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Optimal Quarterly Sales Targets for a Mobile Phone Company with Exogenous Yearly Targets

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Abstract

I consider the problem of determining short-term (quarterly) sales targets for a regional division given yearly quotas exogenously imposed by the corporate parent's headquarters. In an increasingly complex and dynamic economic environment, this problem arises in the attempt to balance the global factors such as corporate budgets, supply and aggregate demand with the division's shorter term issues and the regional market's specific characteristics and attributes. The problem is modeled as a linear program to determine the optimal quarterly allocation of a range of products to maximize the revenue while satisfying the yearly quotas and the short term demand constraints for each product in the range. The linear program is solved for a real-life case. The results indicate the existence of such an optimal allocation and provide further insight into the problem for the division's marketing management. Future research paths which include the combined short-term price-quota determination and the stochastic demand-price instances conclude the exposition.

Introduction

For the last decade, the Middle East region has been experiencing an unprecedented expansion in the Telecommunications industry. Many operators have been established to cater to the needs of the market. Many of the GSM operators have expanded their customer base by offering the "prepaid" service. All of these factors enticed mobile phones manufacturers such as Nokia, Samsung, Sony-Ericsson, Siemens, LG and Motorola to penetrate the region to take advantage of the ever-increasing demand for these products. For instance, the number of GSM subscribers in the United Arab Emirates (UAE) alone has grown form an initial 25000 subscribers to more than 2500000 subscribers in a little over a decade. Furthermore, the replacement market in the UAE is one of the highest in the region. Mobile phone consumers tend to replace their hand-held sets each six months on average. Despite the fact that the UAE market in not the largest in the GCC region, many manufacturers are prioritizing it over other markets due to its emergence as a hub. The first and largest GSM operator in the UAE is "Etisalat", a company which has a majority of its shares traded in the UAE financial markets. A look at the market structure indicates an oligopoly structure. The Finnish manufacturer NOKIA has a commanding share of the market, followed by the Korean maker SAMSUNG. Siemens, Motorola, LG, and Sony-Ericsson have the third to the sixth market share in the region. There are some other players with minor shares and would therefore be excluded from the analysis. LG, the Korean maker has entered the UAE market in 2002. Since then, LG has been actively trying to improve its market position. During a short period of time, it managed to rank 5^{th} in terms of number of units sold and 6^{th} in terms of revenue. Its success was due mainly to its differentiation approach, whereby products customized to the market are introduced at competitive prices. For instance, LG introduced the first mobile phone, the G5300, that targets the Muslim population by incorporating a "Qiblah" direction feature (the direction of Mekkah for Muslim prayers). The market share of each of the main players in the UAE market is presented in Table 1.

In order to strengthen its position in the market and further capitalize on its potential, LG needed to develop a marketing strategy that sets sales targets to maximize revenue while taking into account a number of factors. These factors include: demand, competitors' pricing strategies, specific model prices

Table 1: Market Share as of Quarter 1 2004

Company	Market Share		Rank	
	Units Sold	Revenue	Units Sold	Revenue
LG	3.89%	2.19%	5	6
Samsung	20.99%	20.79%	2	2
Nokia	60.11%	67.59%	1	1
Siemens	6.50%	4.13%	3	3
Sony Ericsson	3.50%	2.55%	6	5
Motorola	5.01%	2.75%	4	4
Sum	100%	100%		

of LG phones relative to competitors, the cost structure, and the allocated quantities of phones to the UAE market by the company's headquarters in Korea. The objective of this paper is to determine quarterly sales targets with the purpose of maximizing revenue and taking into account all of the factors mentioned above. In other words, the objective is to maximize the revenue from LG mobiles phones in the UAE market by determining a proper quantity allocation of the entire lineup for the four quarters in a year. In section 2, a literature review is presented. In section 3, the problem and the different variations of it are discussed. In section 4, the solution procedure is developed. In section 5, the results are analyzed and the model solution is interpreted. In the conclusion, the key findings are summarized and the future research outlook is provided.

