A Two-Stage Project Management Model

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1 Introduction

A specific challenge that companies and organizations face is that of selecting the most efficient ways of using their resources. For example, funding agencies need to decide which research projects will be financed and technology companies have to choose in what kinds of technologies and projects to invest in. Investment companies in banking sector face the portfolio optimization problem to select investment products that offer best risk-return characteristics. Portfolio selection models can be applied for several types of resources allocation problems. For example, Flessa (2003) analyzed optimal allocation of health care resources in developing countries. Sharpe and Keelin (1998) illustrated how a pharmaceutical company SmithKline Beecham rationalized resource allocations process of their R&D projects by applying systematic valuation process and decision analysis.

The valuating of new projects and collecting all the possible information may be expensive. Even if the companies could estimate the exact project values, the related information costs could reduce future profits significantly. Thus, the companies cannot perform thorough analysis of all possible projects but they have to get along with some level of uncertainties. For example, Wyatt (1992) presented that, in the context of universities bidding for research funding, comprehensive selection processes may lead to waste of resources and be very inefficient.

In this study the project evaluation and resource allocation is studied in the context of one- and two-stage project selection strategies. The different strategies are further compared in a simulated case study. Although companies face different kinds of project and investment opportunities the portfolio selection problem is relatively similar in each case. The focus is on a fictitious high-tech company’s project portfolio problem. However, the approach is very generic and could easily be applied to different kinds of investments.

The research problem is to study the properties of two-stage project port-
folio selection strategies. The two-stage strategies are compared to one-stage strategies under three project portfolio management strategies that differ in terms of their approach to project selection.

In Section 2, the one- and two stage project selection strategies and assumptions of the model parameters are determined. In Section 3, a case study is conducted by simulating the project management models. The aim is to study and compare the benefits of two-stage strategies and to determine the circumstances where the two-stage strategies are efficient. Section 4 concludes.

2 Project Management Model

In the project management model, there is a set of projects of which the decision maker should select those that maximize the portfolio value. Each year, there is a set of projects that could be launched, but due to the limited resources only a part of these projects can be launched. The project selection strategies deal with the optimal selection of projects that maximize the portfolio value over time.

For the sake of simplicity, each project is assumed to have a life cycle of 2 years and project selections are carried out between years. This assumption simplifies simulations.

2.1 Project Dynamics

In the project management model $t = 1, ..., T$ time periods are studied with $n$ project candidates per year. The projects candidates for year $t$ are denoted with indices $i \in P(t)$ such that

$$P(t) \cap P(t') = \emptyset \forall t \neq t', t = 1, ..., T, t' = 1, ..., T.$$ 

For each $t$ the decision problem is to select $S(t) \subset P(t)$ and $C(t) \subseteq S(t-1)$
such that $|S(t)| + |C(t)| \leq r(t)$ where $C(t)$ is a set of projects continued, $S$ is a set of new selected projects and $r(t)$ is the maximum number of projects at time $t$.

Each project candidate $i$ has an unknown true value $V_i$ and for projects in $P(t)$ and $S(t-1)$ value estimates $\hat{V}_i^1$ and $\hat{V}_i^2$ respectively with distribution presented below in Table 1.

Table 1: Notation for project values and for corresponding value estimates. The applied simulation parameters for project value and error distributions are also presented.

<table>
<thead>
<tr>
<th>Notation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of a project $i$</td>
<td>$V_i = e^{v_i}$</td>
</tr>
<tr>
<td>log($V_i$)</td>
<td>$v_i \sim N(\mu, \theta) = N(1, 1)$</td>
</tr>
<tr>
<td>First estimate of $v_i$</td>
<td>$\hat{v}<em>i^1 = v_i + \epsilon</em>{i,1}$</td>
</tr>
<tr>
<td>First error term</td>
<td>$\epsilon_{i,1} \sim N(\mu_{\epsilon,i,1}, \theta_{\epsilon,i,1}) = N(0, 1)$</td>
</tr>
<tr>
<td>Second estimate of $v_i$</td>
<td>$\hat{v}<em>i^2 = v_i + \epsilon</em>{i,2}$</td>
</tr>
<tr>
<td>Second error term</td>
<td>$\epsilon_{i,2} \sim N(\mu_{\epsilon,i,2}, \theta_{\epsilon,i,2}) = N(\frac{\epsilon_{i,1}}{2}, 0.5)$</td>
</tr>
<tr>
<td>First value estimate for project $i$</td>
<td>$\hat{V}_i^1 = e^{\hat{v}_i^1}$</td>
</tr>
<tr>
<td>Second value estimate for project $i$</td>
<td>$\hat{V}_i^2 = e^{\hat{v}_i^2}$</td>
</tr>
</tbody>
</table>

