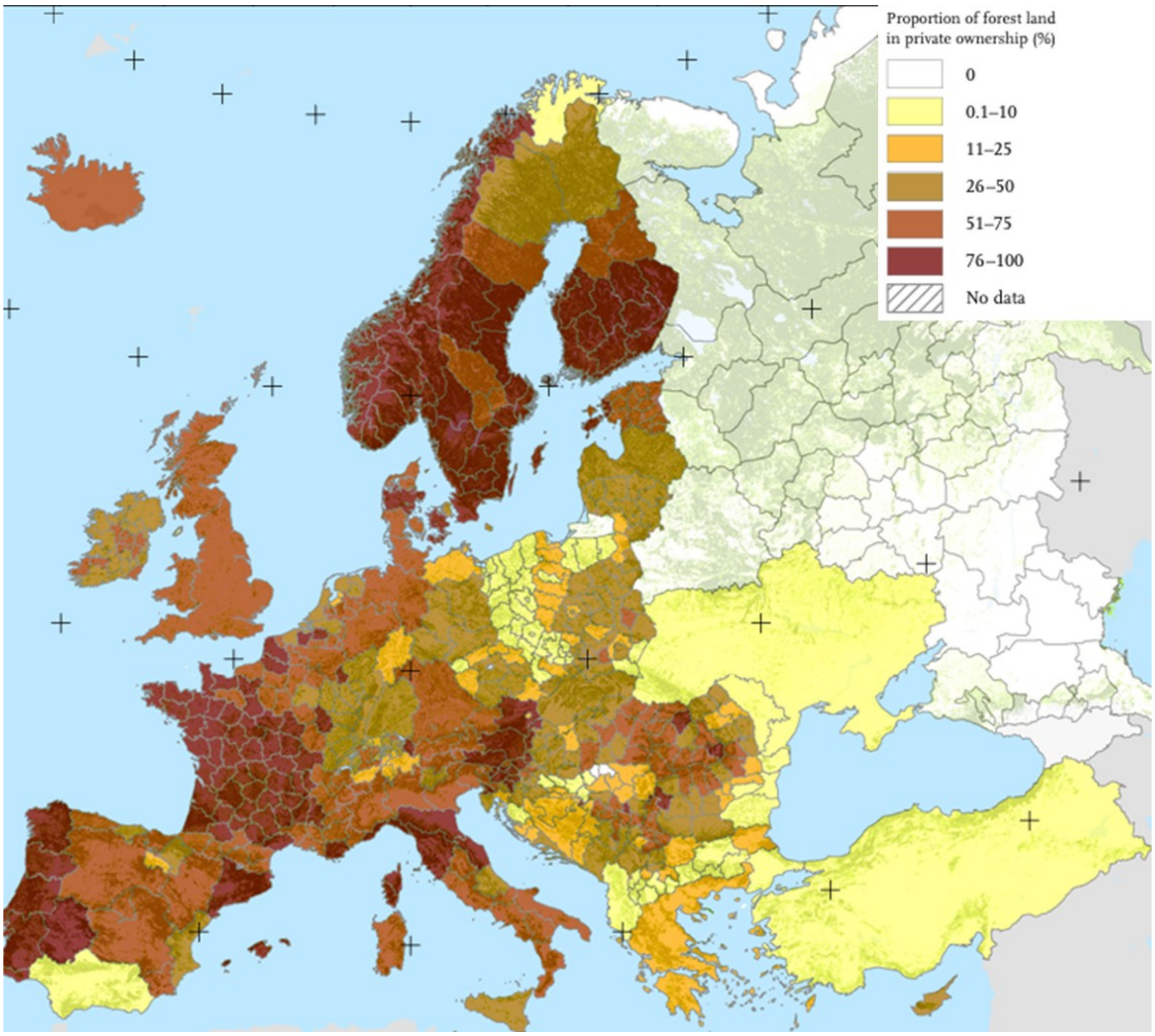

Figure 1: Forest ownership

Source: European Forest Institute.

Notes: The map displays the extent of private versus public ownership for 582 regions in 44 countries. Public forests are managed by municipal, regional, or national authorities. Private forests encompass a wide range of ownership types: traditional, non-industrial holdings such as those owned by families, farms, rural commons, churches, and aristocratic estates, and industrial private owners such as forest industry companies involved in activities such as pulp and paper production.

proportion of forest under private versus state ownership. Across Europe, around 16 million entities, both private and public, own forest land. Public forests are managed by municipal, regional, or national authorities, while private forests encompass a wide range of ownership types. These include traditional, non-industrial holdings such as those owned by families, farms, rural commons, churches, and aristocratic estates. Industrial private owners, on the other hand, are typically forest industry companies involved in activities such as pulp and paper production. There are also intermediate forms of ownership, neither fully private nor fully public, such as community-owned forests managed by local citizens or farm cooperatives. Many of these ownership models trace their origins to historical land tenure systems or recent social movements promoting collective forest management.

