VALUING LIMITED INFORMATION IN DECISION MAKING UNDER UNCERTAINTY

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Abstract

Fresh Juice Inc. (FJI) is in the process of determining whether they should launch a new fruit juice in a market that has been relatively stagnant for the last 15 years. Management of FJI is faced with uncertainty surrounding market share, market size, price, and competitor entry. In addition, FJI has the ability to chose between alternative production processes; this choice directly affects the likelihood the investment will return a positive Net Present Value. This case teaches students how to develop a stochastic simulation models given limited information to analyze risk investment decisions.

Key words: simulation, uncertainty, strategic management, flexibility, limited information, investment analysis

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Introduction

Tom Samson, Executive Vice President for Marketing for Fresh Juice Incorporated (FJI)[1], believes his product development team has created a revolutionary product, in Genetically Enhanced Juice (GE) which may be the ticket to give FJI the new competitive advantage they need. The fruit used to make the juice has been genetically modified to produce increased levels of amino acids and other essential nutrients while maintaining a sweet taste with half of the sugar in other brands. These juice qualities meet consumer demand for an alternative source of nutrient replenishment. In addition to being a healthy juice product, GE Juice is quick and convenient for those consumers who have a busy lifestyle. Consumer demands are met because GE Juice provides a flavorful, fast, and nutritious meal replacement.

The ever-changing taste preferences of consumers have forced Fresh Juice Incorporated (FJI), to reassess the manner in which they make operational decisions on new product launches. Even-though FJI has been producing and distributing competitively priced, high quality fruit juices to all leading national grocery chains for over 30 years, the launching of GE Juice would be the their first launch of a truly innovative product in the juice market in 15 years.

Since 1964, FJI has been a leader in the finished consumer juice industry. Demand for fruit juice has remained steady over the last 10 years but an increase in the number of competitors continues to place pressure on FJI's leader status[2]. The intense competition for shelf space and the continuing fragmentation of consumer's tastes and preferences has kept competitors battling each other on price, advertising, and packaging just to maintain their market share. Since this industry has not seen an innovative product in 15 years, FJI's product development team believes GE Juice may be the ticket to give FJI the new competitive advantage they need.

Tom understands that there are many uncertainties surrounding the introduction of a new product to the market. Due to these uncertainties, Tom must answer a myriad of questions: Can this revolutionary new product earn enough profit to pay back the large investment necessary to start production of GE Juice? What if the market doesn't grow as fast as projected? What will happen if competitors enter the market and take market share and/or pressure prices? In addition, should FJI make the investment in an in-house bottling operation or should they outsource the bottling of GE Juice, a choice which is dependent on all other uncertainties and directly affects the likelihood of a positive Net Present Value (NPV)? With all of this uncertainty, Tom must decide if FJI should proceed with the rollout of the new product and if so, should FJI bottle the GE Juice in-house or out-source the bottling of GE Juice. One thing is for sure; if the decision is not made quickly, then others will surely beat FJI to the market.

The Situation

Tom has assembled your research team to help analyze the decision of introducing the new GE Juice to the market. With the amount of uncertainty surrounding the decision, your team feels that it will be necessary to do some quantitative analysis of the likely profitability of GE Juice. Your team has agreed that the analysis will include the development of a stochastic spreadsheet model to capture the nature of the uncertainties surrounding the decision

To help get started, Tom has provided some initial market analysis conducted by a consulting firm. In addition, the strategy division of FJI has provided an analysis of primary competitors and their likely actions over the next 5 years. Finally, the operations division has provided estimates of the costs associated with producing the new product including investment costs, co-packing costs, product purchase costs, labor, and all other fixed costs. Using this information, your team believes a model can be developed to do a thorough analysis of the alternatives and consequences. Upon completing the analysis, Tom requires that your team provide a detailed report outlining the results of the model which indicates if GE Juice should be launched and how GE Juice should be bottled.

Market Analysis

A consulting group was hired 4 months ago to conduct an analysis of the likely market for GE juice. The group conducted pilot tests of the product in five major metropolitan areas in the United States. One of the critical findings of the study was that consumers were not discouraged by the notion of the juice being genetically modified. Most consumers' responses showed that the FDA labeling was satisfactory and the nutritional value offered by the GE Juice far outweighed the waning concerns over the juice being genetically enhanced (Lusk 2003).

