**Appendix 1: Additional simulations**

**Uncorrelated *B* and *V*; *α* = 0**

In section 4.2 we considered simulations in cases with “altruistic” buyers where *α* = 1, for the case of uncorrelated *B* and *V*. We will in this appendix report on simulations of our alternative specification of the buyer’s objective, *α* = 0, implying that the buyer completely ignores the seller’s objective, and assuming that *B* and *V* are both normal, and independent. Given the prior distributions for *V* and *B*, we can compute the improvement in (ex-ante expected) payoff, when the buyer chooses *H* after first observing *B* (under full information ex post), as compared to when only knowing the prior distribution for *B*.

The buyer chooses *H* to maximize his payoff conditional on the realized value of *B*. From (4), the buyer selects *H* below *EB*; but not necessarily below any given realization of *B*.

To find the value of perfect over imperfect information about *B*, we need an expression similar to (12). However, obtaining such an expression when *α* = 0 is not straightforward. *H* is here chosen to maximize the buyer’s payoff, at a value below *EB* with imperfect information, and below *B* with perfect information. When *α* = 1, *D* (= *B* – *H*) = 0. When *α* < 1, *D* > 0 and takes different values depending on the ex post realization of the initially uncertain *B*, revealed following new valuation information. As we cannot find a closed–form solution for *H*, from (6) and (7), no closed–form solution for *D* exists, and we need to resort to simulations.

We plot, in Figure 4, *EH* as a function of *EB* for the perfect information case, for fixed *EV* (= 10) and fixed standard deviations *σB* = *σV* = 1. *EH* is always below *EB* whenever this standard deviation is positive, and increases in the standard deviation. In the imperfect information case, by contrast, the buyer will need to set a fixed *H*, from (4). On the same graphic, we display the expected value of *H* (= *EH*) in the full information case. *H* here differs depending on the realized value of *B*. The red curve in Figure 5 shows that *EH* (taken over the whole distribution of *H* for a given prior distribution for *B*) is lower, when the prior standard deviation of *B* is greater. It is more favorable for the buyer to reduce *H* more when *B* is low, than to increase *H* when *B* is high. As the means of the two distributions diverge more (to about 3–4 standard deviations), this advantage is reduced. This is similar to Jensen’s inequality, as *H* is a concave function of *B*: .



**Figure 4: *H* and *EH* as functions of *EB* given *EV* = 10, *σB = σV* = 1; *α* = 0, zero correlation**

We wish to find how *D* (in the imperfect information case), and the ex-ante *ED* (in the ex-post perfect information case), which both represent the buyer’s “net gain per transaction”, vary with background parameters when *α* = 0. Figure 5 shows simulations for *D* = *EB*–*H* and *ED* as functions of (ex-ante) *EB* in these cases. We see that *D* and *ED* generally increase partially in *EB*, as one should expect. *ED* (with perfect information) is greater than the fixed *D* (with imperfect information). The difference is however small.



 **Figure 5: *ED* as function of *EB* given *EV* = 10, *σB = σV* = 1); *α* = 0, zero correlation**

These simulations indicate that when the standard deviation of *B* is “relatively small” (as in Figures 4–5), the buyer’s main gain from improved information is to a relatively small degree in terms of lower average payments to the seller, and more in terms of better resource allocation (as mistakes are fully avoided in the VOPI case). Although it is not so easy to see from Figure 5, the gains for the buyer are larger, the closer *EV* is to *EB*. This is intuitive, as the resource is more “contested” when the two expectations are close; a correct decision then depends heavily on the precise value of information about *B*.

When *σB* is larger, the expected change in outcome for the buyer, from the imperfect to the perfect information case, is more dramatic. This is illustrated in Figure 6, where the gain is simulated as a function of the standard deviation of *B*, *σB*, and focusing on a case where *σV* = 1, *EB* = 11, *EV* = 10 (where an essential feature is *EB ≠ EV*). The reason for the relatively drastic change in outcomes between the incomplete and complete information, in Figure 6, is that the informational value of perfect information increases (at least) linearly with the ex-ante standard deviation *σB*: the ex-post adjustments in payments from buyer to seller will then be greater. In particular, these payments will be adjusted down when the ex post observed *B* is high. Overall, this results in ex-ante expected savings for the buyer in terms of reduced payments to the seller, that are larger in the perfect information case.



**Figure 6: *EH* as function of *σB* given *σV* = 1; *α* = 0, zero correlation**

The VOPI for *α* = 0 is shown in Figures 7–9. Several of the results are qualitatively similar to Figures 1-3, for *α* = 1. In Figure 7, the VOPI is lower for *α* = 0 than for *α* = 1 (from Figure 1).