The exponential model for project values $V_i$ is used to achieve a multiplicative error model, in which the error is proportional to the project value. The project values follow log-normal distribution with an expected value of

$$E[V_i] = e^{\mu + \frac{1}{2} \theta^2}$$  \hspace{1cm} (1)

from which the base value of random funding strategy can be calculated.

When the second value estimate is made, the project has been run for a year and the decision maker has more knowledge about the project and can thus make more accurate estimates of its value. The improved accuracy corresponds to a smaller variance in the second error term. However, in making the second estimate the decision maker may be anchored to the first estimate, or may have a systematic error in evaluating a particular project.
so that the estimates become biased. To illustrate this anchoring effect, the second estimate \( \hat{v}_i^2 \) is constructed so that it depends on the first error by setting the mean of the second error term \( \mu_{e,i2} \) to depend on the first error term \( \epsilon_{i,1} \).

The project selections are based on the project value estimates that involve uncertainties. In the two-stage strategies, the valuation of ongoing projects is based only on the second project value estimation. This is, however, a suboptimal way of evaluating the projects since it ignores the first value estimate and does not exploit all the information available and thus leads to heuristic selection strategies. A more appropriate way to the valuation of an ongoing project would be to update the first value estimate with the second estimate. Hence, the information of both value observations would be used and more accurate estimates would be achieved. This suboptimality is considered when the simulation results are reported in section 3.2.

In the two-stage strategies, an ongoing project can be replaced after running it for one year with new a project. However, for new projects it takes two years to be completed before cash flows are generated, whereas the ongoing projects generate cash flows in one year. Launching new projects incurs cost as well, that should be taken in considerations when projects are compared. To take these differences into account the value estimates \( \hat{V}_i^1 \) of new projects are discounted with the interest rate \( dr \) and costs \( c \) of launching the projects are subtracted. This discounted project value estimate defined as

\[
\hat{D}V_i^1 = \frac{e^{\hat{v}_i^1}}{1 + dr} - c
\]

is applied instead of \( \hat{V}_i^1 \) when the first and second year project estimates are compared in the two-stage strategies.
2.2 Selection Strategies

One- and two-stage project selection strategies are applied for evaluating and selecting projects. The assumption is that the company tries to maximize project portfolio value by applying heuristic project selection strategies. There are three types of project selection strategies and each of these is studied as a one- and two-stage strategies. The selection strategies are named so that the A1 is one-stage and A2 a two-stage random funding strategy, B1 is one-stage and B2 two-stage threshold level strategy and C1 and C2 are one- and two-stage complete prioritization strategies respectively.

2.2.1 One-stage Selection Strategies

In one-stage selection strategies all started project are continued, i.e. $C(t) = S(t − 1) \forall t = 2, ..., T$. Below the one-stage strategies for selecting $S(t)$ and $C(t)$ each year are explained in detail.

**A1 Strategy**  In A1 $k = r(t) − C(t) = r(t) − S(t − 1)$ number of projects $i \in P(t)$ are randomly selected for $S(t)$. Intuitively this strategy appears very inefficient, as the company ignores the potential of other projects that could offer far more value. However, there are two major reasons to include this relatively simple strategy in the simulations. First, this strategy illustrates the minimum value that would be achieved, if no systematic selection process is applied. Second, it may be that projects are very similar in value and the cost efficiency overrides the added value of more deliberate project selection processes. In addition, high uncertainties in project values might induce large errors in decision makers estimate of project values thus bringing down the gained benefits of rigorous project valuations. However, to comply with the uncertainties in decision and risk analysis have been applied successfully, Kleinmuntz (2006).

Furthermore, the A1 strategy is a good starting point and benchmark for all the other strategies. The simple A1 strategy is also a good basis in
comparison of used resources to the added value of more systematic selection process.

**B1 Strategy** In B1 projects \( i \in P(t) \) such that \( V_i^1 > T_r \) are taken and from these \( k = r(t) - C(t) = r(t) - S(t - 1) \) number of projects are randomly selected for \( S(t) \). The B1 strategy is a compromise between the accuracy in selecting the most valuable projects and cost efficiency in estimating the project values. The threshold level can be set based on the previous experiences of the company’s projects or on the return expectations of the risky investments.

