Portfolio Analysis for Investment on Ecosystem Restoration

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Investment on Ecosystem and Modern Portfolio Theory

Investment on ecosystem restoration

Current status of ecosystem degradation (Millennium Ecosystem Assessment, 2005)
- e.g. 20% of global coral reef disappeared during the last few decades

Ecosystem degradation implies the loss of natural assets
- Investment on natural capital for conservation or restoration attracts global attention

Modern portfolio theory

Theory of investment allocation for better expected return and lower risk

Efficient frontier:
- collection of portfolios for the lowest risk for a given level of expected return or vice versa

Capital allocation line (CAL):
- possible combination of risky and risk-free assets
  → its slope represents the Sharpe ratio; measure of the excess return per unit of risk

Market portfolio:
- portfolio of risky assets for highest Sharpe ratio
# Simulation Scenario & Data

## Simulation scenario

Investment on restoration projects for the following 7 ecosystems
- Funding resource may come from the global fund, domestic public investment or private stocks

Investigation of the market portfolio and prioritization from the economic viewpoint
- Implication for local policies and business

## Simulation data

<table>
<thead>
<tr>
<th></th>
<th>Coral reef</th>
<th>Coastal</th>
<th>Inland wetland</th>
<th>Freshwater</th>
<th>Tropical forest</th>
<th>Temperate forest</th>
<th>Grassland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Min. value</strong> (US$/ha/yr)</td>
<td>14</td>
<td>248</td>
<td>981</td>
<td>1,779</td>
<td>91</td>
<td>30</td>
<td>297</td>
</tr>
<tr>
<td><strong>Max. value</strong> (US$/ha/yr)</td>
<td>1,195,478</td>
<td>79,580</td>
<td>44,597</td>
<td>13,488</td>
<td>23,222</td>
<td>4,863</td>
<td>3,091</td>
</tr>
<tr>
<td><strong>Min. restoration cost (US$/ha)</strong></td>
<td>452,083</td>
<td>193,917</td>
<td>11,371</td>
<td>3,333</td>
<td>1,032</td>
<td>566</td>
<td>143</td>
</tr>
<tr>
<td><strong>Max. restoration cost (US$/ha)</strong></td>
<td>15,949,758</td>
<td>431,563</td>
<td>33,944</td>
<td>188,497</td>
<td>22,213</td>
<td>3,190</td>
<td>1,377</td>
</tr>
<tr>
<td><strong>Annual average return (%)</strong></td>
<td>-2.98</td>
<td>-2.70</td>
<td>2.64</td>
<td>-2.95</td>
<td>2.88</td>
<td>3.32</td>
<td>5.15</td>
</tr>
<tr>
<td><strong>Standard deviation (%)</strong></td>
<td>2.95</td>
<td>2.23</td>
<td>2.10</td>
<td>2.31</td>
<td>2.93</td>
<td>2.57</td>
<td>2.13</td>
</tr>
</tbody>
</table>

Value and cost data come from the TEEB D0 Appendix C + Climate Issues Update at the global level
Simulation Results

Maximum Sharpe ratio: 2.373

Sensitivity analysis

<Market portfolio>
- Coral reef: 0%
- Coastal: 0%
- Inland wetland: 20%
- Freshwater: 0%
- Tropical forest: 10%
- Temperate forest: 20%
- Grassland: 50%
Implication for local policy and business

Implication for local policy

• Some ecosystems (coral reefs, coastal area, and freshwater) may not be covered by the market portfolio due to their low expected return
  → Local governments may need to support or complement ecosystem restoration through public investment

• Firmly established economic valuation of ecosystem services will lower the risk of portfolio, subsequently achieve better Sharpe ratio
  → Local specific valuation may contribute to attract private investment on local ecosystem restoration

Implication for business

• Investment on ecosystem restoration will be economically efficient once the economic value of ecosystem services are recognized within the market

• Investment priority for inland wetland, tropical forest, temperate forest and grassland will be comparatively high from the economic viewpoint

• Some financial derivatives relevant to ecosystem restoration can be developed on condition of further valuation and analysis

• A new financial mechanism such as GDM may consider the possibility of portfolio (e.g. GDM portfolio)
Thank you for your attention