Literature Review

The literature studying the specific problem of optimal short-term sales targets determination given exogenous yearly sales targets and competitive pricing forces is quite rare. Most of the literature focuses on the pricing issue. However, in many practical situations, geographical divisions of large multinational companies get yearly quotas from the headquarters of the parent firm. Due to the different competitive factors of which price is an important one, determining the shorter term (particularly quarterly) sales targets is not an obvious problem for the regional division. Sales quotas are generally determined taking into consideration the seller's market share and the nature of the competitive domain. An important feature of oligopolistic markets is the strategic interaction between the firms offering their products on such markets (Hauenschild and Stahlecker 2003). Aggregate demand functions are typically used for quota determination despite the many issues economists raise regarding their existence and downward-sloping nature (Kyer and Maggs 2003). Aggregate demand functions give the quantity demanded of a commodity as a function of a number of parameters including prices and total expenditures (Matsuda 2005). Chintagunta (2004) warn that demand functions parameters may be biases and inconsistent if both endogeneity and heterogeneity are not accounted for appropriately. It is important to note that demand curves estimated from market data need not reveal true consumer preferences in any normatively significant sense of the term (Ariely et al. 2003).

In an industry that has a clear leader, price collusion is observed. Due to the difficulty of charging the "right" price stemming from the many uncertainties (Elmaghraby and Keskinocak 2003), followers generally charge prices that are a function of the leader's prices for similar models. Although the differentiation between the standard products is reduced, price competition does not necessarily intensify (Dewan et al. (2003)). The only application I have found that relates directly to the problem at hand is in Lovell and Morey (1991). The paper describes an application to the US Army recruitment, where decisions are made on what incentives to offer to enlistees to meet yearly enlistment targets. Literature on pricing is quite abundant. Dockner and Jorgensen (1988) and Thompson and Teng (1984) look at the optimal pricing problem for new products in dynamic oligopolies. Dockner and Jorgensen compare the pricing patterns for myopic and dynamic oligopolies, and conclude that myopic oligopolists price higher than

their dynamic counterparts when imitation and/or cost learning effects dominate, and vice versa if saturation effects dominate. Thompson and Teng show that the optimal constant pricing rule is a weighted average over time of the instantaneous marginal pricing rule. Gallego and Van Ryzin (1994) consider the situation when the company must sell a certain stock by a specified period of time, under conditions of sensitive and stochastic prices, to maximize the revenue. An interesting finding they report is the fact that "simple fixed-price policies work surprisingly well in many instances." This provides the necessary ground for assuming fixed prices for the problem at hand. Krishnan et al. (1988) use a variation of the generalized Bass model to determine optimal pricing policies for new products that are consistent with the empirical result that prices should not necessarily be based on the sales volume growth. Jain et al. (1999) look at the conditions under which a price skimming or penetration strategy would be preferable for companies that offer both the cell phone sets and the phone calls. They observe that although the cell phones' prices have dropped significantly, the calls prices did not exhibit the same pattern. They find that for high levels of production costs, skimming is a better alternative; whereas penetration is better in the case of low production costs. This also supports the choice of the penetration strategy in our study. Zhao and Zheng (2000) use sample path arguments to show that for perishable assets with non-homogeneous demand, the optimal price decreases with inventory.

Problem Statement

There is no argument that sales and marketing are correlated. In order to drive sales volumes up, sufficient marketing activities should be conducted regularly. Furthermore, marketing activities should focus on the unique selling proposition of each product. The key features and benefits of the product should be highlighted to the target audience upon running any advertising campaign. For instance, European and American companies rely heavily on advertising to improve their sales. The Korean counterparts, on the other hand, believe that the sales volume will allow them to support the marketing activities and not vice versa. As such, these companies utilize a percentage of sales method to determine their advertising budgets. For an already established company, such as Samsung, this would present no difficulties. However, for new entrants, this approach can hinder their quick penetration in the market. Moreover, the presence of a clear market leader and implicit price collusion, followers price their products as a function of the leader's prices, in our case, Nokia and Samsung. Nokia and Samsung have a clear pricing pattern that is quite standard. Nokia drops its prices by 10% for the first quarter and 5% for each quarter afterwards. Samsung reduces the price of each model by 5% each quarter. The LG UAE division has a very basic price calculation formula where the price of each model is set at 90-95% of the price of the benchmark competitive model. The price list is presented in the Table 3 in the appendix.

