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# The Economics of Blended Finance†

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Humanity faces substantial environmental challenges, the greatest being the accelerating loss of biodiversity and the continuing changes in Earth's climate. Overcoming these challenges will require massive investments in biodiversity conservation and the mitigation of greenhouse gas emissions. The investments needed could total more than a trillion dollars annually for several decades (e.g., Songwe et al. 2022), and many of them will be in emerging markets. Where will the funding come from?

There are clearly three main sources: government funds, funds from multilateral development banks (MDBs), and private funding from fund managers, pension funds, and insurance companies. It seems likely that the bulk of these investments will have to come from private investors, as there are tight constraints on government and MDB investment budgets. Yet it is not obvious that the underlying investments will be appealing to private investors, as they will in many cases be in novel technologies and in countries in which western fund managers have not traditionally invested. Because of these challenges, as well as other reasons that we explain below, these investments may not offer attractive risk-return profiles.

Our aim in this paper is to investigate a mechanism for making risk-return profiles more attractive to private investors. Specifically, we investigate the potential of an approach that involves blending funds from different types of investors—such as governments, MDBs, and private investors—in a way that increases the attractiveness of the investments to private investors. There are many ways in which this can be done, and all involve some combination of governments and MDBs accepting a reduction in returns and/or an increase in risk exposure.

One of the main reasons why biodiversity conservation projects may not offer attractive risk-return profiles is that many services that biodiversity offers are public goods, and it is notoriously difficult to monetize the benefits accruing from the provision of public goods. The same is true of the benefits from a more stable climate. In Section I, we investigate the mechanisms for monetizing the benefits that flow from the provision of public goods and, in particular, consider a model in which public goods are bundled with private goods, and their protection increases consumers' willingness to pay for the private goods.

The returns to conservation projects are uncertain for many reasons. If these projects are in emerging markets, investors may face exchange rate risks. Moreover, they may face political risks, especially in the sensitive areas of land ownership and use and the provision and pricing of energy. Particularly in the case of biodiversity conservation projects, the nature of the underlying projects is often novel in a way with which investors are unfamiliar. There may also be deep scientific uncertainty about the possible outcomes of the projects. In Section II, we investigate how the structuring of investment contracts can change the private investors' risk-return profiles and, in particular, whether there are changes in contract structure that lead to profiles that stochastically dominate a given profile so that the outcome will be more appealing to any risk-averse investor (second-order stochastic dominance) or to any investor (first-order).

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## I. Bundling Public and Private Goods

Because biodiversity is a public good, we cannot in general expect that its provision will earn a commercial return on investment.[1] There are however situations where the provision of biodiversity is profitable, and these are when it can be bundled with a private good whose value it enhances. The classic illustration is ecotourism in Africa. Landowners conserve biodiversity, generally lions, leopards, cheetahs, elephants, giraffes, and other "charismatic megafauna," and tourists pay for safaris on which they can view these striking animals. They do not actually pay to see the animals: they pay for tented accommodation, meals, guide services, and local transportation, but they pay at rates that would make little sense were it not for the presence of the animals. Accommodation rates in excess of $1,000 per person per day are common. Clearly the public good—biodiversity—is bundled with and increases the willingness to pay for the private goods sold by the safari operators.

We can model this formally and show that, in certain circumstances, this can lead to the efficient provision of the public good. The following is a simple case of the more general model in Heal (2003).

A single firm produces private and public goods. It faces individuals indexed by $i \in N$, who buy the private good and whose welfare is affected by the public good. $h_i$ is the amount of the private good sold to the $i - th$ buyer, and $e$ is the level of provision of the public good, the same for all buyers. Individual $i$ has an income level of $y_i$ and a utility function $U_i(y_i, h_i, e)$, which is differentiable and strictly concave. Prior to any production occurring, buyers have initial endowments of $(y_{i,0}, h_{i,0}, e_0)$. Suppose the amounts of the private and public good change to $(h_{i,0} + \Delta h_i, e_0 + \Delta e)$. We can define agent $i$'s willingness to pay for these changes as the value $w_i$ given by $U_i(y_{i,0}, h_{i,0}, e_0) = U_i(y_{i,0} - w_i, h_{i,0} + \Delta h_i, e_0 + \Delta e)$. This is the reduction in income that leaves the agent just as well off as before the change.