B1 strategy reflects the environment of many technology companies, where the companies put effort to analyze the alternative projects and they can make relatively accurate estimates of the project values. However, they cannot conduct thorough analyzes for each possible project due to time and resource constraints.

**C1 Strategy** In C1 \( k = r(t) - C(t) = r(t) - S(t - 1) \) number of projects \( i \in P(t) \) are selected for \( S(t) \) so that

\[
\sum_{i \in S(t)} \hat{V}_i^1
\]

is maximized.

Arguably, this kind of a strategy models that rationale of funding agencies, as research units apply funding for their projects. In such a process, the research units apply funding by presenting their research plans, funding needs and expected gains from the projects. In this kind of a process the institute has a good understanding of the projects and they can analyze all the projects and choose the best ones.
2.2.2 Two-stage Selection Strategies

The two-stage selection strategies allows the company to shift its resources from earlier projects to new projects, i.e. $C(t) \subseteq S(t-1) \forall t = 2, ..., T$. After running a project for a year company thus re-evaluates the ongoing projects and if the value estimate of some new project is higher the company can close down earlier projects and start new ones. This process is described in Figure 1. The grey shapes illustrate the launched project. In the middle of the project life the value of the project is reassessed. If estimated value of an ongoing project is lower than estimated value of a new project the first one is closed down and new one launched. Closing down a project is illustrated with the red in the figure.

The one stage strategies A1, B1 and C1 presented above are applied in the beginning of each year to select the launched projects. After launching the selected projects they are ran two years until they are completed. The initial project selection process in the two-stage strategies is similar to the corresponding one-stage strategies but the ongoing projects are re-evaluated and compared to new projects after running them for one year. As discussed above, the discounted value estimates $\hat{DV}_i^1$ are used for value estimates of new projects in the two-stage strategies instead of $\hat{V}_i^1$. 

Figure 1: Time line for projects. The chosen projects are launched in the beginning of the year and are marked with the grey shapes. After the first year the project is re-evaluated. Depending on the present value, the project is either continued (grey second year) or if there are new projects with higher present values the projects is stopped (red/dark grey second year) and a new project is launched.
A2 Strategy  The most simple two-stage strategy is A2, which is a two-stage version of A1 strategy. In A2 $r(t)$ number of projects $i \in P(t)$ are first randomly selected into $P'(t) \subset P(t)$. Then $S(t) \subseteq P'(t)$ and $C(t)$ are constructed so that

$$\sum_{i \in S(t)} \hat{D}V_i^1 + \sum_{i \in C(t)} \hat{V}_i^2$$

is maximized subject to $|C(t)| + |S(t)| \leq r(t)$. Maximum number of projects in $S(t)$ is thus $r(t)$ in case all $i \in S(t-1)$ are stopped.

B2 Strategy  In the two stage threshold value strategy B2 $r(t)$ number of projects $i \in P(t)$ such that $V_i^1 > T_r$ are first selected randomly into $P'(t) \subset P(t)$. If $|\{i \in P(t)|V_i^1 > T_r\}| < r(t)$, then less than $r(t)$ number of projects are selected into $P'(t)$. $S(t) \subseteq P'(t)$ and $C(t)$ are then constructed so that equation

$$\sum_{i \in S(t)} \hat{D}V_i^1 + \sum_{i \in C(t)} \hat{V}_i^2$$

is maximized subject to $|C(t)| + |S(t)| \leq r(t)$.

C2 Strategy  Third and the most comprehensive strategy C2 is full prioritizing strategy, in which each year all new projects are valuated. In C2 $S(t)$ and $C(t)$ are constructed so that equation

$$\sum_{i \in S(t)} \hat{D}V_i^1 + \sum_{i \in C(t)} \hat{V}_i^2$$

is maximized subject to $|C(t)| + |S(t)| \leq r(t)$.
3 Comparative Analysis of Strategies

In the section above the project management model and the selection strategies are represented. To test the project management models a case study is conducted, in which the one- and two-stage strategies are simulated by using Monte Carlo methods.

