SHOULD THE CONCEPT OF POTENTIAL CUSTOMERS BE THE FOUNDATION OF DEMAND THEORY IN BUSINESS SIMULATIONS?

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ABSTRACT

The foundation of marketing demand variables in business simulations are two basic computations in business simulations: firm demand and industry demand. A number of papers presented at ABSEL conferences have addressed various issues involved in these two concepts. . All of these papers except for one paper presented in 2011 at ABSEL by the author have one thing in common. The concept of potential customers has not been adequately addressed. The primary purpose of this paper is to present a demand algorithm based on the concept of potential customers. As will be explained later in the paper, such an algorithm has been developed and tested and found workable within the framework of an actual simulation.

INTRODUCTION

The foundation of marketing demand variables in business simulations are two basic computations in business simulations: firm demand and industry demand. A number of papers presented at ABSEL conferences have addressed various issues involved in these two concepts, Gold and Pray (1983), Goosen (1986,2011), Carvalho (1991), Teach (1990), Lambert (1988), and Thakvikuwat (1988). All of these papers except for one paper presented in 2011 at ABSEL by the author have one thing in common. The concept of potential customers has not been adequately addressed. The primary purpose of this paper is to present a demand algorithm based on the concept of potential customers. As will be explained later in the paper, such an algorithm has been developed and tested and found workable within the framework of an actual simulation.

In this paper, only the concept of a linear demand curve will be used. Therefore, firm and industry demand may be mathematically defined linearly as follows:

Firm demand:

$P^F = Po - K^F(Q^F)$
- P^F - Firm price
- Po - Price at the Y-intercept

$Q^F = (Po - P^F)/K^F$
- K^F - Line slope coefficient
- Q^F - Quantity

Industry demand:

$P^I = Po - K(Q^I)$
- P^I - Average industry price
- Po - Price at the Y-intercept

$Q^I = (Po - P^I)/K^I$
- K^I - Line slope coefficient
- Q^I - Industry demand

Based on these equations it is quite easy to prepare a graph of demand as a downward right-sloping demand curve. After demand values have been determined, it is fairly simple to prepare a demand schedule.

In both firm demand and industry demand, there are two key parameters: Po and K. It should be noted that Po, the value at the Y intercept, determines the elasticity of demand at each price. K is the value that determines the slope of the demand curve and determines the magnitude of demand. A change in the value of K does not affect the elasticity of demand.

Before presenting a complete demand algorithm for firm demand and industry demand based on potential customers, it is necessary to discuss the following:

1. Expressing demand in terms of percentages rather than units.
2. Introducing the concept of maximum potential customers
3. Using potential customers as a basic demand variable
4. Introducing advertising as a marketing variable
5. Introducing the concept of informed potential customers as a demand variable
6. Using informed potential customers as the basis of determining market share

EXPRESSING DEMAND IN TERMS OF PERCENTAGES RATHER THAN UNITS

It is possible to state demand in terms of percentages. For example, at a price of 100 demand could be 30% of some base number. A fundamental principle is that at zero price demand is at a maximum. Given this maximum value, it is possible to state all other prices as a percentage of this value. The percentage associated with any price may be computed by the following equation:

$$PDP\% = ((Po - P)/K)/((Po - 0)/K) \quad \textbf{(1)}$$

PDP	-	Price demand percentage
Po	-	Price at the Y-intercept
K	-	Line slope coefficient

For example, assume the following values:

Po	-	$110
K	-	.1
P	-	$70

PD% =((110 - 70)/.1) / (110 - 0)/.1) = (40/.1) / (110/.1)
= 400/1100 = .3636

Demand is at a maximum when price is zero. The expression, (Po - 0)/K) gives maximum demand. The .3636 value represents the percentage of maximum demand that will be purchased at a price of $70. Based on these given values for Po and K above, we can prepare the following demand schedule:

Table 1
Price and Demand

Price	Quantity	Price Demand %
110	0	0
100	100	9.09%
90	200	18.18%
80	300	27.27%
70	400	36.36%
60	500	45.45%
50	600	54.54%
40	700	63.63%
30	800	72.73%
20	900	81.81%
10	1,000	90.90%
0	1,100	100.00%

In this demand schedule, demand is at a maximum (1,100) when price is zero. At this point, it is essential to establish a fundamental principle. In the above example, the K value was assumed to be .1. The fundamental principle is that regardless of what value is assigned to K, the percentage associated with a given price will not change. If we computed the price demand percentage (PDP)using .002 or .09 rather than .1, we still would wind up with the same exact percentages as shown above. For example, let K = .09 and price be $70. Using equation 1, we get:

PDP = (110-70)/.09 / (110 - 0) / .09) = 444/1222 = .3636

The resulting percentage of 36.36% is the same when the value of K was .01.

INTRODUCING THE CONCEPT OF MAXIMUM POTENTIAL CUSTOMERS

Given the concept that the response or effect of price may be stated in terms of percentages, we may revise equation 1 as follows:

TPC = MPC x ((Po - P)/K)/ ((Po - 0)/K) **(2)**

What we have done is introduce maximum potential customers as a demand variable in place of units of product. Rather than generating units of product, we are now assuming that the effect of price is to create potential customers. How potential customers can be converted to units of product will be explained later. In order to use equation 2, all we have to do is specify maximum potential customers at zero price. Let us assume that we wish maximum potential customers to be 10,000 and that price is $60.00. Total potential customers willing to purchase as the set price may be computed as follows
To illustrate, let us assume the following values:

Price	=	$ 60
MPC	=	10,000
K	=	.1
Po	=	$110

We may compute potential customers as follows:

TPC = 10,000 x ((110 - 70)/.1) / (110 - 0)/.1)
= (40/.1) / (110/.1) = 400/1100 = 3,636

While it is true that a change in maximum potential customers (e.g., MPC = 10,000) implies a different value for K, we do not need to know this value because the end result of knowing this value would give us exactly the same price percentage values. The only value that changes the demand percentages is Po. The ability to use price percentages gives the simulation designer a lot of flexibility. The assignment of total potential customers to the simulation becomes very easy. Because we can ignore further consideration of price percentages due to a change in the slope of the line, the simulation designer can assign any desired value to represent maximum potential customers.

Once the values for Po and K have been determined and deemed suitable for the simulation under construction, the simulation designer need not worry about changing these values. The only remaining task is to determine how large the simulation designer wishes the market to be in terms of potential customers. Changes from units of product to potential customers do not change the validity of the underlying demand algorithm.

USING POTENTIAL CUSTOMERS AS A BASIC DEMAND VARIABLE

The revised demand algorithm being presented in this paper will be based on the concept of potential customers. It seems rather fundamental that in any market the number of potential customers is finite. For purposes of this paper a potential customer is someone who could benefit from purchase of the product being sold. If the product being sold in a given city is dog food, it stands to reason that only individuals who own a dog would buy dog food. If there are 10,000 dog owners in the city, then it would seem reasonable to assume that the maximum potential customers would be 10,000. How many cans of food potential customers will purchase during a given period of time will be addressed later in this paper.

It is essential at this point out that there are different levels of potential customers. First, there is a total of maximum potential customers in a given market. In absence of advertising, these potential customers would be classified as uninformed. A given amount of advertising will inform a certain percentage of maximum potential customers. For example, if the cost of informing one potential customer is $2.00, then an advertising budget of $10,000 perhaps would inform 5,000 potential customers. Assume for the moment that all maximum potential customers have been informed. This does not mean that all of these potential customers will necessarily purchase. This is where price comes into play. The number that will purchase will depend on the price percentage as previously discussed. If at a price of $60, 45% percent of informed potential customers are willing to purchase, then the number of potential customers actually purchasing would be 2,250. By introducing potential customers as a demand variable, the magnitude of various of various marketing variables can be determined. For example, if we know that MPC is 100,000 and that $2.00 is required to inform one potential customer, then we know that an advertising budget of $60,000 would reach less than 100% of the total potential customers.

