# A MULTIPLE CRITERION MODEL FOR THE PRODUCT PRICING DECISION

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## ABSTRACT

There are a number of arguments that relate to how firms should do product pricing. Although classic economic arguments suggest that prices are set to maximize profit, empirical evidence indicates that cost-plus pricing is the most widespread approach used in practice. However, other researchers have found other views of how prices are set, including attaining a satisfactory profit and not making too much profit. This paper argues that product pricing requires a multiple goal model where firms vary the priorities that they place on the achievement of particular goals as part of setting prices. A goal programming model is developed that captures these multiple objectives.

## I. INTRODUCTION

One of the most important decisions made by firms is the pricing of their products. Pricing decisions help determine what profit levels will be attained. Since profit lev-

els influence stock prices, product pricing decisions ultimately influence stock prices. In much of classic economic theory it is assumed that prices are set to maximize profit. Even accounting organizations, such as the American Institute of Certified Public Accountants, have given prominence to the view that prices are set to maximize profit, and provided guidelines to their members (AICPA 1965). However, empirical evidence suggests that firms use different approaches to set prices (such as cost-plus) in order to meet other goals, such as minimum or maximal profit.

This paper provides an application of goal programming (e.g., Charnes and Cooper 1977) to the product pricing problem. Such applications are important since they provide settings for the use of important tools designed to facilitate goal programming and related approaches. In addition, approaches, such as goal programming provide different ways of looking at previous research issues, focusing the analysis on multiple goals, rather than any one way of looking at the world. For the case at hand, typically researchers have argued that one approach is better or one approach is used more or one approach has limitations, and so on, all with the focus on "one approach." By viewing the problem as a multiple goal problem we break away from the historical focus on a single view and see that multiple goals offer an alternative explanation.

The paper proceeds in the following manner. Section II discusses the multiple objective nature of the pricing decision. Section III outlines a goal programming model of the pricing decision. Finally, section IV briefly summarizes the paper and discusses some extensions and some implementation issues.

## II.  GOALS AND CONSTRAINTS OF PRICING DECISIONS

Historically, research on product pricing decisions has focused on two overall findings. First, there are a number of different approaches to pricing. Second, in some situations one approach may have some advantages, while in other settings, another approach may have additional advantages. However, modeling pricing using multiple objectives has received little attention.

Alternative objectives to pricing decisions include pricing so as to obtain original cost, plus some increment for profit; exceeding minimum profit goals and not exceeding maximum profit goals. Ultimately, however, it is likely that rather than a single goal being the focus of the pricing decision that multiple goals or a portfolio of goals are addressed. Further, since few goals are likely to be met exactly, real world models must allow for over- or underachievement of goals.

### A.   Cost Plus

The cost plus approach to pricing is to use the cost of the product and some markup (to cover profit requirements, research and development, and so forth) in

order to set prices. According to Hilton, Swieringa, and Turner (1988) empirical evidence indicates that this is the most widespread approach used to product pricing in practice. Even the AICPA (1985) recently provided guidelines for pricing, completely based on cost plus approach.

## B. Satisfactory Profit

An important view of product pricing derives from Simon's (1957) concept of satisficing. A number of researchers have argued that the firm sets prices in order to earn a satisfactory profit. For example, some researchers have captured the need to attain a satisfactory level of profit as a constraint (e.g., Baumol and Quant 1964). Garrison (1985, p. 503) noted that "rather than attempting to maximize profits, many firms seek only to earn a 'satisfactory' profit. for the company. They think in terms of a reasonable return on investment that has been made in the company and they strive to set prices in such a way as to earn that return. The concept of a satisfactory profit underlies the actions of a great many business firms today."

## C. Not Too Much Profit

There are also incentives against a firm setting prices so that the firm does not make too much profit. As a result, scholars such as Garrison (1985, p. 503) have noted that "a limitation of the (profit maximization model) is that even if business firms have a precise knowledge of the slope of the demand curves, we cannot automatically assume that they would price in such a way as to maximize profits. The reason is that this might bring accusations from the public of 'profiteering' and 'charging all that the traffic will bear'. "

So-called "political costs" of making too much profit can be quite costly (e.g., United States oil companies during the oil crisis of the 1980s). Profiteering could lead to such undesirable events as legislation limiting profits or even nationalization of industries.

## D. A Portfolio of Pricing Approaches

Rather than a single objective, pricing decisions are likely to reflect multiple objectives in order to meet the many constraints placed on the firm. Shareholders and their desire for an appropriate return on investment or for an appropriate price-earnings level for stock price are likely to desire a minimum profit level. Other stakeholders, such as consumers will require that the firm not make too large a profit. Accordingly, because of these differing stakeholder groups we will see the firm employ a portfolio of pricing objectives, ultimately putting different weights on these objectives to meet particular political situations.

E.   Over and Underachievement of Multiple Objectives

In the face of a wide range of objectives, some of the objectives are likely to con-
flict or inhibit other objectives. As a result, the firm must plan so as to permit
underachievement of some objectives and overachievement of other objectives. A
goal programming approach allows for such over- and underachievement.