3.1 Simulation Parameters

In the case study, the model is tested by simulating it over 20 years time period. For the simulations the following parameters are fixed: mean and variance of the log-returns $\mu = 1$ and $\theta = 1$, discount rate $dr = 15\%$, time periods $T = 20$, number of available projects per year $n = 30$, $r(t) = 10 \forall t = 2, ..., T$ and $c = 1$. In order to have an equal number of projects available for one- and two-stage strategies, the maximum number of projects in $S(1)$ is set at $r(1) = 5$ in the simulations.

The six strategies of selecting projects are simulated using the same project values and project value estimates for each strategy. For each set of parameters 500 simulation runs are carried out to achieve reliable and statistical significant simulation results.

The project portfolio decision making is based on the project values estimates, which are determined one or two times, depending on the applied strategy. The first estimation is conducted at the beginning of the year in which the project could be launched and in the two-stage strategies A2, B2 and C2 at the beginning of the second year again if the project was initially launched.
### 3.2 Simulation Results

All of the six strategies are simulated simultaneously, so that the achieved values are not affected by the variations in variables. Presented results are average values of 500 simulations. Average portfolio value is the sum of the completed projects’ values $V_i$. Because the two-stage strategies involve additional costs from non-completed projects, profits of each strategy are calculated. The average profits are calculated by subtracting number of launched projects from average portfolio value. This is because the cost $c$ of launching a project is set at 1.

Table 2 presents the simulation results of the base scenario where the default parameter values are applied. Two-stage strategies A2 and B2 offer substantially higher returns than the corresponding one-stage strategies A1 and B1 respectively, where as there seems to be no major difference between the strategies C1 and C2.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Average portfolio value</th>
<th>No completed projects</th>
<th>Average value per completed project</th>
<th>No. launched projects</th>
<th>Average profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>403.0</td>
<td>90.0</td>
<td>4.48</td>
<td>100.0</td>
<td>303.0</td>
</tr>
<tr>
<td>A2</td>
<td>598.9</td>
<td>86.6</td>
<td>6.92</td>
<td>108.5</td>
<td>490.4</td>
</tr>
<tr>
<td>B1</td>
<td>547.7</td>
<td>90.0</td>
<td>6.09</td>
<td>100.0</td>
<td>447.7</td>
</tr>
<tr>
<td>B2</td>
<td>734.6</td>
<td>80.2</td>
<td>9.16</td>
<td>115.4</td>
<td>619.2</td>
</tr>
<tr>
<td>C1</td>
<td>911.1</td>
<td>90.0</td>
<td>10.12</td>
<td>100.0</td>
<td>811.1</td>
</tr>
<tr>
<td>C2</td>
<td>914.3</td>
<td>85.7</td>
<td>10.67</td>
<td>109.4</td>
<td>804.9</td>
</tr>
</tbody>
</table>

In the A1 strategy the projects are randomly funded. Thus the average portfolio value in this strategy can be considered as the minimum level of the average portfolio value that the company achieves from the projects. The average portfolio value from the first strategy is 403 units. As in all one stage strategies the number of completed projects is 90 and the number of launched projects is 100 in this A1. The difference in these numbers is due to the un-
finished projects of the last year, but does not affect the simulation results since it is the same for all of the strategies. Average value per completed project is 4.48, that is very close to the theoretical value 4.50 calculated as an expected value in Equation 1.

In the A2 strategy ten projects are chosen each year randomly and compared to the ongoing projects. Compared to the one-stage strategy A1, the two-stage strategy A2 offers higher average portfolio values and profits. The average portfolio value is 62 percent higher in A2 than in A1 and average profits are percent higher respectively.

In the more advanced strategies B1 and B2, project values are estimated at the beginning of the year in the order of appearance and project selections are based on the threshold level of project value estimates. B1 has average profits of 447 that is at the same level as A2 in which projects are funded randomly, but estimated in two-stages. The two-stage strategy B2 provides average profits of 619 that are 38 percent higher than the average profits of the similar one-stage strategy B1.