One of the primary concerns with GE Juice is whether consumers would want to have a meal replacement type drink that tasted like a fruit juice. The study found that 75 percent of those sampled found the taste of GE Juice to be equal if not better than their preferred brand of currently available fruit juices. The study also found that 21 percent would likely choose the fruit juice over other currently available meal replacement drinks. Consumers felt the product was truly unique and piqued their interest for health reasons, not as a meal replacement, but rather as a healthy alternative to currently available fruit juices.

The current fruit juice market is about 10,000,000 cases annually. The fruit juice market is in a mature phase with very little growth in total demand for fruit juices. The six primary players in the market place have not introduced new products to the market in several years and consumers have continued to purchase approximately the same amount of fruit juice for the past several years.

The consultants and Tom differ in their expectations of total market potential for GE juice. Tom believed there could be a large market for the product but perhaps not as strong as the consultants' estimate of 2,750,000 cases. After discussions with Tom, the belief is that there is a 90% chance the market for GE Juice is between 2,250,000 and 2,750,000 cases annually. Table 1 contains data relevant to total market demand for year 1. Therefore, the most likely

scenario for annual market demand of GE Juice is 2,500,000 cases, but the aforementioned interval recognizes the uncertainty in this estimate of market size.

Finally, in 1985 FJI introduced a new product called ENER Juice. ENER Juice was a formulated juice product that produced increased energy levels relative to regular fruit juice. This product had a similar acceptance rate with consumers in pilot tests conducted at that time relative to those pilot tests conducted on GE Juice. Annual product adoption of ENER Juice can serve as a proxy for the annual sales of GE Juice over the next ten years. This annual product adoption data follows the classic product life cycle and is summarized in Table 2. In addition to this information, FJI has an analysis of competitor actions over the product life of ENER Juice.

Competitor Analysis

The strategy division has compiled data on ENER Juice and the five primary competitors' actions during its product life cycle from 1985 through 1999. Table 2 summarizes the data compiled by the strategy division. This data is indicative of the mature nature of the ENER Juice market (i.e. lack of a significant number of new customers in later years). First the table lists the total cases marketed annually for all juices in ENER Juice's product market and then FJI's sales of ENER Juice over the given period. Next is FJI's market share of the ENER Juice market. Between the years of 1985 and 1987, FJI was the only firm in the market and therefore FJI's market share is represented by a 1 or 100% of the market. Competitors could not enter the market initially because of the difficulty in emulating the formula for ENER Juice. Over the product life cycle of ENER Juice, competitors developed a similar product and entered into the market. The next column gives the number of competitors in the market. FJI lost market share as more competitors entered into the market until FJI reached its long run market share (33%). The 'Capacity/Power of Competitors' column represents the strategy division's estimate of market power for competitors currently in the market relative to FJI. Further explanation of the significance and interpretation of this number is below. For now, this market power measure is directly related to FJI's market share because competitor market power is on a relative basis to FJI. Finally, the nominal average price for a case of ENER Juice is given.

Market share is certainly a critical variable in determining the profitability of GE juice. It is understood that market share is closely related to the actions of your competitors. The question is how much impact does each competitor have? Perhaps the data provided by the strategy division could be of use here. Of course, once the team knows what the impact of each competitor might be on FJI's market share for GE Juice, the team would still need to determine when or if any of the competitors might enter the market. Luckily, the crack strategy division has already been looking into that issue.

Table 3 contains the strategy division's estimates for both the relative power of each competitor and the likelihood of each competitor entering the GE Juice market. It should be noted that the relative power indices were estimated through conjoint analysis. A good resource for implementing conjoint analysis is outlined by Winston (1999). Competitor number one is a relatively small company with a relative power rating of only 0.27. The strategy group believes that this company does not have the products in place to enter this market in the first year. They expect the company, however, to be moving fairly rapidly with a 30 percent increase in the

probability of entering the market in each of years 2 through 4 with a certain entry into the market by year 5. Competitor number two is the smallest of the competitors with a relative power rating of 0.25. This competitor's focus does not seem to fit the GE juice market, thus the likelihood of their entry into the market is not nearly as strong as the other competitors. Of primary interest are competitors 3 and 5. These are the two strongest competitors that FJI faces and both of them are actively pursuing the market for GE juice. Competitive intelligence has discovered that competitor 3 is gearing up and will enter the market at the same time FJI plans to enter the market. Apparently, competitor 5 has been a little slower in developing their product but still has a good chance of entering the market in year 1 (80% probability of entering the market) and will certainly enter the market by the second year. Finally, competitor 4 has the third highest relative power index (.36). While they are not expected to enter the market in year 1, their probability of entry increases in subsequent years with an expected entry in year 5.