F.   Summary of Objectives

Although there could be other pricing objectives, our model is built on three:
price to earn enough to cover costs plus some additional profit margin; price to
earn enough profits; and price to make sure that you do not earn too much profits.
Further, our model is designed to facilitate over- and underachievement of objec-
tives because of their potential for conflict.

# III.   MODEL

This section sketches a model of the product pricing decision as a goal program-
ming problem with multiple objectives.

## A.   Goal Constraints

Goal constraints focus on attaining three different goals: attaining cost, plus a
percentage of cost; attaining a satisfactory profit; not getting too much profit. The
model focuses on situations with multiple products where costs can be assigned to
particular products directly, however, this can be extended to so-called joint cost
settings.

*Cost Plus Pricing*

Cost-plus pricing sets the price of product $i$ at the cost of product $i$ ($c_i$) plus some
incremental differential price ($d_i$), where the differential $d_i$ is set between some
upper and lower bounds $U_i$ and $L_i$ typically represented as a percentage of total
product cost. Ultimately revenues for product $i$ are set equal to $(c_i + d_i)(p_i)$.

From a goal perspective we wish to minimize overachievement ($\gamma_i$) of the upper-
bound ($U_i$) or underachievement ($\eta_i$) of the lower bound ($L_i$). As a result,

$$U_i - \gamma_i = d_i \text{ or } U_i - d_i = \gamma_i$$

$$d_i \geq L_i + \eta_i \text{ or } d_i - L_i = \eta_i$$

*Satisfactory Profit Pricing*

Satisfactory profit pricing indicates that the price $(c_i + d_i)$ must result in a satis-factory profit, or at least we must minimize deviation $(\varepsilon_i)$ from that satisfactory profit, $P_{Li}$. Since profit is captured as the product of the differential over cost and quantity, we have

$$\varepsilon_i = (d_i)\,(p_i) - P_{Li}$$

*Not Too Much Profit*

"Not too much profit" means that the firm cannot show too much profitability, or potentially experience some political costs. This can be accomplished by min-imizing overachievement $(\delta_i)$ of profitability $P_{Ui}$.

$$\delta_i = P_{Ui} - (d_i)\,(p_i)$$

## B.   Objective Function

The objective function should reflect each of the goals discussed above. Asso-ciated with each objective $k$, for product $i$ is a weighting factor $\Gamma_{k,i}$ $(\geq 0)$. As a result, the objective function, related to these objectives can be written as

$$\text{minimize } \Sigma_i\,(\gamma_i\,\Gamma_{1,i} + \eta_i\,\Gamma_{2,i} + \varepsilon_i\,\Gamma_{3,i} + \delta_i\,\Gamma_{4,i})$$

## C.   Selected Model Constraints

In addition to production constraints, there are additional constraints on the achievement of the multiple objectives, including the following nonnegativity constraints on the goal achievement variables and pricing increment variable, as seen below.

$\eta_i \geq 0$
$\gamma_i \geq 0$
$\varepsilon_i \geq 0$
$\delta_i \geq 0$
$d_i \geq 0$

Further, the product of deviation variables is required to be zero (e.g., $(\eta_i)\,(\gamma_i) = 0$; and $(\varepsilon_i)\,(\delta_i) = 0$).

# IV. SUMMARY, EXTENSIONS AND IMPLEMENTATION ISSUES

## A. Summary

Literature on product pricing has found a number of objectives play a role in pricing decisions. Those objectives include covering costs and a certain percentage of costs, making a certain minimal level of profit and staying below some maximal profit level. Although previous researchers have focused primarily on using single goals to model pricing decision making, the primary contribution of this paper is to emphasize the importance of a portfolio of objectives. This was implemented by modeling the process as a goal program. That model permits multiple goals and over and under achievement of the potentially conflicting goals.

## B. Extensions

The model developed in this paper can be extended in a number of directions. First, the focus could consider additional motivations of the firm, beyond those considered here. For example, Gordon, Cooper, Falk, and Miller (1981) found evidence that firms set prices for individual goals such as liquidity along with seven other pricing objectives. In particular, they also studied the following pricing objectives, total profits, total sales, market share, price earnings ratio, employee job security, industrial relations and return on investment. Jackson and Wallace provide another view of pricing, focusing on principle agent settings and cost-benefit as a goal.

Second, this paper modeled the decision associated with products each with a set of identifiable costs. In some product pricing settings there are so-called joint costs. This research could be extended to account for such situations.

Third, this paper focused on linear models throughout. However, we could focus on nonlinear models where production is not set or where pricing is not just incremental in nature.

## C. Implementation Issues

There are a number of implementation issues. First, the model would take on more "interest" with the addition of constraints on issues such as liquidity, etc. as considered individually by Gordon and colleagues (1981). However, this paper accomplishes its objectives by viewing the problem as a multiple goal problem and as noted above, can be extended to include such constraint structures.

Second, the model calls for setting production and solving for price. However, there is a simultaneity problem with price and quantity, that suggests that a quadratic approach would be superior. In either case, it is assumed that the demand function or at least points on it are available.

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