Secondly, at the industry level we have potential customers that are informed. Each of these potential customers will purchase at the right price. At the industry level, there is no duplication of potential customers. At the firm level a potential customer of firm 1 may also be a potential customer of firm 2. Finally, at the industry level there are those informed potential customers that actually purchase. The units purchased by these informed potential customers represent industry demand

This analysis to this point has concentrated basically on price. Advertising as a second marketing variable will be now discussed in the framework of potential customers.

INTRODUCING ADVERTISING AS A MARKETING VARIABLE

In all simulations that the author of this paper is familiar with, advertising is always a key marketing variable. The introduction of advertising as a marketing variable compels us to develop a theory of advertising concerning how it affects demand in a business simulation, simply stated for purposes of the demand algorithm being proposed, the purpose of advertising is to inform potential customers about the product and to convince them they should purchase the product. In absence of advertising, the value MPC represents uninformed potential customers. They are not yet aware of the product. Advertising converts uninformed potential customers into informed potential customers and price converts informed potential customers into buying customers. In marketing theory, advertising is just one element in the total marketing strategy. However, in most business enterprise simulations what constitutes the various modes of advertising is seldom specified. As used in this paper, advertising includes all marketing means by which potential customers become aware of the product and the firm that sells that product.

INTRODUCING THE CONCEPT OF INFORMED POTENTIAL CUSTOMERS AS A DEMAND VARIABLE

If we are to introduce advertising as a marketing variable, then we must introduce another demand variable, IAP (Informed advertising percentage). Only those potential customers who have been informed because of advertising will purchase. The greater the advertising budget the greater will the percentage of potential customers informed. Eventually, as some level of advertising 100% of the potential customers will be informed. A fundamental principle regarding advertising is that at some point as advertising is increased the effectiveness of additional advertising decreases. The relationship between the dollar amount of advertising and the IAP% is one of decreasing returns. The number of informed customers may be computed as follows:

$$\text{Informed potential customers} = \text{MPC} \times \text{IAP}$$

Assume that maximum potential customers are equal to 10,000 and IAP is 60%. Consequently, the numbers that are informed and thus are willing to potentially purchase is 6,000. The price demand percentage (PDP) is applied not to maximum potential customers but to informed potential customers.

There seems to be general consensus simulation theory that the relationship between advertising and the effect on demand should be one of decreasing returns at some point. The equation to express this relationship may vary in form and mathematical complexity. For purposes of this paper, the equation used will be:

$$IAP = \sqrt{Adv / Maxadv}$$

IAP	-	Informed advertising percentage
Adv	-	Advertising budget in dollars
Maxadv	-	The amount of advertising required to inform 100% of the maximum market potential.

This equation will create IAP results that represent decreasing returns.

Assume that MPC is 10,000 and that an advertising budget of $20,000 is required to inform 100% of the MPC. The average cost of informing one customer would therefore be $2.00.

Based on the advertising function equation above, the following schedule may be prepared:

Table 2
Schedule

Advertising Budgeted	Informed Percentage
$10,000	31.6%
$20,000	47.2%
$30,000	54.7%
$40,000	63.2%
$50,000	70.7%
$60,000	77.4%
$70,000	83.6%
$80,000	89.4%
$90,000	94.8%
$100,000	100.0%

An increase in advertising from $10,000 to $20,000 increases the IAP by 15.6%. However, a $10,000 increase from $70,000 to $80,000 only increased the IAP by 5.8%. This advertising schedule above may be presented graphically as follows:

When we introduce advertising as an marketing variable, we must modify equation 2 as follows:

$$TPC = (MPC \times IAP) \times ((Po - P)/K) / ((Po - 0)/K) \quad \textbf{(3)}$$

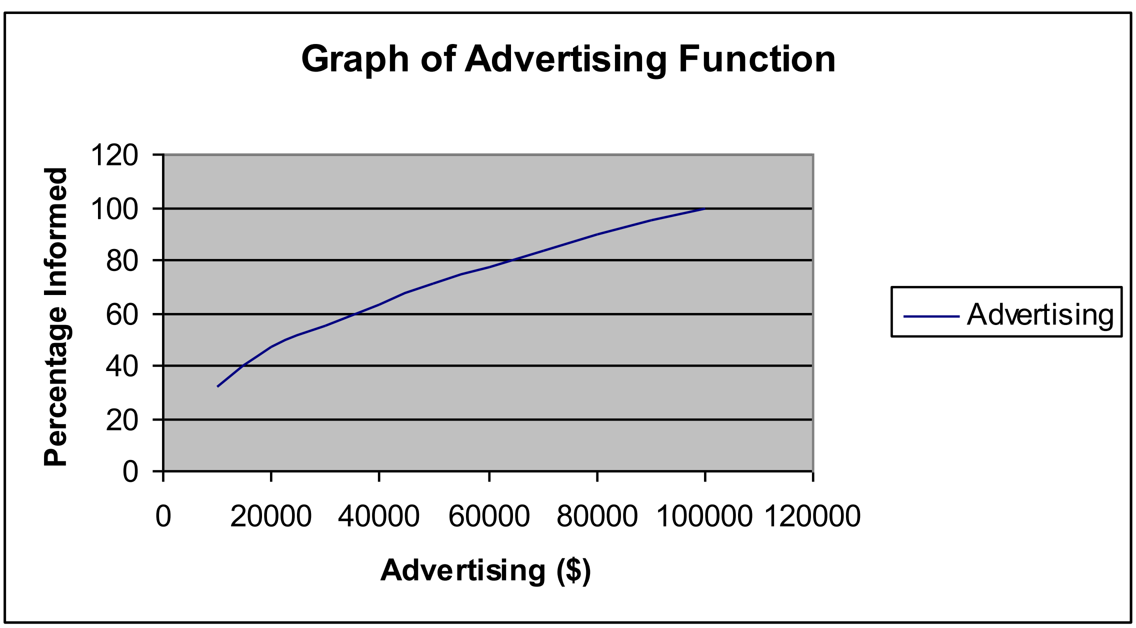
The term (MPC x IAP) represents the proportion of maximum potential customers that have been informed. This same equation may be used at both the firm level and the industry level. However at the industry level it is essential that eventually units sold be determined. At will be shown later, this is easily accomplished by introducing a variable that determines the average number of units of product purchased per potential customer. However, the demand algorithm now being presented does not require units of product at the firm level. The objective at the firm level is to simply compute total informed potential customers willing to buy from each firm. However, at the industry level both potential customers and units of product will be computed.

USING POTENTIAL CUSTOMERS TO COMPUTE MARKET SHARE

In business simulations, a firm demand algorithm is used to compute market share percentages.

In the real world, market share can only be computed when the sales of each firm is known. However, in business simulations the process is reversed. Market share must be

Figure 1
Advertising Function



computed before the number of units sold by each firm is determined. In this paper, market share percentages must also be computed; however, the main difference is that now the basis of market share is potential customers and not units of product.

Equation 3 above is a generic equation and not exactly in the form necessary to be used in a business simulation. At the firm level, equation 3 must be modified as follows:

$TPCi = (MPC \times IAPi) \times ((P^Fo - Pi)/K^F)/((Po - 0)/K^F)$ **(4)**
i = 1to N
where N is the number of firms in the industry

Based on this equation, the potential customers of each firm willing to purchase may be computed. Assume for the moment that this equation generates the following values:

	Total Informed Potential Customers Willing to Buy
Firm 1	1,000
Firm 2	2,000
Firm 3	3,000
Firm 4	4,000

	10,000

It needs to be explained at this time that total potential customers generated by equation 4 may exceed the maximum potential customers in the industry. In the example above, the total maximum potential customers appears to be 10,000. However, a potential customer of one firm may also be potential customers of the other firm. A potential customer may be willing to purchase from more than one firm in the industry. However, eventually the customer in a given time period will purchase from only one firm. The firm with twice the potential customers compared to another firm will most likely have twice the sales. The assumption is that total sales of each firm will be proportionate to the potential customers of each firm.