Private ownership of forest area ranges from 0% (in one region each in Belarus, Germany, and Montenegro, two regions in Serbia, and every region in Russia) to 100% (in one region in Serbia). The average extent of private ownership of forest area in the sample is 46.2%. Across EU member states, approximately 60% of forests are privately owned and 40% are publicly owned. See Figure 1 for more details.

Secondly, we utilize the location-specific biodiversity indicator, Mean Species Abundance (MSA), which is calculated using the GLOBIO model developed by the PBL Netherlands Environmental Assessment Agency (www.globio.info). The MSA quantifies biodiversity intactness by assessing its response to various human-induced pressures, including land use, road disturbance, habitat fragmentation, hunting, atmospheric nitrogen deposition, and climate change (Schipper et al. (2019)). The MSA index ranges from 0 to 1, where 1 indicates a fully intact species assemblage and 0 means all original species are locally extinct. It compares the abundance of native species under human pressures to their abundance in undisturbed conditions, excluding opportunistic species whose increase under disturbance could otherwise inflate the indicator. For this study, the MSA index was derived from data for 2020.

As Figure 2 indicates, the average region has an index of biodiversity of 0.38. There is large heterogeneity in the data across countries, with Scandinavian countries exhibiting the highest and central European countries the lowest, levels of average biodiversity. However, there is also significant within-country cross-region variation.

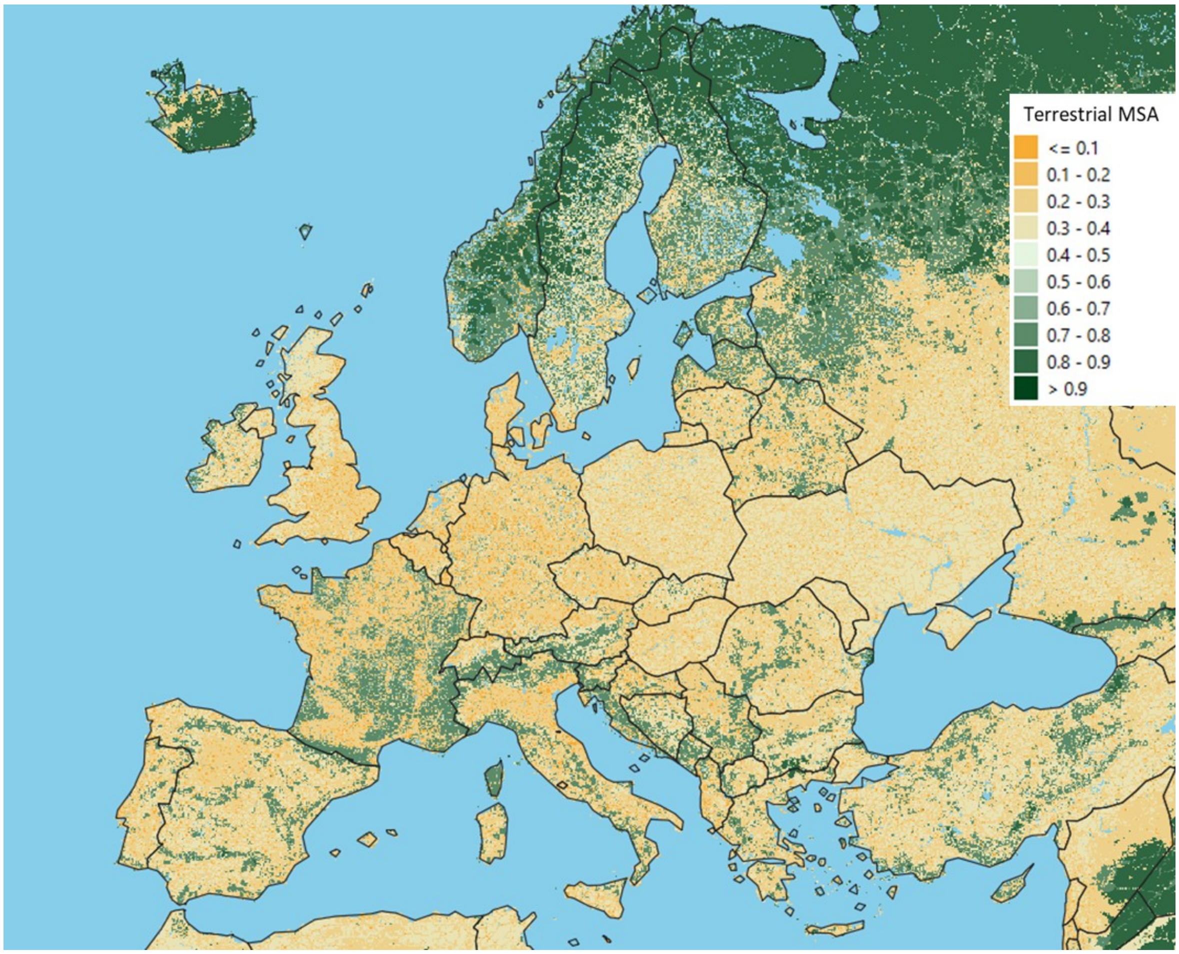

Figure 2: Terrestrial biodiversity intactness index

Source: PBL Netherlands Environmental Assessment Agency.