Problem Formulation

Although it may be more optimal to solve the headquarters problem at large, it is not my intention in this manuscript nor was it the intention of the division's marketing management. The division's problem and solution thereof may be *myopic*, however this relates directly to the headquarters-division decision making balance. For a broader supply chain perspective on pricing and replenishment strategies, the reader may consult Chen et al. (2001) and Ha et al. (2003). The attempt is therefore, as it should be, to model the real life problem as described and not the fantasized theoretical version of it. Note that this is would be a tool in an overall decision support system (DSS). Lilien et al. (2004) have shown that decision makers who use high-quality model-based DSSs make objectively better decisions than those who only have access to generic decision tools. However, they point to the fact that the subjective evaluations of the decisions and the processes that lead to those decisions do not necessarily improve as a result of DSS use. The allocation problem facing LG has the following characteristics:

- There are a number of different sets, each with its own sales target that must be met. The yearly quotas are set by headquarters in Korea. The main feature of this scenario is the "the exogenity of the [yearly] sales targets" (Lovell and Morey (1991)).

- The price charged for the product is a function of the price charged by competitors for the closest benchmark model. The penetration mechanism employed means that the prices charged will generally be lower than those of competitors.
- The goal of the UAE division is to determine the optimal quarterly sales targets so as to simultaneously meet the yearly quotas and maximize the revenue to enhance the company's market share in terms of revenue and units sold..

The price for LG is a function of the price charged by competitors offering the closest competing model to the LG model. There is a fixed sales quota by the LG headquarters that must be met. Let q_{ij} be the quantity of model i allocated to quarter j, and p_{ij} be the price charged for model i in quarter j. Further, let Y_i be the yearly quota of product i, and D_{ij} be the maximum demand for model i in quarter j at the price level p_{ij}.
With these definitions, the objective function is to maximize the yearly sales as follows:

$$\max \sum \sum p_{ij} q_{ij} \tag{1}$$

The first constraint is the yearly quota set by headquarters. One may argue that setting such a constraint would be illogical given the fact that we would normally strive to sell as much as possible. Albeit the fact that this is true, it is important to remember that the yearly quota is not set arbitrarily. It takes into account several factors that include available resources, yearly aggregate demand, capacity limits, marketing efforts and the competition among others. The constraint can be formulated as follows:

$$\sum_j q_{ij} = Y_i; \quad i := 1, \ldots, I \tag{2}$$

Since the price changes from quarter to quarter as explained earlier, then according to the demand function, the maximum quantity that can be sold of each model also changes from one quarter to the next. With everything else is assumed unchanged (i.e. marketing effort, competition pricing, ...etc), the only variant in the demand function is the price. The maximum quantity demanded for each model in each quarter, D_{ij} can be derived directly (see Table 4 in appendix for the different models' demand functions), and the constraint on the quarterly demand can be stated as follows:

$$q_{ij} \leq D_{ij}; \quad i := 1, \ldots, I \quad j := 1, \ldots, 4 \tag{3}$$

With this objective function and these constraints definitions, the basic model can be stated as follows:

$$\begin{aligned} BP: \ \max \quad & \textstyle\sum_i \sum_j q_{ij} p_{ij} && (4) \\ & \text{s.t.} \\ & \textstyle\sum_j q_{ij} = Y_i; \quad i := 1, \ldots, I \\ & q_{ij} \leq D_{ij}; \quad i := 1, \ldots, I \quad j := 1, \ldots, 4 \\ & q_{ij} \geq 0; \forall i, j; \end{aligned}$$

Solution Procedure

The model is applied to the real-life case of LG UAE with 12 different models and 4 quarters. Consequently, the problem is a straightforward linear program with 48 decision variables and 60 constraints excluding the non-negativity constraints. The problem is consequently fairly manageable and was solved

on MS $Excel^{®}$ solver. The usefulness of such a solution method is its flexibility and the ability to carry out various "'what-if"' analyses and modifications efficiently.

