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Selecting Investments in Start-ups: an OWA-based Methodology

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Abstract

Investment process on startup companies faces several difficulties based on the characteristics of this type of companies, such as lack of historical data, current operating losses and absence of comparable companies. In this paper we focus in a new methodology based on ordered weighted averaging (OWA) operators. OWA operators are useful instruments that enable the aggregation of information; in other words, from a data set we are able to obtain a single representative value of that set. The investment methodology presented consists on the application of OWA operators to the targeted startup companies based on the capacity of cash-flow generation and also on the planned scenario of future growth for each company. This paper shows that the methodology proposed can serve as a valuable tool, complementing the qualitative criteria (which, obviously, should not be ignored) for assessing and selecting a start-up investment.

Keywords: Start-ups, Investments, OWA, Uncertainty.

1. Introduction

In this paper we propose a methodology for selecting investments in start-ups using the concept of ordered weighted averaging (OWA) operators. The application of this methodology enables us to rank investment alternatives and to select the best investment from a previously analyzed series of start-ups. Moreover, and in the specific case of start-ups, a diversified investment strategy is often available for an investor, which enables that investor to spread their risk, rather than investing everything in a single project. The investment selection methodology proposed – an OWA-based approach – can also be adapted to this need to determine a range of investment preferences across all available start-ups, thus facilitating investment in more than one company through the analysis of alternative investment scenarios.

2. The Start-Up Concept

The period from the creation of the company and during which the company continues to be referred to as a 'start-up' usually extends up to seven years. In this time the newly founded firm generally evolves through various phases, each of which has been studied extensively in the literature. The "inventive stage", in which the new start-up is no more than an idea in the entrepreneur's mind, is followed by the "seed stage", during which the company is legally established. In this phase, research is undertaken in order to determine an optimal product configuration, and at the same time the firm begins its market product research. By the "early stage" a product prototype based on the outcomes of the previous stage has been developed. In addition, a core team of managers and employees has been set up around the entrepreneur. It is during this phase, too, that the company develops its technical infrastructure and

operations. Subsequently, the company launches its product, developing its own equipment and infrastructure. This is when the start-up begins to generate its first revenues.

3. Owa Operators

OWA, that is, ordered weighted averaging, operators are instruments that enable the aggregation of information; in other words, from a data set we are able to obtain a single representative value of that set. Aggregation operators are a type of mathematical function used for merging information: i.e., for combining n values in domain D and returning a value in the same domain. Aggregation operators have multiple applications in a wide range of fields requiring the construction and evaluation of alternatives, typically in the frame of multi-criteria decision-making.

The OWA operators, as one specific family of aggregation operators, unify classical criteria decision-making under uncertainty in a single model; in other words, a unification that encompasses the classical criteria – optimistic, pessimistic, Laplace and Hurwicz – in a single expression.

The OWA operator is a function $F: R^n \rightarrow R$ of dimension n, having an n-dimensional vector associated W with dimension n with $w_{ij} \in [0, 1]$ and $\sum_{j=1}^{n} w_j = 1$, so that:

$$F(a_1, a_2, \ldots, a_n) = \sum_{j=1}^{n} w_j b_j$$

where b_j is the jth largest a_j.

Meanwhile, an ascending ordered weighted averaging (AOWA) operator is a function $F: R^n \rightarrow R$ of dimension n having an n-dimensional vector associated W with dimension n with $w_{ij} \in [0, 1]$ and $\sum_{j=1}^{n} w_j = 1$, so that:

$$F(a_1, a_2, \ldots, a_n) = \sum_{j=1}^{n} w_j b_j$$

where b_j is the jth smaller a_j.

The vector W is used to indicate the level of compensation between the criteria and the level of optimism of the decision maker.

Aggregation operators can be used to obtain composite indicators that summarize in a single value the results of other indicators.

4. Investment Issues Affecting Start-Ups

Investing in start-up companies presents certain challenges given the nature of companies of this type. First, start-up companies, by the very fact of their having a minimum life-span (less than seven years) typically cannot present any historical data series (for sales, costs, profits, etc.) that would allow a potential investor to extrapolate the future development of the business with any degree of certainty. However, any consolidated data that do exist can serve as the basis for numerous valuation methodologies, and thus help greatly in determining a start-up's value.

A further drawback in the case of start-ups is that their short life-span is typically associated with low profit levels and, in some cases, quite high financial losses. These losses are attributable to low sales volumes (logically, as in these early stages only a prototype is in existence) and to substantial expenditure owing to product research costs and payments to market research consultants. In technology start-ups, infrastructure costs are often particularly high.

Determining a value to facilitate the investment decision is further complicated in the case of start-ups owing to initial uncertainty about the feasibility and performance of the business model, which is a source of high volatility. Moreover, the existence of a single product and/or service in the early stages can generate binary scenarios in which the product and/or service either works or does not work, which is a scenario of great income uncertainty.

In the absence of a 'consensus valuation' method determined under conditions of uncertainty as regards which firm constitutes the most profitable start-up, investors draw upon various criteria to guide their investment choice. These 'consensus' criteria are:

1) Scalability, i.e., that the company can grow and reach a reasonable size.

2) An existing and clearly defined market, i.e., that the promoter of the start-up is able to identify ten potential customers with an interest in the product or service offered.

3) A competitive advantage over competitors.

4) An experienced team or one with the ability to see the project through to fruition, as well as a team of staff with the qualities needed to lead a successful start-up.

5) The time-to-market should be appropriate for launching the new product.
6) The ability to generate cash flows, i.e., that the future business can generate sufficient resources, especially necessary for the investor who seeks to sell his stake at a future date and obtain the expected return (that is, satisfy the provisions made at the time of investing).