The producer faces a differentiable and strictly convex cost function denominated in units of income, $C(\Delta h_1, \Delta h_2, \ldots, \Delta h_N, \Delta e)$. The producer is profit maximizing and is able to price discriminate fully, extracting from each buyer his or her total willingness to pay for any bundle of private and public goods. The producer therefore has to choose $\Delta e$ and $\Delta h_i$ so as to maximize profits, which are given by

$$\sum_i w_i - C(\Delta h_1, \ldots, \Delta h_N, \Delta e),$$

subject to the definition of willingness to pay. If we assume that $\partial C / \partial h_i = \partial C / \partial h \; \forall i$ so that the cost of producing the private good does not depend on the buyer, then the first-order conditions for a profit maximum are

$$\frac{\partial C / \partial e}{\partial C / \partial h} = \sum_i \frac{\partial U_i / \partial e}{\partial U_i / \partial h_i},$$

which are the standard first-order conditions for the efficient provision of a public good. Accordingly, we can assert the following:

THEOREM 1: *If utility functions are strictly concave and the cost function strictly convex, then a profit-maximizing producer who provides a private and a public good and who can practice first-order price discrimination will provide a Pareto efficient combination of the public and private goods.*

Bundling with private goods may therefore provide a mechanism through which the value of a public good can be monetized.

[1] While we frame the arguments in terms of biodiversity protection, the same applies to climate protection and other efforts to promote the United Nations' Sustainable Development Goals (SDGs).

## II. Managing Risk and Return

The ability to earn an attractive risk-return combination on biodiversity conservation is not something we can count on. In this section, we present a version of the model in Flammer, Giroux, and Heal (2024) that shows how blending several sources of finance can improve the risk-return profile of private investments. First, we focus on a situation where the return is certain but too low and then extend the analysis to projects whose return is uncertain, with a noncommercial risk-return profile.

### A. *Certain Returns*

Assume that we have a set of possible investment projects indexed by $i$, $i \in [0, I]$. Assume also that each project costs \$$C$. The total social return on project $i$ is $S(i)$, and the private return is $R(i)$, where $S(i) \geq R(i)$. We are only considering projects with positive externalities. We assume projects are ranked by the index $i$ in decreasing order of private returns so that $dR(i)/di \leq 0$. All projects have the same social return, so $S(i) = S$. Finally, the private hurdle rate is $H$, so the private sector will invest in any project for which $R(i) \geq H$. We assume that the social return to these investments exceeds the private hurdle rate, that is, $S \geq H$. We let $i^*$ be the value of $i$ at which $R(i^*) = H$, so this is the marginal privately profitable project. Projects with $i > i^*$ will only be executed if some incentive additional to the private return is available, and we investigate the possibility of this occurring through blended finance.

A development finance institution (DFI) has a total sum of \$$K$ to invest and wants to invest this to add the greatest possible social value. It will clearly not invest in any project for which $i \leq i^*$, as the private sector will invest in these. It will focus on projects for which $i \geq i^*$ and will seek a strategy that leads to the maximum number of these being executed. It could just invest in the first $K/C$ projects for which $i \geq i^*$, but it can clearly do better than this by leveraging private investment and using its capital to raise the return on projects for which $i > i^*$ up to the hurdle rate.

There are several ways with which the DFI can raise the returns to private investors. One that reflects actual practices is to provide concessional capital seeking a return less than the private hurdle rate for a part of the investment in the project. We will model this approach and, for simplicity, assume initially that the concessional capital seeks a zero rate of return. In this regard, concessional funding is commonly called "catalytic funding," as it is expected to catalyze the provision of private finance.

Consider project $i'$ with $i' > i^*$ and $R(i') < H$. We let $\Delta(i') = H - R(i')$ be the shortfall between the commercial hurdle rate and the private return on project $i'$. Suppose the fund provides an amount of capital $K(i')$ to this project at a zero rate of return: Then the modified return $R_m(i')$ to a commercial investor who provides the balance of $C - K(i')$ is

$$R_m(i') = R(i') \frac{C}{C - K(i')},$$

and for this to equal the hurdle rate, the provision of concessional capital has to satisfy

$$K^*(i') = C\left[1 - \frac{R(i')}{H}\right] = C \frac{\Delta(i')}{H}.$$

In words, the concessional contribution has to equal the cost (\$$C$) times the shortfall as a proportion of the hurdle rate.

