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Case Article

Inkjet Printer Pricing

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The inkjet printer business had adopted the “bait and hook,” also known as the “razors and blades” or “tied-products,” business strategy, offering a basic printer product at a very low (possibly below cost) price but charging a highly marked-up price for its proprietary ink cartridge. This case explores the pricing of two interrelated products: the printer and its ink cartridge to maximize the overall profit.

This case is designed as an introductory-level case study that emphasizes the basics of spreadsheet modeling. The learning goals for this case are to improve students’ skills of modeling a business problem of this nature, determining the parameters involved, exploring the tradeoffs between different pricing criteria, and analyzing how profit can be affected by variations in the input parameter values such as printer cost, cartridge cost, printer price elasticity, and cartridge-to-printer projected sales ratio.

Key words: tied products pricing; spreadsheet modeling

History: Received: June 2009; accepted: June 2010.

1. Introduction

The “bait and hook” or “tied-products” business strategy is a well-known business model that has been widely adopted in various industries. In essence, the model offers a basic product or service at a very low price (the bait) with the intention of making substantial profit from selling the associated secondary products or services (the hook). Some examples include—

- Cell phone (bait) and phone service (hook)
- Razor (bait) and blade (hook)
- Printer (bait) and ink cartridge (hook)
- Computer game console (bait) and games cartridge or software (hook).

In this paper, we provide a short introduction to the business model and explain how it has been used as a classroom exercise at our institution to teach business spreadsheet modeling to undergraduates (from accounting, business, economics, information systems, and social science majors) in our Computer as an Analysis Tool (CAT) course. This course is mandatory for all undergraduates in our university. Leong and Cheong (2008a) explain in detail about the teaching of CAT course (Leong 2007). Similarly, others (including Davis 2008, Evans 2000, Liberatore and Nydick 1998, and Winston 1996) also use Excel™ in their classrooms to teach management

science courses. Their focus though is on well-defined problems, whereas our exploratory approach is oriented toward ill-defined and less-structured problems. For more examples and tips on such business modeling with spreadsheets, please refer to Leong and Cheong (2008b), the course textbook for CAT and two other graduate (Master of Information Technology in Business and Master of Applied Finance) program courses in spreadsheet modeling.

The main objective for this case study is to determine the prices for an inkjet printer and the ink cartridge that maximize overall profit. During the class, instead of the traditional teaching paradigm of providing step-by-step instructions of what to do, all class exercises are designed to encourage self-exploration and learning. The case study is given to the students prior to class, and the students are expected to do the background reading, understand the business problem context, and discuss the problem in the classroom before working on the spreadsheet model. The students have to think proactively, extract the relevant information, ask the appropriate questions, and model the business scenario from scratch. This approach of learning is more experiential and challenging for the students and the instructors. Nonetheless, over the years, CAT has gained an excellent reputation as one of the “best and most useful courses offered” at the university. The course is

offered twice a year. Every semester, CAT is almost always rated above 4.2 points out of 5 (or equivalently, above the 75th percentile of all courses) in student end-of-course evaluation reports.

2. Teaching Objectives

Over the year, this case has been designed and successfully delivered to thousands of our undergraduates from the Schools of Accountancy, Economics, Information Systems, and Social Science and the Business School. For incoming students who lack a management science or information systems background, we have to start with the basics of modeling (i.e., to effectively understand the nature of the problem), develop a simple model from scratch, and further enhance it into more complex decision-support models for analyses.

This case study's main objectives are to help students in the following areas:

- Acquiring practical skills that bridge technology and the business world
- Building models of a business problem without prior industry knowledge
- Analyzing and solving real-world business problems using the Excel spreadsheet
- Performing *Tradeoff* and *What-if* analyses.

The Excel spreadsheet is used as an exploratory modeling tool to help the students develop a deeper conceptual understanding and business intuition on interrelated product pricing. It also provides a valuable decision-support tool to compare alternative pricing possibilities and analyze any implications and visualize the results.

3. Case Analysis

The analysis of the problem in this case study starts with understanding the problem and making appropriate assumptions about printer and cartridge prices and demand, given the unit cost for both products. After a "brainstorming" discussion, students are able to identify the key input and output variables of the problem. Making some basic assumptions about the printer price and possible market responses, the basic demand model can be developed in a spreadsheet.

During the process of modeling, we expect students to query the situation by varying combinations of printer and cartridge prices. As we all know, the price of the printer has an inverse correlation with the demand. In another words, when the printer price is set low, more printers will be sold, which could result in higher overall revenue. Yet fewer printers will be demanded if the printer is more expensive, which will indirectly affect the demand for cartridges and hence the revenue from them. Students can illustrate the *What-if* tradeoffs between the relative prices

of the printer and its ink cartridge graphically. This Excel model helps the decision maker see the trade-offs between the printer and ink cartridge prices and the key performance indicators such as printer and cartridge profit and profit margin.

We limit *Sensitivity* analysis (commonly known as one of the most valuable concepts used in the dynamic business environment studies) only to the uncontrollable variable. Changes in controllable variables (commonly known as decision variables) have already been analyzed with *Tradeoff* analysis. Given the unknown printer cost, demand, or cartridge-to-printer projected demand ratio, students need to explore how the profits will be affected by varying different input values and to illustrate the solutions graphically.