Results Analysis

The main result is that the targets exhibit a highly seasonal nature. Due to the dynamic nature of the prices, the model generated allocations that would maximize the revenue while ensuring that the yearly quota is achieved, and that the specific models demand data is taken into account. It is also evident from Figure 1, and Table 5 in the appendix, that the quantities tend to increase in the second and third quarter of the year. This reflects the seasonal nature of the demand, especially the impact of the activity that generally takes place in the third quarter when most expatriates, who represent the majority of the UAE population, are preparing for their summer vacations. Based on the optimal allocations generated

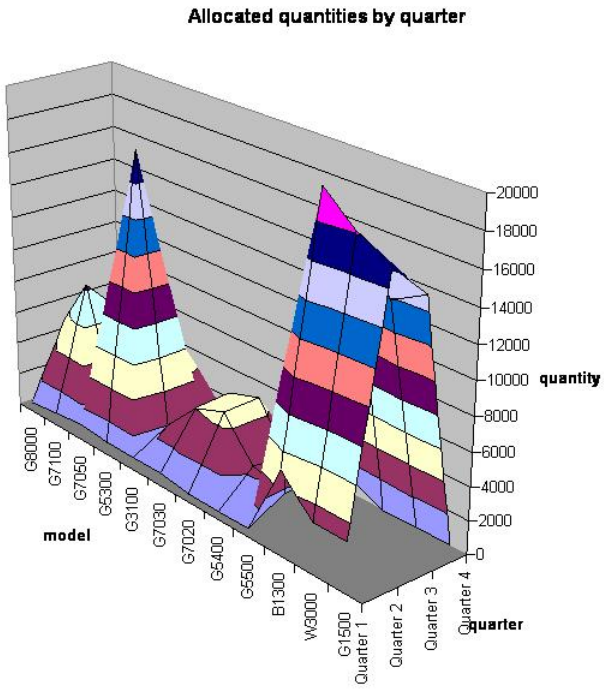

Figure 1: Optimal Quarterly targets

by the model, LG's market share is expected to improve considerably. Namely, it moves to the third position in terms of both revenue and units sold from an initial position of 6^{th} and 5^{th} respectively . Table 2 shows the impact of the proposed solution.

By investigating the shadow prices for the allocated yearly quota constraints for each model (see Table 6 in the appendix), it is apparent that an increase in the yearly quotas for any model will increase the total revenue. In particular, the models with the highest shadow prices should be given priority in any request by the division for increases in the quotas in the presence of supply constraints. For instance, an increase in the quotas for the G8000, G7100 and G5400 would be quite desirable and would positively

Table 2: Market Share with Proposed Solution (end of 2004)

Company	Market Share		Rank	
	Units Sold	Revenue	Units Sold	Revenue
LG	9.74%	6.10%	**3**	**3**
Samsung	19.23%	20.10%	2	2
Nokia	56.97%	64.74%	1	1
Siemens	6.16%	3.95%	4	4
Sony Ericsson	3.32%	2.45%	5	6
Motorola	4.59%	2.66%	6	5
Sum	100%	100%		

impact the total revenue.