The optimal policy for the fund is to spend its capital $K$ leveraging private funds in this way. It will fund projects from $i^*$ to $\hat{i}$ where $\hat{i}$ is given by

$$\int_{i^*}^{\hat{i}} K(i) di = \frac{C}{H} \int_{i^*}^{\hat{i}} \Delta(i) di = K.$$

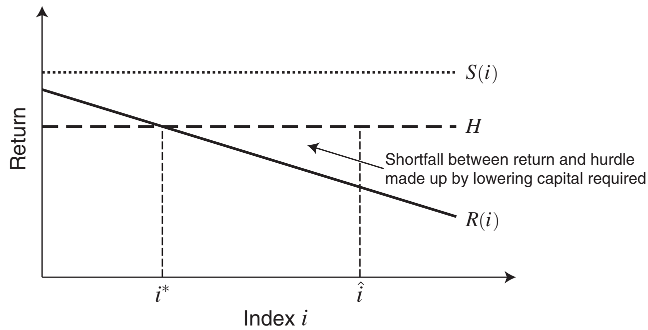


FIGURE 1

To simplify, assume that $R(i)$ is linear with slope $-\beta$, and, since we are not interested in projects for which $i < i^*$, we set $i^* = 0$. Then the shortfall is $\Delta(i) = \beta i$, and

$$\frac{C}{H}\int_{i^*}^{\hat{i}} \Delta(i)di = \frac{C}{2H}\beta\hat{i}^2 = K,$$

so the last project funded is given by

$$\hat{i} = \sqrt{\frac{2KH}{C\beta}}.$$

These calculations are illustrated in Figure 1: The private return $R(i)$ is given by the solid line, intersecting the hurdle rate $H$ at $i^*$ so that projects between $i^*$ and $\hat{i}$ are funded in part by concessional capital. (Projects to the left of $i^*$ are funded by the market.)

What is interesting about this result is that it establishes a relationship between the amount of catalytic capital going into a project and its deficit from the hurdle rate: $K^*(i) = \Delta(i)\,C/H$. We can think of the deficit from the hurdle rate as a measure of the extent to which the social benefits from the project are nonmonetizable, that is, the extent to which it provides positive externalities or public goods. This is a testable proposition: The more public or external the benefits of a project, the more it will need concessional funding. This prediction is in line with the findings of Flammer, Giroux, and Heal (2025), who show that biodiversity projects with a higher biodiversity impact are more likely to receive concessional capital, as well as the findings of Flammer, Giroux, and Heal (2024), who find evidence for a higher concessionality in blended finance projects that have higher environmental and social impact.

### B. *Random Returns*

If returns are uncertain, there are two ways in which blended finance can enhance the investment's risk-return profile. One is to increase the share of the concessional capital to further increase the expected return of private investors. The second is to reduce the spread of the distribution of returns.

In order to draw general conclusions, we need to use the concept of stochastic dominance.

DEFINITION 1: *Cumulative distribution F first-order stochastically dominates cumulative distribution G (F FOSD G) if, for every nondecreasing function* $u : \mathbb{R} \to \mathbb{R}$,

$$\int u(x)dF(x) \geq \int u(x)dG(x).$$

From this definition, a standard result tells us that the distribution $F$ first-order stochastically dominates distribution $G$ if and only if $F(x) \leq G(x)\ \forall x$.

DEFINITION 2: *For any two cumulative distributions F and G with the same mean, F second-order stochastically dominates G (F SOSD G, or F is "less risky" than G) if, for every nondecreasing concave function* $u : \mathbb{R} \rightarrow \mathbb{R}$, *we have*

$$\int u(x)dF(x) \geq \int u(x)dG(x).$$

There are other ways of characterizing SOSD. Distribution $G$ is a mean-preserving spread of distribution $F$ if $G$ is the reduction of a compound lottery made up of the distribution $F$ with an additional lottery so that when $F$ selects $x$, the final outcome is $x + z$, where $z$ is a random variable whose mean is zero. Using this terminology, we can formulate the following, well-known equivalence proposition:

PROPOSITION 1: *Consider two distributions F and G with the same mean. Then the following statements are equivalent:*

(i) $F(\cdot)$ second-order stochastically dominates $G(\cdot)$.