Notes: The Mean Species Abundance (MSA) biodiversity index quantifies biodiversity intactness by assessing its response to various human-induced pressures, including land use, road disturbance, habitat fragmentation, hunting, atmospheric nitrogen deposition, and climate change. Data are for 2020.

With these data in hand, we run the following regression:

$$BiodiversityIndex_{r,c} = \alpha + \beta ShareStateOwned_{r,c} + \gamma_c + \varepsilon_{r,c} \tag{11}$$

where $BiodiversityIndex_{r,c}$ is the value of the MSA Biodiversity Index in region r in country c, and $ShareStateOwned_{r,c}$ is the share of the forest area in region r in country c that is owned by public entities. We include country fixed effects γ_c in order to net out background factors that are common to all regions in a country, and we cluster the standard errors by country.

The estimates from this regression equation are reported in Table 1. We document a significant increase in biodiversity intactness in state ownership, with an increase of 0.009 in the biodiversity index following a 10 percentage-point increase in state ownership. Put differently, 50% state/private ownership is associated with 13% higher values of the MSA than 100% private ownership.

Table 1: Public ownership and biodiversity

Variable	MSA Biodiversity Index
Share state owned	0.0883**
	(0.0376)
Constant	0.3371***
	(0.0198)
Country fixed effects	Yes
Clustering	Country
# Observations	582
R-squared	0.47

Notes: The table presents estimates from Equation (11) where the dependent variable is the Mean Species Abundance (MSA) biodiversity index. 'Share state owned' denotes the share, from 0 to 1, of the percentage of forest areas that is managed by municipal, regional, or national authorities. Data come from the European Forest Institute and from the PBL Netherlands Environmental Assessment Agency.

At the same time, the intercept points to high levels of MSA in the absence of public ownership: even with fully private ownership of forest areas, the MSA is at 0.34, which corresponds to one-third of the absolute maximum and to one-half of the inter-quartile range.

Through the lens of the model, it is natural to interpret the evidence as confirming two of the main implications of our model. Firstly, public ownership of natural capital increases biodiversity intactness because of the higher public investment in conservation. Secondly, even with very high levels of private ownership, the quality of natural capital does not decline to very low levels. This is due to the endogenously arising incentive of firms that rely on natural capital to invest in conservation.

At the same time, given the empirical set-up we employ, the data point to no more than a strong statistical correlation between state ownership and biodiversity intactness rather than a true causal relationship. Regions with a higher share of state forest ownership may differ systematically from regions with a low share of state forest ownership along many dimensions, and state ownership itself may be endogenous to the extent of regional biodiversity. The country fixed effects do not address possible within-country cross-region selection. With this caveat in mind, private conservation in the data appears to be non-trivial but lower than optimal from a social point of view. Consistent with the logic of the model, this is because a public conservation top-up is needed to recalibrate current consumption versus future growth.

4 Conclusion

This paper argues that biodiversity conservation is partly an equilibrium outcome of market incentives rather than solely a consequence of regulation. Treating natural capital as productive capital explains why private conservation emerges endogenously while also clarifying why it remains socially insufficient. More broadly, our framework helps explain when biodiversity finance is likely to be effective by identifying the economic incentives that lead firms to invest in natural capital.

We develop a model where natural capital is an input in the production function, together with physical capital and labor. The model yields a balanced growth path with both private and public conservation effort in equilibrium. There are two main empirical implications. Firstly, the model predicts that firms that monetize natural capital have incentives to invest in conservation. In this way, a natural non-zero private conservation effort emerges in equilibrium, making sure that natural capital is maintained at a level necessary to support economic production. Secondly, while non-trivial, private conservation is low from a social point of view, and so a public conservation top-up is required to shift the balance away from current consumption towards future growth.

More broadly, our framework suggests a different way of thinking about biodiversity within economics. Environmental economics has traditionally emphasized the conflict between economic production and nature conservation. Our analysis shows that once natural capital is recognized as productive capital, conservation becomes part of firms' intertemporal investment problem rather than merely a regulatory constraint. Markets therefore generate meaningful conservation incentives even in the absence of regulation, although these incentives remain incomplete because firms cannot appropriate the full social value of biodiversity.

Our analysis suggests that biodiversity policy should not be framed necessarily as correcting a complete market failure. Once natural capital is modeled as productive capital owned by firms, conservation ceases to be an exogenous policy choice and becomes an endogenous market outcome. Consistent with this prediction, the data suggest that markets already generate meaningful incentives to preserve productive ecosystems. Public policy is still necessary, but for a different reason than in standard environmental economics: not because markets produce no conservation, but because they produce too little. The role of public policy therefore is to complement private incentives by protecting the broader welfare value of nature that markets cannot capture. Viewed through this lens, biodiversity policy is not about replacing markets, but about complementing the conservation incentives that markets already create.

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