Strategies C1 and C2 are the most comprehensive, in which all of the 30 new projects are estimated in the beginning of the year and the projects with highest value estimates are launched. In the basic scenario both C1 and C2 strategies provide over 20 percent higher average portfolio values than the next best strategy. The average portfolio value and the average value per completed project are highest in C2. However, in C2 9.4 projects are closed down after the first year which incurs additional costs so that the highest average profits are achieved from the one-stage strategy C1. Hence, in the situation where all of the projects are first evaluated and then the most valuable projects are launched, the marginal costs of changing to more valuable project are higher than the marginal profits from the changes.
3.2.1 Accuracy of Project Value Estimates

Accuracy of the first project value estimation impacts the benefits of the two-stage project valuation. In the basic scenario, the A2 and C2 strategies, in which additional project valuation is conducted in the beginning of the second year offered over 30 percent higher average profits than the one-stage strategies A1 and B1. However, in the most comprehensive strategies C1 and C2, the two-stage strategy did not offer higher average profits because the initial project selections was efficient. In this Section, the effect of the accuracy of the first project value estimate is studied. Figure 2 reports the average portfolio values as the standard deviation $\theta_{\epsilon,1}$ in the distribution of the first error term $\epsilon_{i,1}$ is varied. The standard deviation $\theta_{\epsilon,1}$ is 1 in the basic scenario and 0.1 in the more accurate and 2.0 in the less accurate scenarios.

The two stage strategies seem to be especially sensitive to the standard deviation $\theta_{\epsilon,1}$. The average portfolio values in A2, B2 and C2 strategies offer 10 to 30 percent higher values as $\theta_{\epsilon,1} = 0.1$ and 10 to 25 percent lower values as $\theta_{\epsilon,1} = 2$. The A2 and B2 strategies are sensitive to the $\theta_{\epsilon,1}$ because the two-stage selection strategies are efficient only if the decision maker has a fair understanding of project values. Inaccuracies in project value estimates create additional costs as ongoing projects are stopped to launch new projects with higher values estimates that however do not offer higher values. The C2 strategy does better compared to C1 strategy as the accuracy $\theta_{\epsilon,1}$ rises. With a low accuracy, low value projects are launched and better projects possibly stopped in the C2 strategy.

Another factor in achieving higher average profits in the two-stage strategies A2 and B2 is the enhanced accuracy in the second project value estimation. The enhanced accuracy and thus smaller errors in the second value estimation illustrates the decision maker’s learning. To study the effect of learning to the average profits the simulation was conducted without accuracy enhancement in the second value estimation and was compared to the basic scenario. Strategies A2 and B2 with with enhanced accuracy offered
Figure 2: Sensitivity of the average portfolio values to the accuracy of the first project value estimate. The average portfolio values with higher ($\theta_{e,1} = 0.1$) and lower ($\theta_{e,1} = 2$) accuracy are compared to the basic scenario.

4 and 9 percent higher average profits respectively, compared to the same strategies with higher variance in error term. The learning in project valuation can thus increase the average profits and is considered as an important factor in the simulations.

### 3.2.2 Impacts of the Threshold Level

In B1 and B2 strategies the projects are selected and launched if they have a value estimate above the predetermined threshold value. Thus, the threshold level has a significant effect on average portfolio values. In case the threshold level is too high all available resources are not used. On the other hand, if the level is too low the completed projects are not the most valuable. Table 3 reports the effects of threshold level. Compared to the basic scenario both of the tested threshold levels 4.5 and 6.75 offer higher average portfolio values and profits in strategies B1 and B2 compared to the default threshold level 1.75. With the threshold level of 6.75, 85.6 projects are on average completed in strategy B1. With the threshold level of 4.5, 89.3 projects are completed in the strategy B1. Because the number of completed project is very close to
the maximum 90 projects, the threshold level 4.5 is very close to the optimal in terms of number of completed projects. However, the threshold level 6.5 offers higher average portfolio value than the threshold level 4.5. The reason is that with the higher threshold level there are usually enough resources available to launch the most valuable projects.

Table 3: The impact of threshold level to the portfolios in the threshold strategies B1 and B2.

<table>
<thead>
<tr>
<th>Threshold value 6.75</th>
<th>Strategy</th>
<th>Average portfolio value</th>
<th>No completed projects</th>
<th>Average value per completed project</th>
<th>No. launched projects</th>
<th>Average profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>776.6552</td>
<td>85.634</td>
<td>9.0695</td>
<td>97.834</td>
<td>678.8212</td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>888.11</td>
<td>74.65</td>
<td>11.897</td>
<td>121.282</td>
<td>766.828</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threshold value 4.5</th>
<th>Strategy</th>
<th>Average portfolio value</th>
<th>No completed projects</th>
<th>Average value per completed project</th>
<th>No. launched projects</th>
<th>Average profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>708.9013</td>
<td>89.284</td>
<td>7.9398</td>
<td>99.884</td>
<td>609.0173</td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>859.2787</td>
<td>73.46</td>
<td>11.6972</td>
<td>122.5</td>
<td>736.7787</td>
<td></td>
</tr>
</tbody>
</table>