4. Student Interactions

The case can be used as a class exercise to build experience in business modeling. Students are encouraged to read about this case prior to the class. At the beginning of the class, students need to determine the inputs, outputs, and their relationship. This discussion lasts about 10 minutes and stimulates their interest as they exchange ideas. The challenges include how to determine the printer price and its effect on printer demand, how to establish the ink cartridge price (which should not be higher than the printer price) and thus the cartridge-to-printer price ratio, determining the fixed costs, etc. Students, especially if they come from diverse backgrounds, will have different views and thoughts about how to approach and solve the problem. It is interesting to listen to their viewpoints, but as efficient instructors, we need to direct the discussion in a productive way. Some time must be set aside to teach students the relevant Excel skills, as they are needed to address the problem. In this case, the needed methods include the *fill*, *conditional formatting*, and *data table*.

We have found it useful to ask the students to start building the basic model in Excel from scratch, rather than providing them with a template to get started. For the first few lessons in CAT, they will find it hard to get started without template. Nevertheless, after a few lessons, they learn to appreciate the power of the spreadsheet as a problem discovery and framing mechanism and can work toward creating models in which the inputs can be changed as easily and frequently and the outputs are still computed correctly. The solutions can be easily replicated to many other cells with appropriate use of *relative* and *absolute referencing*.

The next step is to challenge students to think about how to modify the model if the input parameters or problem structure is changed. We find it beneficial if

the students help each other during class, as they can learn from each other. The instructor thus becomes more available to other students who need deeper guidance. Toward the end of the session, the instructor can illustrate the workings and explain various correct and erroneous approaches to solve the problem and why one option is better than the others.

The main objectives of this class are to encourage students to learn basic modeling and to build a simple business spreadsheet model in Excel that computes the profit and projected demand volumes for the printer and cartridge. The model can help users identify the printer and ink cartridge price combination that maximizes overall profit. The accuracy of the input parameter values will also affect the overall profit. Students can understand why uncontrollable variable values should also be varied to examine their effect on the profit outcome and find ranges of decision variable values that will make the profit less sensitive to changes in the uncontrollable variables.

This exploratory spreadsheet model supports the use of a “razors and blades” business model in the inkjet printer business. It seems that selling printers at a loss in order to sell more printers and hence more ink cartridges does indeed result in maximizing profit for the company. In fact, if the price ceiling for ink cartridges is high enough, the optimal price combination would be to give away printers and sell ink cartridges for the highest possible price.

5. Discussion

This case seeks to determine the optimal pricing for two linked products, an inkjet printer and its cartridge, using spreadsheet modeling. The case is given to the students prior to the class meeting, and they are encouraged to understand the problem context from it and, with this, participate interactively during class discussions. We understand that a course that is taught using cases such as this must be taught in an interactive manner. We require our students to bring their laptops to class, and lessons are conducted in small classes with a studio atmosphere. We try to interact with the class as a whole and simultaneously give each student individual attention and feedback.

Some students in our classes may have taken Management Science and other supportive courses (that increase their comfort with business modeling) but still lack spreadsheet technical competency; others may be experienced Excel users who know little about business modeling. We acknowledge their differences and try to use this to our advantage by encouraging students to help each other during our class interactions and activities. This approach further strengthens the value of our class sessions without necessitating more teaching assistants or additional instructors.

In a typical teaching session, we begin by discussing the issues around a case, to help students understand the context and identify the key problem. After that, we allocate 10–15 minutes for students to interact with the problem on a spreadsheet to develop in-class hands-on experiences in building the model in Excel. Before proceeding to do tradeoff analysis and more in-depth discussion, we show our model spreadsheet solution. The students are expected to finish the whole exercise within 90 minutes, usually giving us enough time to do two exercises per 3-hour class session.

The case is useful in illustrating the problem-solving steps of defining a model, stating assumptions, and explaining how the basic model can be enhanced to allow the conduct of *Tradeoff* and *What-if* analyses. Many cases in management science textbooks can be taught using the problem-solving methodology presented here, emphasizing more the exploratory modeling and problem discovery aspects rather than teaching an optimization method and the business model per se (see Cochran 2000 for discussion on this issue). At the end of the course, the students need to submit a final project, which constitutes 30% of the overall course grade. They need to find a real client and help solve a real-world business problem for the client using Excel spreadsheets. Through their learning in the project work, we feel that our students will be able to use their skills after the course to competently resolve real business problems.

Because this course is offered to students from different schools (Accountancy, Business, Economics, Information Systems, and Social Science), we need to organize and pace our classes accordingly. Professors who are conducting the class need to make sure that weaker students do not find it too hard to follow and stronger students do not get bored. Over years of conducting this course at our university, many students who have taken the class have admitted that they have learned a tremendous amount from the course. In particular, the mathematically weaker social science students have completed the course feeling more analytically confident and equipped.

Regardless of students' major, most students felt challenged in this course. Student feedback in the end-of-course evaluations indicates that they have learned valuable practical skills that help them better understand and frame problems and derive solution approaches. A sample of student comments we have received states this course as—

“The most interesting and one of the most intellectual challenging courses I’ve taken.”

“The problem-solving approach taken throughout the course is very practical and useful even beyond the computer.”

“Course was very challenging but I learnt a lot. The project helped me understand the practical nature of the course and its usefulness in everyday life.”

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