**Figure 7: The VOPI as function of *EV*; *α* = 0, zero correlation**

Similar comparative results are found when comparing Figures 2–3 (for *α* = 1), to Figures 8–9 (for *α* = 0). From all diagrams, we find the VOPI when *α* = 0 to be, typically, between one half and two thirds of its value for *α* = 1. This shows that when the buyer always makes a globally optimal resource protection decision (as when *α* = 1), instead of always making a “selfish” decision (as when *α* = 0), not only is the overall expected resource value lower; the value of adding more information (here of perfect information, VOPI) is also reduced.

Note also that when *α* = 0, the VOPI no longer takes its highest value when *EB* = *EV*, as was the case for *α* = 1. The reason is that *H* is set below *EB* in this case: maximizing VOPI here instead requires *H* (or *EH*) to be close to *EV*; which requires *EB* > *EV*.



**Figure 8: The VOPI as function of *σB* (= *σV*); *α* = 0, zero correlation**



**Figure 9: The VOPI as function of *σB* given *σV* = 1; *α* = 0, zero correlation**

**Positive correlation between *B* and *V***

In this section, we analyze and simulate the value of perfect information if *B* and *V* are positively correlated. We first study the case of a fully altruistic buyer, *α* = 1. The assumption that *B* and *V* are independent may not always be fully realistic. A reason for positive correlation between *B* and *V* is that some aspects of forest protection value, *B* (such as net rent from product harvesting), may depend positively on forest access, which could be positively correlated with net agricultural rents.

Appendix 2 gives a detailed mathematical analysis of payoffs under incomplete information for positively correlated *B* and *V* when *α* = 1. Under positive correlation, the strategies of the fully altruistic buyer can be studied analytically and numerically. Along with choosing a modified offer *H* under positive correlation, the resulting payoff to the buyer and seller will also differ.

Consider the strategy of choosing *H* for the altruistic buyer under positive correlation. We restrict this discussion to *EB = EV,* which allows for simplified analysis and interpretations. When *EB* and *EV* differ, the issue of how to interpret positive correlation is less clear.The constrained efficient solution then yields *H* = *EB* = *EV* as shown in Appendix 2.

Payoffs under incomplete information will depend on the joint distribution for *B* and *V*, and in on several other parameters. With higher degrees of correlation, and with similar standard deviations of *B* and *V*, *B* will be closer to *V*, allowing for less net rent extraction by the seller. However, it is not straightforward to show analytically what happens to the value of prefect information, as the rates of decrease for payoff under imperfect and perfect information can differ depending on the distributions of *B* and *V*.

Figure 10 considers the VOPI under identical assumptions as above except that *B* and *V* have a positive and increasing correlation coefficient, *ρ*, in the figure along the *x*–axis. The VOPI is higher when *B* is more uncertain than *V*. We see that unless *B* is significantly more uncertain than *V*, the VOPI under higher correlations eventually will start decreasing with higher correlation. This is understandable, since when the uncertainty about *B* is equal to or less than the uncertainty about *V*, higher correlations allow for more information under the incomplete information case than would otherwise be made available. However, when *B* is much more uncertain than *V*, the VOPI increases with increasing correlation. As explained in the mathematical appendix 2, our results cannot be analyzed for correlation above 0.5. We note that when *EB* = *EV* and *σB* *= σV*, the VOPI is expected to go to zero for the altruistic case, as net payoff in both the perfect and imperfect information cases is 0.

The mathematical appendix 2 gives us similar results under positive correlation for *α =* 0, illustrated in Figure 11. The VOPI is then lower than when *α =* 1, but the trends are similar. Figure 11 shows a change in derivative for the case where *σB* *>> σV*. For higher correlation values, VOPI might eventually start to decrease. Changes in correlation will here impact on the VOPI, but qualitatively, this will not change the overall results when considering low correlation values. VOPI is still higher in the altruistic *α =* 1 case than when *α =* 0.

Note that increased correlation reduces the maximum utilities both from perfect matching, and from imperfect matching when both *B* and *V* are uncertain to the buyer. VOPI is the difference between these two utility values. It is difficult to have a good intuition on this difference; it can as we see either increase or decrease, and shows no strong pattern in our simulated examples.



**Figure 10: The VOPI as function of the rate of correlation; *α* = 1**



**Figure 11: The VOPI as function of the rate of correlation; *α* = 0**