Conclusion

In this paper, the issue of determining the optimal quarterly sales targets for a mobile phone company range of handsets was considered. The main feature of the model is the fact that the quarterly sales targets are to be determined subject to yearly quotas that have been exogenously imposed by the headquarters. Furthermore, the company operates in an oligopoly with implicit collusive pricing. The largest quantity allocation is made in the second and third quarter. The impact on the company's performance in terms of sales and revenue is quite significant. For the same amount sold during the year, the company is able to significantly improve its market share in terms of units sold and revenue. The model could be extended to consider the case where the price is also a decision variable. The problem becomes nonlinear (quadratic), and it is the intention of the author to consider this problem and compare the prices currently charged based on competitors' prices to those that would be determined by a mathematical program. The future research would also be expanded to consider the case where demand is a random variable, and meeting the deadlines is only achieved through reliability constraints.

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Appendix

Table 3: LG: Models Cost, Benchmark, and Quarterly Prices

Company: LG	Model	Cost	Benchmark (LG price as % of benchmark)	**Price in each Quarter (AED[a])**			
				Quarter 1	Quarter 2	Quarter 3	Quarter 4
Camera Phone	G8000	869	Samsung SGH-V200 (90%)	1295	1154	1094	1033
	G7100	900	Samsung SGH-X600 (90%)	1385	1026	972	918
	G7050	710	Siemens SL55 (95%)	940	799	755	733
Color Screen Bar Type	G5300	474	Samsung SGH-C100 (90%)	683	556	527	497
	G3100	335	Motorola C350 (90%)	512	351	332	314
Color Screen Folder Type	G7030	672	Samsung SGH-S300 (95%)	1024	875	829	783
	G7020	612	Samsung SGH-T400 (95%)	876	821	778	738
	G5400	652	Samsung SGH-T100 (95%)	981	948	898	848
	G5500	640	Siemens S55 (95%)	770	727	686	673
Basic Phone	B1300	245	Nokia 3310 (95%)	330	312	295	277
	W3000	330	Nokia 3410 (95%)	414	363	343	337
	G1500	300	Nokia 2100 (95%)	350	359	339	319

[a]AED (Arab Emirates Dirham) 1 AED = 0.27 US$

Table 4: LG: Demand Functions for Different Models

Company: LG	**Model**	**Demand Function**
Camera Phone	G8000	$D = -4.0329p + 9800$
	G7100	$D = -7.3148p + 15800$
	G7050	$D = -1.7413p + 2707.7$
Color Screen Bar Type	G5300	$D = -29.06p + 34000$
	G3100	$D = -5.198p + 3816.7$
Color Screen Folder Type	G7030	$D = -4.1237p + 7600$
	G7020	$D = -5.2053p + 9000$
	G5400	$D = -2.2556p + 4500$
	G5500	$D = -2.7513p + 3753.3$
Basic Phone	B1300	$D = -51.911p + 36000$
	W3000	$D = -56.745p + 38706$
	G1500	$D = -38.847p + 31000$

Table 5: LG: Optimal Quarterly Sales Targets

Company: LG	Model	**Quantity Allocated to Each Quarter**				Total
		Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Camera Phone	G8000	500	5145	4355	0	10000
	G7100	750	8295	5955	0	15000
	G7050	1000	1316	1393	1291	5000
Color Screen Bar Type	G5300	750	17850	6400	0	25000
	G3100	750	1995	2090	165	5000
Color Screen Folder Type	G7030	750	3990	4180	1080	10000
	G7020	500	4725	4775	0	10000
	G5400	500	2363	2137	0	5000
	G5500	500	1754	1865	881	5000
Basic Phone	B1300	5000	19800	15200	0	40000
	W3000	3000	18086	13914	0	35000
	G1500	3000	17050	14950	0	35000
Total		17000	102442	77113	3445	200000

Table 6: Shadow Prices for the Yearly Allocation Constraints

Company: LG	Model	Shadow price	Allowable increase
Camera Phone	G8000	1094	1035
	G7100	972	2735
	G7050	733	139
Color Screen Bar Type	G5300	527	12299
	G3100	314	2021
Color Screen Folder Type	G7030	783	3290
	G7020	778	175
	G5400	898	337
	G5500	673	1019
Basic Phone	B1300	295	5499
	W3000	343	5318
	G1500	339	2875