The B2 strategy in which the ongoing projects are revalued in the beginning of the second year offers clearly higher average portfolio values than the B1 strategy in the basic scenario as shown in the Table 2. If the threshold level is raised to 4.5 or 6.75 the difference is smaller in relative and absolute terms. The reason is that with the higher threshold level better projects are initially launched and less projects need to be changed. With the higher threshold level more projects are launched in B2, because as projects with higher value estimates are selected, the discounting factor and additional cost from closing down ongoing project have smaller effect on project comparisons.

### 3.2.3 Benefits and Costs of Project Valuations

Different project selection strategies provide the decision maker with different average portfolio values as shown in the Table 2. Clearly, the more sophisticated strategies offer higher average portfolio values as the decision maker
has more investment alternatives and better knowledge of the project values. The value of more alternatives can be seen in comparing the one-stage strategies A1, B1 and C1 among each other as well as comparing the similar one- and two-stage strategies in Table 2. The value of accuracy in project value estimation is seen in Figure 2, where the two-stage strategy surpass one-stage strategy in case the value estimates are accurate enough but do not perform better if value estimates are inaccurate.

An important issue in the project selection process is however, to choose the level of resources that are used for project management. This study does not cover the cost of information acquisition very extensively; but the effect of information costs are studied by approximating the information costs as a product of number of project valuations and costs of a single valuation. Figure 3 presents profit analysis for the different strategies. Figure 3 shows the average portfolio values in each strategy as project launching cost $c$ is 1 and the valuation costs of a project is varied. The tested project valuation costs are 0, 0.3, 0.5 and 0.7 units per each project valuation. As the number of valued projects varies depending of the strategy, the average number of valued projects are calculated and multiplied by the unit costs. The 0 valuation cost level corresponds the basic scenario. As the valuation costs rise, the more sophisticated strategies, in which more valuations are carried out, turn less profitable. As the valuation cost increase some of the one stage strategies outperform two stage strategies.

If the second project value estimations in two-stage strategies had been done optimally, by utilizing both project value observations as discussed in section 2.3, the value estimates of the ongoing projects would have been more accurate. This would have reduced the number of high value projects that were stopped due to errors in project valuations. Hence, the two-stage strategies would have been more efficient and profitable.
Figure 3: The average profits as the costs of conducting a project valuation are varied. The studied valuation costs are 0, 0.3, 0.5 and 0.7 units per each valued project.

4 Conclusions and Discussion

In this study we determine the benefits of the two-stage project selection strategies in project management. The benefits are studied by comparing similar one- and two-stage project management strategies. The basic model and strategies are similar to Keisler (2004), in which the different decision making strategies are simulated to determine the value of information in the project selection. This study takes the Keisler’s model and strategies as a starting point, but pursues them another direction. The main focus is to study the effect of the second value estimation of ongoing projects to the achieved average portfolio values.

The benefits of two-stage project selection strategies depend on the accuracy of the values estimates in the first stage but are significant in a base scenario. Overall, the average profits were between 0 percent and 50 percent higher in two-stage strategies compared to one stage-strategies.
In the base scenario, the two-stage strategies proved to be very efficient providing substantially higher average portfolio values than the one-stage strategies. The benefits of the two-stage strategies were higher for the less advanced selection strategies A2 and B2 in which the initial selection is less efficient and the information of the second valuation thus valuable. The average portfolio values of full prioritization strategies C1 and C2 do not differ significantly, even so that the one-stage selection strategy provides higher average profits than the two-stage selection strategy. If the valuations of ongoing projects in the two-stage strategies had been done optimally, using both value observations, these strategies might had offered slightly higher average profits due to improved accuracy in project estimates. If the costs of conducting value estimations are relative high, average profits of two-stage strategies and advanced one-stage strategies B1 and C1 approach the average profits of the random funding strategy A1.

The benefits of two-stage strategies are highest when the decision maker has to operate under uncertainties, however with a moderate level of knowledge about project values. The benefits and costs of project management go hand in hand and thus modeling the value and costs of information could be a particularly interesting field of study in the future. Moreover, studying applicability of Bayesian methods to exploit all available information in project value estimations, might prove highly beneficiary, also for many real world applications.

References