(ii) $G(\cdot)$ is a mean-preserving spread of $F(\cdot)$.

Accordingly, decreasing the capital required of an investor while not changing the pattern of returns will always lead to an outcome preferred by any utility maximizer, and reducing the spread of a distribution by cutting off tails will always be attractive to risk-averse investors while not changing the returns. These are basic tools that blended finance can use when blending different sources of financing in order to attract private capital to otherwise unattractive projects.

THEOREM 2: *Consider an investment project whose return \$x is distributed with a probability density function (PDF)* $f(x)$. *The project requires an investment of \$K. A proportion* $\alpha$, $0 \leq \alpha \leq 1$, *of the investment is provided by concessional capital that requires no return. The rate of return to the investor is* $r = x/[(1-\alpha)K]$. *If* $\alpha_1 > \alpha_2$ *then the return distribution associated with* $\alpha_1$ *FOSD that associated with* $\alpha_2$ *and so is preferred by any utility-maximizing investor.*

PROOF:

Let $F_1(r)$ and $F_2(r)$ be the cumulative return distributions associated with $\alpha_1$ and $\alpha_2$ respectively.

$$\Pr\left(\frac{x}{(1-\alpha)K} \leq Z\right) = \Pr(x \leq Z(1-\alpha)K),$$

and hence $F_i(r) = F(r(1-\alpha_i)K)$, $i = 1,2$. Clearly, as $F(\cdot)$ is an increasing function, $F_1(r) = F(r(1-\alpha_1)K) \leq F_2(r) = F(r(1-\alpha_2)K)$, and hence $F_1(r)$ FOSD $F_2(r)$. ∎

This confirms that we can always make an investment more attractive to private investors by requiring less capital. Note the generality of this result: it does not depend on the investor's risk preferences but applies to any expected utility maximizing investor. This of course is not costless: it requires that we find more concessional capital willing to invest for no (or a low) return.

We can also establish that a mean-preserving contraction of the distribution of returns will always make the investment more attractive to any risk-averse investor (risk-aversion is required for this result).

THEOREM 3: *Consider an investment project whose return \$x is distributed with a PDF* $f(x)$. *The project requires an investment of \$K. A proportion* $\alpha$, $0 \leq \alpha \leq 1$, *of the investment is provided by concessional capital that requires no return. The rate of return to the investor is* $r = x/[(1-\alpha)K]$.

*Let the density function $f(x)$ be altered to $g(x)$ by a mean-preserving contraction, that is, $f$ is a mean-preserving spread of $g$. Then any risk-averse investor prefers the distribution $g$ to the distribution $f$.*

PROOF:
Follows from Proposition 1. ∎

We can illustrate the above considerations with a numerical example. Suppose we begin with a uniform distribution of returns over $[0, 10]$ and alter it (through blending) to a uniform distribution over $[0, 20]$. Doing so doubles the expected return but roughly quadruples the variance. For an investor who values return but dislikes risk, it is not immediately obvious that this change is an improvement. Theorem 2 tells us that it is. And Theorem 3 tells us how to improve the risk-return profile even further. Note that the fact that these changes improve the risk-return profile does not imply that the new profile is sufficiently attractive to bring in private investment. Private investors have an outside option given by the market, and the change in the risk-return profile has to be sufficient to match this.

In general, there will be many combinations of mean-preserving contractions and decreased capital requirements that will take the project's risk-return profile above the outside option, and the project manager's job is to find the least costly way of doing so. Lowering capital requirements means that more concessional capital is needed, and this is presumably scarce. So we economize on this capital by using only a mean-preserving contraction when possible and, if this is not possible, by using the minimal reduction of capital requirements. As long as the resulting risk-return profile matches the one of the investors' outside option, no change in capital requirements is needed.

Finally, we note that these considerations are in line with empirical evidence. Flammer, Giroux, and Heal (2025) show that blended financing structures help de-risk biodiversity projects in a way that matches the risk-return profiles of projects that attract pure private capital. Relatedly, Flammer, Giroux, and Heal (2024) show that blended finance structures often include risk-mitigating provisions (such as currency swaps and first-loss guarantees) among projects that face a high degree of risk, as measured by the degree of political risk and opacity in the country where the underlying (environmental and/or social) projects are conducted.

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