Price Analysis

Your team recognizes the impact that prices for the new product will have on profitability. Prices in this market place have traditionally been determined by the demand for the product and the relative strengths of competitors in the market.[3] To determine the impacts that demand and competitors will have on the price for GE juice, your team believes that the prices for ENER Juice over the 15-year period serve as a good proxy. Tom has indicated that the initial price for GE Juice will be $3.35 per case (Table 4). Your team knows that if supply and demand elasticity can be estimated from the ENER Juice data, then capturing these effects on the price of GE Juice should be no problem.

Cost Analysis of Alternative Investments

The operations department has finished its test runs of the GE Juice formulation suggested by the product development team and has produced a list of production costs for GE Juice which can be found in Table 5. To start production of GE Juice, FJI must make a substantial investment. Given the unique qualities of the genetically modified fruit, a special juice extractor must be purchased to ensure the integrity of the GE Juice. This special juice extractor costs $150,000.[4] In addition to this cost, FJI must either build a new in-house bottling and labeling line or outsource this process to another firm. Establishing an in-house bottling and labeling line will cost FJI $1,225,000.

The operations manager has estimated that the variable cost of producing and bottling the juice in-house most closely follows the classical polynomial average variable cost per unit curve (on a 1000-unit basis) with the following equation:

(1) $$AVC_q = 3.75 - 0.007q + 0.000006q^{2.5}$$

This equation includes the purchase of raw products. In addition, fixed annual overhead costs for in-house bottling will be $300,000 including a bottling line manager and scheduled annual maintenance. The operations manager also inquired about the possibility of shipping the formulated product, in bulk tanks, to a co-packer to be bottled. This implies that juice extraction

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must occur at FJI. Using this alternative would reduce fixed costs for Fresh Juice to $7,500. For the co-packing option, variable costs are a constant $3.05 per case.[6]

Tom has indicated that a substantial marketing campaign would likely have to be undertaken to get the product off the ground. Current marketing campaign plans (Table 6) would spend approximately $295,000 in the first year to produce in-store displays and advertising in local media. After the first year, marketing activities would continue to run over $200,000 until year 6 when our market share is anticipated to level out and marketing costs would decline substantially. Of course, the return on the project would have to be able to cover the marketing costs as well as operational costs for the project.

Finally, discussions with the finance department yielded several important pieces of information concerning this investment. This information is summarized in Table 7. First, the finance department has indicated that the depreciable life of any new equipment purchased would be about 10 years. Thus, approximately 10 percent of the initial investment value would be remaining at the end of 10 years. In addition, the finance department has indicated that most new projects must meet the company's customary hurdle rate of 15 percent before the CEO will consider the launch of GE Juice.

Assignment and Application

Armed with all of this information, your research team is ready to begin the development of a quantitative model to determine the profitability of GE Juice. Before your team begins modeling, it is important to determine the following: what are the key output and input variables, determining the intermediate outputs and design output tables, what are the equations needed to calculate the intermediate and final output variables, and determining which of the variables will be stochastic. Tom has stated that he wants an estimate of the project's NPV based on a 10-year analysis for both bottling options. Given the uncertainty for each of the scenarios, your team's recommendation should also include an overall risk assessment of the project. In essence, the model should be able to calculate the likelihood of profitability and the NPV of the project over a 10-year period.   From this likelihood, the recommendation should indicate which bottling method yields the highest payoff for FJI under scenario analysis.

In order to accomplish this task, your team needs to incorporate the uncertainty surrounding competitor entry, market size, market share, and price into your model by making sure the stochastic simulation model uses the proper distribution given the limited data. Once your team has correctly specified the distributions for the random variables in the model, it is time to move to the next step, correlation. This analysis should account for correlation between the random variables because market size, market share and price are random variables that are related to each other. If the correlation is ignored, your teams will either over or under estimate the total risk in the system.

By accounting for all of the uncertainty mentioned above, your team will provide Tom with the necessary information to make an economically informed decision on launching GE Juice. To assist your team in your analysis, you should be able to produce the following output:
1) Run the simulation model for 2000 iterations for both investment options.

      a. NPV should be an output variable.

      b. Cumulative Cash flows in each year should be an output.

