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Stochastic budgeting – forecasting large uncertain sales projects

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While markets have become increasingly fast and sophisticated in their data processing, the mechanisms that create the expectations have barely developed. Most stock-listed companies, not to speak of SMEs, still use quite arcane budgeting and forecasting processes. Depending on prospect lists, rough sales estimates and “best guess success probabilities made by sales persons, the accuracy of numbers depends highly on the person doing the work. Yet sales persons are different, and they have different personal motivations that influence their reporting. The notorious “sand bagging” process prevails, and is typically counteracted with a brute force “lifting the target” approach.

Budgeting and forecasting large projects – the challenge of the swing factor

There is a class of companies who are particularly vulnerable to the weaknesses of traditional budgeting approaches. Turn-key project providers, EPCI (engineering-procurement-contracting-integration) houses and other large scale project integrators often deal with a sales pipeline where one project easily can exceed the company's annual revenues. On top of that, these projects often have a high degree of uncertainty tied to multiple dimensions – the start date, the scope and the duration can all change dramatically over the sales cycle. In addition, individual projects can be linked to each other, and the company's overall capacity (availability) may put further restrictions to how revenue can be realized. In addition, large projects often face external market uncertainties, which may pertain to market interest rates, commodities prices, regulative outcomes or even the political situation in a country or region. Typical examples of this kind of companies are equipment (plant) providers to metals and mining, oil and gas, or chemicals, military systems providers and large scale construction and infrastructure providers. Their customers are often big natural resource companies, governments, or government agencies and institutions. However, as more and more companies are expanding their offering from products to services and complex product-service combinations, the challenge of predicting sales and revenue is getting more and more acute across the board.

Applying the basic concept of random variables

In this paper we want to expand on some ideas on how simple mathematical tools could be applied to improve the sales budgeting and forecasting process, and how these can also provide interesting insight for the management regarding the company's future outlook. Most certainly very advanced mathematical tools could be applied to achieve this, but these have the negative effect of being hard to implement with the frontline sales staff who after all have the best view on what is happening in sales. Thus we limit ourselves to some basic concepts, and then propose applying more advanced tools on the overall outcome of the initial modeling in a more centralized fashion.

To develop a stochastic budgeting model, one first has to define what parameters in the sales pipeline are to be treated stochastically (that is, which parameters are allowed to have a random character). In addition, one needs decide how to deal with uncertainty. Here we take a pragmatic approach – we assume discrete probability distributions, and we describe revenue streams with discrete vectors. In addition, we apply the central limit theorem without too much worry about mathematical rigor; in practical cases there will always be a fairly large number of projects in the pipeline so one can assume convergence towards a normal distribution in a basic scenario, where there are no interdependencies among projects.

Defining the elements of uncertainty

Typically, it is enough to assume that for each project there is uncertainty in terms of its start, scope and potentially duration. This can be done by describing each project as a stream of revenue (the time resolution can be chosen to months, quarters or years depending on needs), where each stream has a certain probability. Each revenue stream is simply a vector with revenue for each period of time. A more challenging issue is to deal with are projects with internal dependencies; this could stem from various factors, for example there might be a situation where two companies are competing for a certain commission, which only one can win. Our company might be the supplier for both. A simple approach to deal with this situation is to combine these two projects and treat them as alternative outcomes for a specific case. Thus, instead of representing project “A” and “B” separately in the model, one might represent all outcomes with the matrix “A and/or B”. The space of all the alternative outcome vectors forms a matrix and each line has a certain realization probability. In such a case interdependencies of the outcomes are simply “manually” inserted.

Let us consider a simple example. A project P has the revenue stream 20-50-20-10 over four consecutive periods. The sales person expects that the likelihood of the project starting in the first period is 20%, in the second period 60%, and in the third period 20%. The sales person thus is certain he eventually will win the project and merely uncertain of when it will start. If we form three vectors P-a, P-b, and P-c of this, and simply calculate averages and standard deviation, we obtain the plot in figure 1. Here the revenue streams of each project scenario, and the resulting average stream and the average plus/minus standard deviation plots are seen. There is clearly some weakness in the analysis, since the average minus standard deviation becomes negative, and this would have to be corrected in actual modeling, but the example illustrates how moving from three alternative scenarios to describing the project with statistics changes the view.

