

# Risk, Reward, and Payments for Ecosystem Services: A portfolio approach to ecosystem services

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## Background

- Globally the number of Payment for Ecosystem Service (PES) schemes that forest owners have the opportunity to participate in is growing.
- In Finland, forest owners can participate in biodiversity conservation schemes.
- However, the growth and volatility of prices for differing PES can vary widely and have a major impact on forest owners' financial risk management.

## Objective

- Evaluate the financial diversification benefits of PES schemes, for climate change mitigation and biodiversity loss, in the optimization of a portfolio of different forest management regimes.

## Data and Methods

- MOTTI stand projection software was used to model stands for three site quality types (Rich, Medium, and Poor) and three current age classes (70, 90, and 120) using Finnish forest inventory data for southern Finland.
- Business-as-usual (BAU) management was based on the Finnish government (TAPIO) forest management recommendations.
- Biodiversity achievement was evaluated based on current Finnish practices (Juutinen et al., 2013). Climate mitigation was evaluated based on additionality of carbon sequestration relative to the BAU.
- Biodiversity PES data from Finland during 2003-04 and European Union carbon emission allowance prices from 2005-2012 were used to calculate the two PES return series. Climate PES were only considered for the period 2005-2012 due to the availability of data. Biodiversity PES were considered from 1995-2012 using Finnish 10 year bond return series as a volatility proxy for government PES payments.
- PES programs were compared with alternative financial investments (stocks and bonds) and the choice of harvesting the standing timber and replanting (BAU). Both 10 and 20 year PES contracts were considered.
- Modern Portfolio Theory was used to evaluate the risk – return trade-off when PES were available to forest owners (Markowitz, 1952). Previously, financial methods have not been used for evaluating the financial trade-offs between different PES programs.

## Results

- A strong correlation between forests under PES and BAU management resulted from the dominance of wood harvesting returns, which limited the financial diversification benefit of PES participation (Tables 1 & 2).
- Benefits were greater for the climate scheme than the biodiversity scheme; especially when stocks and bonds were included.
- Biodiversity PES were most favorable during low risk free rates. Benefits were also greater on rich site types than for medium or poor sites, which corresponds to current practices in Finland.

**Table 1. Share of the portfolio during 1995-2004 allocated to forest management under Payments for Ecosystem Services contracts and Business-As-Usual harvests both with and without consideration for other financial assets.**