2) Build a table that shows the Mean, Standard deviation, Coefficient of Variation, 5th, 25th, 50th, 75th and 95th percentiles and probability of being above zero for the NPV of both bottling options.

3) Develop a graph that contains the CDF for both bottling option NPVs.

4) Develop two series distribution graphs for cumulative cash flow (i.e. one for each bottling option).

5) Using the CDF, conduct a stochastic dominance analysis on the NPV output variables.

6) Take the difference between the NPV for bottling and the NPV for Co-packing using all 2000 iterations. Draw the CDF based on the difference of the NPVs.

7)

Use the output from above and anything else your team deems necessary to write a 2-4 page recommendation to Tom regarding how and/or if GE juice should be introduced into the market place. The text should be double spaced, 12 point font, and 1-inch margins. You may include all the tables and graphs you want to support your argument but they must be referenced in the text.

Footnotes

[1] The case is based on an actual company; however the name of the company and persons involved have been changed to protect their identity.

[2] Data was provided by an actual company, some of the financials have been changed to protect the company's identity.

[3] It is assumed that there is enough capacity available to meet market demand.

[4] The extractor equipment costs are incurred for both the in-house and co-packing bottling options.

[5] The calculation for total variable cost (TVC) for the in-house bottling operation would be as follows:

$$TVC = \left[3.48 - 0.007 * \left(\frac{q}{1000} \right) + 0.000006 * \left(\frac{q}{1000} \right)^2 \right] * q$$

[6] The calculation for total variable cost (TVC) for co-packing would be as follows: $TVC = 2.85 * q$

Table 1. Total market demand expectations in year 1

Most Likely	2500000
Worst Case	2250000
Best Case	2750000
Lower Percentile	5
Upper Percentile	95

Table 2. Historical information for Ener Juice

Estimated Total # of Consumers: 2500000

Year	Total Annual Market Sales	Our Firm's Sales	Our Firm's Share	Capacity/Power of Competitors	Number of Competitors	Price
1985	429885	429885	1.00	0	0.00	2.88
1986	719087	719087	1.00	0	0.00	3.30
1987	970380	970380	1.00	0	0.00	3.62
1988	1049537	1011850	0.96	1	0.27	2.84
1989	1600187	1451477	0.91	1	0.27	2.73
1990	1788933	1479509	0.83	2	0.52	2.49
1991	1716579	1264333	0.74	3	1.12	1.55
1992	1585359	1069566	0.67	3	1.12	1.58
1993	1888628	1193088	0.63	4	1.48	1.46
1994	1689309	892344	0.53	4	1.48	1.49
1995	1654920	846668	0.51	4	1.48	1.64
1996	998333	391218	0.39	5	2.03	1.17
1997	1163044	447395	0.38	5	2.03	1.31
1998	904736	297397	0.33	5	2.03	1.37
1999	685750	226397	0.33	5	2.03	1.49

Table 3. Relative power of competitors and probability of competitor entry

Firm	Relative Power	Probability of Competitor Entry Assigned to Each Year:									
		1	2	3	4	5	6	7	8	9	10
1	0.27	0.00	0.30	0.60	0.90	1.00	1.00	1.00	1.00	1.00	1.00
2	0.25	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
3	0.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	0.36	0.00	0.25	0.55	0.75	1.00	1.00	1.00	1.00	1.00	1.00
5	0.55	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 4. Initial market parameters

Expected Beginning Market Share	0.49
Initial Expected Price	3.35
Our Market Power	1.00
Total Initial Power	2.04

Table 5. Costs for the bottling options

| Production Costs | Investment Cost ($) | Variable Cost | | | Fixed Cost ($) |
		Constant	Q	Q^2	
Bottling (on a 1000-unit case basis)	1375000	3.75	-0.007	0.000006	300000
Co-Packing (per case basis)	150000	3.05	0.00	0.00	7500

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Table 6. Advertising campaign costs

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Advertising Campaign Costs	295000	290000	215000	200000	200000	165000	40000	20000	15000	10000

Table 7. Investment and financial considerations

Hurdle Rate	0.15
Percent of Investment Financed	0.50
Interest Rate	0.09
Length of the Loan	10
Salvage Value	0.1

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