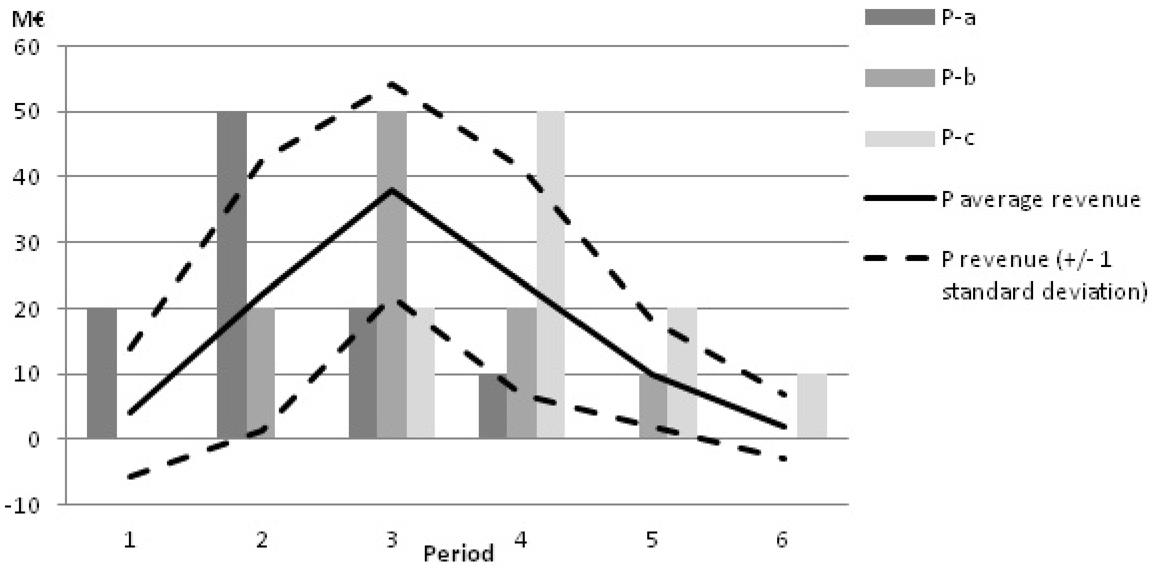

Figure 1. Modeling three potential scenarios a-b-c for a project P, and plotting the average and standard deviation.

Now, assume one would manage the modeling of all projects in the pipeline with some acceptable statistics, this would provide a revenue projection for the entire project portfolio. A key element of this is of course the actual modeling, but equally important is making sure the input parameters are simple and readily understood by the sales persons. The modeling thus must make sure it captures key uncertainties that are seen by sales persons in real life, but also that the parameters used to describe the uncertainties are intuitive and straightforward to estimate. Thus, in the above example the sales person only had to describe the revenue streams of the project and predict the likelihood of the starting period.

When the practice of using these types of project likelihood estimates has been used for some time, historical estimates should be compared to actual occurrences to assess their accuracy and develop the estimates for the future and historical project hit-rates can also be used as estimates of future probabilities.

External boundary conditions

The second phase is to apply the boundary condition that a company's capacity to deliver is not infinite, but rather has a fairly clear limit stemming from one or more factors; engineering capacity, manufacturing capacity (either own or supplier network), installation and commissioning, or project management capacity. While these parameters may be flexible over time, they tend to be hard to change within the time span of the projects in the pipeline. Thus, for example a large chemical plant construction project in the Middle East may take several years to complete. Should project management resources be a limiting factor to whether a company can take such a project on or not, one could of course try to hire more project managers. However, usually the real bottleneck becomes among those project managers who really can handle the overall project, and such resources are scarce and take years to develop from within. Typically the scarcity of these key resources also becomes even worse in an up-market, as everyone seeks to hire more. Thus capacity constraints have to be seriously accounted for in the modeling work.

Modeling this can be challenging. Although one might attempt to do this by simple prioritization, various factors can complicate things. Project profitability might be one prioritizing factor, but typically this varies over life. Also, there may be various levels of risk involved. Thus care must be taken that the modeling reflects the real-life complexities of the process. A simple model might assume that projects are handled on a first-come, first-served basis. In this case any project for which its vector element takes the total annual output over its capacity limit would thus be removed from the set.

As more data is gathered and a stochastic budgeting process utilized for some time, one can take on more sophisticated measures for project prioritization and resource allocation to different projects. Using a KPI (for example, probability weighted expected profit of a project) when allocating resources and prioritizing the project portfolio can improve the decision making and ensure best use of the available resources.

Connecting the stochastic model to reality

A model is only as good as its ability to predict reality. Thus moving towards stochastic budgeting is a step-wise process where one starts with a very simple model, typically running it in parallel with normal budgeting, and then carefully refines it iteration by iteration to make it increasingly useful. Improving the model is only one part, however. Equally important is to verify the ability of the people responsible for feeding in key parameters into the model, and through follow-up seek to train their ability (or alternatively, introduce correction factors). However, given that we are now dealing with stochastic variables rather than absolute values, we have much more room to apply various techniques for both model enhancement and input parameters accuracy improvement. In addition we now have the additional capability of looking at confidence intervals. This can become quite useful once the model has gone through a few iterations and starts to become a part of the regular toolkit used in the company.

Starting the journey

A real life implementation of stochastic budgeting requires care, and this short article can by no means provide a full insight into the required process and techniques. While a simple mathematical model and demonstration tool can be done in days, to make the approach useful in practice would require careful step-by-step implementation. The front line sales force need to be involved from the start. The model should be intuitive, and capture the key uncertainties sales persons deal with in their daily work. Capturing every uncertainty may be too much, so prioritization is important. Further, thorough understanding of data availability, the flexibility/adaptability of current systems, and the needs of management reporting is required. However, in our experience a stage-wise implementation procedure that builds on piloting and an iterative approach (refining the approach as experience accumulates) can provide a path to an improved process across the corporation in fairly short times, in the scales of months and quarters, rather than years.

As we move into an increasingly fast paced global economy where changes occur quickly and markets analyze our statements in microseconds, developing our internal processes to respond to these requirements is becoming increasingly important for all companies operating on a regional or global scale. Sales budgeting and forecasting is an area where even basic improvements can yield a much deeper insight into the company’s situation and outlook.