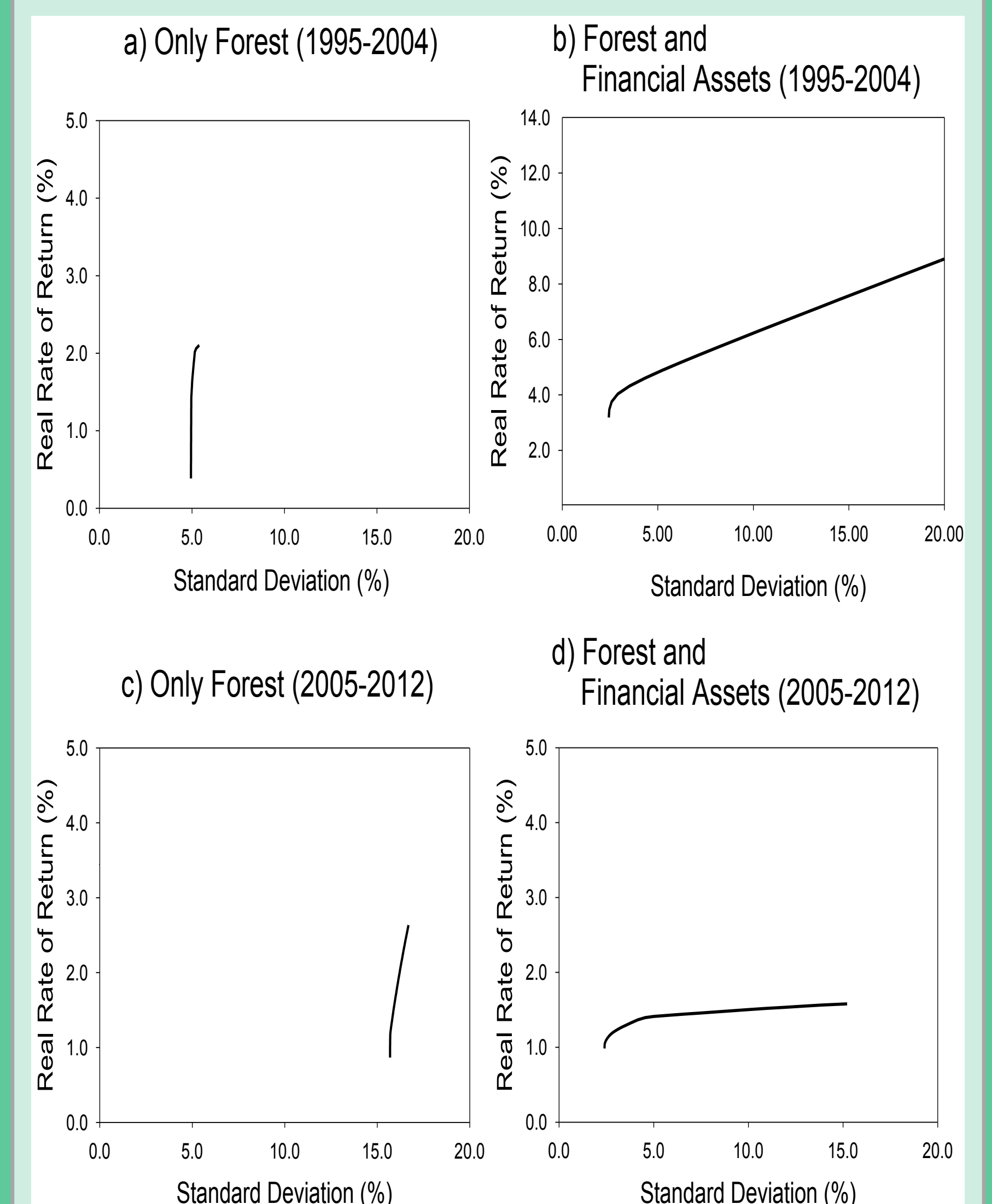
Asset Classes/ Management Regimes	Period 1995-2004					
	Forestland Only			Forestland and Financial Assets		
	Risk-free Rate (%)					
	0%	3%	6%	0%	3%	6%
Stocks	Excluded			0.03	0.08	1.00
Government Bonds	Excluded			0.91	0.92	0.00
BAU Management	0.28	0.86	0.86	0.00	0.00	0.00
Biodiversity PES (+10 Yrs.)	0.59	0.04	0.04	0.00	0.00	0.00
Biodiversity PES (+20 Yrs.)	0.13	0.10	0.10	0.06	0.00	0.00
Climate PES (+10 Yrs.)	Excluded					
Climate PES (+20 Yrs.)	Excluded					
Sharpe Ratio	0.39	-0.16	-0.69	1.45	0.39	0.21

**Table 2. Share of the portfolio during 2005-2012 allocated to forest management under Payments for Ecosystem Services contracts and Business-As-Usual harvests both with and without consideration for other financial assets.**

Asset Classes/ Management Regimes	Period 2005-2012					
	Forestland Only			Forestland and Financial Assets		
	Risk-free Rate (%)					
	0%	3%	6%	0%	3%	6%
Stocks	Excluded			0.00	0.00	0.00
Government Bonds	Excluded			0.88	0.05	0.05
BAU Management	0.00	0.00	0.00	0.04	0.00	0.00
Biodiversity PES (+10 Yrs.)	0.00	0.00	0.00	0.00	0.00	0.00
Biodiversity PES (+20 Yrs.)	0.00	0.00	0.00	0.00	0.00	0.00
Climate PES (+10 Yrs.)	1.00	1.00	1.00	0.08	0.95	0.95
Climate PES (+20 Yrs.)	0.00	0.00	0.00	0.00	0.00	0.00
Sharpe Ratio	0.16	-0.02	-0.19	0.44	-0.09	-0.28

- The inclusion of other financial assets resulted in greater volatility and returns possibilities at all risk free rates, which increased the Sharpe Ratios (Tables 1 & 2, Fig. 1).

**Fig. 1. Efficiency frontiers for both 1995-2004 and 2005-2012 when other financial assets were included and excluded. All axes are not equal given the wider standard deviation range for (b).**



## Why This Research Matters

- The results indicate that policy makers can improve the appeal of PES schemes by focusing more on the associated price risks.
- Financial diversification benefits of PES schemes do exist, but are limited by correlations with return series for traditional ecosystem services. Policy design and environmental site quality also have a major role in determining diversification benefits.
- Falling carbon offset prices positively increased their favorability. Those results are not expected to apply consistently in the future.

"The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO."

## References

Juutinen, A., Mäntymaa, E., and Ollikainen, M., 2013. Landowners' conservation motives and the size of information rents in environmental bidding systems. *Journal of Forest Economics* 19, 128-148.

Markowitz, H., 1952. Portfolio selection. *The Journal of Finance* 7 (1), 77-91.