5. Applying the OWA-based Methodology to Investment Selection in Start-Ups

The aim of this paper, therefore, is to illustrate how the problem of investment selection in start-ups can be overcome by using OWA operators in the decision-making processes. Such operators not only identify the most favorable investment, but they also offer a means for selecting starts-ups based on the application of various criteria.
Suppose an investor is presented with five investment alternatives in start-ups and wants to select the most profitable, establishing at the same time a rank order from the most profitable to the least profitable investment. These can be symbolized as follows:

I1 : Start-up A
I2 : Start-up B
I3 : Start-up C
I4 : Start-up D
I5 : Start-up E

The determining factor in the decision-making process is identifying the company likely to post the highest cash flow. Thus, a team of experts is requested to estimate the future cash flow values of each of the start-ups. However, as the environment is very uncertain, these results must be conditional on different states of nature Si – related to the economic situation of the economy – that may occur in the future. Thus, we consider a range of possibilities for each of these scenarios and so assess the corresponding cash flow. Thus, let us consider the following scenarios:

S1: Very negative economic situation
S2: Negative economic situation
S3: Slightly negative economic situation
S4: Slightly positive economic situation
S5: Positive economic situation
S6: Very positive economic situation

Then we can assume that the expected results for each of these scenarios are:

Table 1: Alternatives and Scenarios

	S_1	S_2	S_3	S_4	S_5	S_6
I_1	70	60	50	40	40	40
I_2	-10	40	70	80	100	110
I_3	0	10	20	80	120	150
I_4	30	40	40	50	50	50
I_5	-30	0	15	50	70	150

The team of experts, drawing on their expectations of the occurrence of these economic scenarios, set a weight vector, in such a way that:

$$W = (0.1, 0.1, 0.1, 0.2, 0.2, 0.3)$$

We can then proceed to apply the aggregation generic operators in order to make an informed decision as to what is the most suitable investment alternative for the investor. To do this, we consider the results obtained with the maximum, minimum, arithmetic mean (AM), weighted average (WA), OWA and AOWA operators. The maximum and minimum operators correspond to the start-ups' highest and lowest cash flows, respectively, for all the scenarios; the AM is calculated as the average of the cash flows over the six scenarios; the WA is calculated applying the values from the weight vector to each cash flow for each economic scenario; the OWA operator ranks in descending order the different cash flow values and then values from the weight vector are applied to them; and, finally, the AOWA operator ranks the cash flows for each of the start-ups in ascending order and proceeds as for the OWA operator.

The results obtained are:

Table 2: Results

	Max	Min	AM	WA	OWA	AOWA
I_1	70	40	50,0	46	46	55
I_2	110	-10	65,0	79	48	79
I_3	150	0	63,3	88	41	88
I_4	50	30	43,3	46	40	46
I_5	150	0	42,5	67,5	21	67,5

By way of example, take the case of start-up I1. After ranking its cash flow values in descending order, the OWA operator weights the results of the organization in accordance with weighting vector W, so that (70 * 0.1) + (60 * 0.1) + (50 * 0.1) + (40 * 0.2) + (40 * 0.2) + (40 * 0.3) = 46.

As the table above highlights, the investment decision varies according to the operator applied. If the AM or the OWA operator are used, the investor opts to invest in start-up I2. If the maximum operator is used, he opts for I3 or I5. If the WA or the AOWA operators are used, the decision would be to invest in start-up I3. Finally, based on the minimum operator, the investor would choose to invest in I1.

The results in the table also allow the investor to place the profitability of these investments in rank order. This is useful if he seeks to make more than one investment or wants to compare the different returns on all available investments.

The results obtained from applying this methodology show that each of the operators provides a different order of priority for making investments in the start-ups. Thus, depending on the operator used, the decision maker will come to a different decision. However, the underlying logic of these methods is that we assume the decision maker will have chosen the criterion and the vector of weights that best suits his preferences as regards risk and his other interests. As such, the outcomes can be expressed as follows:

Table 3: Operators

Operator	Ordination
Max	*I3 = I5 > I2 > I1 > I4*
Min	*I1 > I4 > I3 = I5 > I2*
AM	*I2 > I3 > I1 > I4 > I5*
WA	*I3 > I2 > I5 > I4 = I1*
OWA	*I2 > I1 > I3 > I4 > I5*
AOWA	*I3 > I2 > I5 > I1 > I4*

(Note that > means "is preferred to".)

6. Conclusion

Assessing the value of any business is by no means a straightforward task, but it is considerably more challenging when that business is a newly established company. Indeed, as discussed, most of the criteria available for evaluating a start-up with a mind to investing in it are qualitative. Given this state of affairs, in this paper we have proposed a quantitative methodology to facilitate the investor in this decision-making process.

The methodology comprises the application of the OWA operators, which enables the investor to unify the classical criteria of decision-making under uncertainty, as typified here by investing in a start-up. Such businesses by their very nature do not dispose of historical data that would enable the investor to extrapolate future cash flows; therefore, the provisions made in the firm's financial statements are highly subjective. However, the OWA operators allow the investor to consider a number of different economic scenarios for the start-up.

The use of cash flows as opposed to profits can be justified on two grounds. The first justification is mathematical in nature: accounting concepts such as profits, which offer no indication of a firm's liquidity, cannot be updated. And the second justification, which is economic in nature, is that in the first few years of their existence the start-ups may not in fact return any profits.

Finally, in summary, it can be concluded that the methodology proposed can serve as a valuable tool, complementing the qualitative criteria (which, obviously, should not be ignored) for assessing and selecting a start-up investment.

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