The process for computing the market share percentage of each firm is as follows:

Step 1 Compute total potential customers for each firm by using equation 4.
Step 2 Compute total potential customers: TPC = эTPC_i
Step 3. Compute market share percentages by dividing the total potential customers

of each firm by the Total potential customers:

$$MSP_i = \frac{TPC_i}{эTPC_i}$$

MSP_i - Market share percentage for a given firm

Demand (product sold) by each firm is then computed by multiplying the market share percentages times industry demand.

Allocated $demand_i$ = $MSP_i \times Q^I$
Q^I = total industry demand

USING POTENTIAL CUSTOMERS TO COMPUTE INDUSTRY DEMAND

The ultimate goal of a demand algorithm in a business simulation is to compute units sold or demanded by each firm in the industry. In a business simulation, it is necessary to compute industry demand in addition to firm demand. The objective now is to show how using the concept of potential customers can be used to compute industry demand.

In order to compute demand at the industry level it is necessary to use average price. Average price may be computed by the following equation: P^A = эP_i / N

To compute industry demand, we must modify equation 4 as follows:

$Q^I = (MPC \times IAP^I) \times ((P^Io - P^{AI})/K^I)/((Po-0)/K^F) \times UPPC$ **(5)**

Q^I - Industry demand in units
UPPC - units purchased per potential customer
MPC - maximum potential customers
Po - Price at the y-intercept
K^I - line slope coefficient
P^{AI} - Average industry price
IAP^I - Informed advertising percentage (industry level)

The new element in this equation not previously discussed is UPPC. It is possible to not include this variable in the equation; however, the assumption would then be that each informed potential customers has purchased just one unit of product. In this case, units sold would be equal to total potential customer actually purchasing. Also, the IAPI is determined by average advertising.

At the industry level, the term (MPC x IAPI) represents actual informed potential customers without any overlap. At the firm level, (MPC x IAPI) represents potential informed customers willing to buy from one or more firms. IAPI represents the percentage of the maximum market potential that has been informed by all of the firms. The computation of this percentage is based on average advertising. At the industry level, some potential customers may know about firm 1 but not firm 2. It is possible for one firm to have informed 100% of the market while other firms have only informed less than 50% of the market. Firms 2, 3, and 4 may have informed only 25% of the market respectively. In other words, the marketplace as whole is not completely informed about all the firms and the respective price of each firm. How does one determine the extent to which the market has been informed at the industry level? The procedure in business simulations has been to use average advertising and that will be the procedure now adopted in this paper.

The IAP at the industry level will be computed in the manner discussed above concerning the IAP at the firm level. The industry level equation for advertising will be:

$$IAP^{I} = \sqrt{(Adv^{A} + E) / Maxadv^{I}}$$

E - represent a dollar value that causes the elasticity of the advertising function at the industry level to be greater than the elasticity of the advertising function at the firm level.

Adv^{A} - average advertising

$Maxadv^{I}$ - Advertising required to inform 100% of potential customers

ILLUSTRATION OF THE POTENTIAL CUSTOMER DEMAND ALGORITHM

Firm Level:

At the firm level, the ultimate objective of the demand algorithm is to compute market share percentages. The model being introduced in this paper has the same objective; however, the difference is that now market share is determined by informed potential customers willing to purchase. At the firm level then, the demand equation as previously discussed is:

$$TPCF^{i} = (MPC \times IAPF^{i}) \times ((PFo - PF^{i})/KF) / ((Po - 0)/KF)$$

I = 1to N

where N is the number of firms in the industry

The equation at the firm level for determining the effect of advertising is:

$$IAP_{I}^{F} = \sqrt{Adv_{I} / Maxadv}$$

Industry Level:

At the industry level the ultimate objective of the demand algorithm is to compute industry demand. The model being introduced in this paper has the same objective; however, the difference is that now market share is determined first by computing the number of potential customers that purchase. Given that the number of purchasing potential customers is known, the total number of units purchased is obtained by multiplying this value times the number of units purchased per potential customer. The equation for computing industry demand as previously discussed is:

$$Q^{I} = (MPC \times IAP^{I}) \times ((P^{I}o - P^{AI})/K^{I}) / ((Po - 0)/K^{F}) \times UPPC$$

The equation for computing the industry informed advertising percentage:

$$IAP^{I} = \sqrt{(Adv + E) / Maxadv^{I}}$$

A complete demand algorithm containing all the essential elements for determining market demand has now been presented. In order to illustrate some results from this demand algorithm, the following parameter values will be assumed:

	Number of firms -	4
Price:		
	Firm 1	80
	Firm 2	70
	Firm 3	60
	Firm 4	50
Advertising		
	Firm 1	\$40,000
	Firm 2	\$50,000
	Firm 3	\$60,000
	Firm 4	\$70,000

Maximum potential customers		100,000
Maximum advertising required		\$100,000
Firm parameters:		
	Po -	110
	K -	.1
Industry parameters -		
	Po -	150
	K	.1
	UPPC	2

Based on the firm equation presented above, the following potential customer results are obtained:

	WTB	IAP	TPC
Firm 1	.2727	.6424	17,245
Firm 2	.3636	.7007	25,477
Firm 3	.4545	.7745	35,010
Firm 4		.8366	46,632
			123,364

Based on these values market share percentages are:

	Market Share
Firm 1	.1397
Firm 2	.2065
Firm 3	.2837
Firm 4	.3698

The next step is to compute industry demand. To do this the following values must be computed:

Average advertising = (220,000/4) = 55,000

Average price = $((0 + 70 + 60 + 50)/4) = 65$

Advertising percentage = $\sqrt{((55{,}000 + 15000)/100{,}000)}$
$= .83$

Percentage willing to buy $= ((150 - 55)/.1)/((150 - 0) / .1)$
$= .4333$

Based on the above values industry demand may be computed as follows:

Industry demand = 100,000 x .83 x .4333 x 2 = 72,216

Given the results of firm demand equation and the industry demand equation, industry demand would be allocated as follows:

	Allocated Industry Demand
Firm 1	(.1397 x 72,216) = 10,086
Firm 2	(.2065 x 72,216) = 14,912
Firm 3	(.2837 x 72,216) = 20,488
Firm 4	(.3698 x 72,216) = 26,705

The introduction of potential customers as a variable in computing demand works very well. In one sense, the model just presented is the same as the traditional model. The results may not be significantly different in terms of total allocated demand. However, the underlying theory is easier to understand and provides more useful information for decision-making. The question that then needs to be addressed now is: how does the introduction of potential customers make a simulation more effective in achieving profitability results?

BENEFITS OF SPECIFYING POTENTIAL CUSTOMERS IN A BUSINESS SIMULATION

Business simulations attempt to provide learning about real business in the framework of a simulated marketplace. In the real world, knowing the size of the market is important. With proper market research and analysis, it is possible to determine with some degree of accuracy the number of potential customers for a defined period of time. If knowing the number of potential customers is important information in the real world, then potential customers should logically be key information in a business simulation.

The size of the advertising budget and the number of sales people in a real business situation that are required should correlate directly with the number of potential customers. In absence of knowing the number of potential customers, decision-making becomes more a matter of guess work than decision-making based on rational financial analysis of all the economic factors that determine profitability.

Current economic theory suggests that advertising simply shifts the demand curve and business simulation as currently designed have adopted this theory. While this theory is not necessarily wrong, it is not helpful in revealing by how much the curve will shift with a given increase in advertising. Typically, in business simulations, no clue is given as to what amount of advertising is required to inform all potential customers. However, regarding the demand model introduced in this paper, size of the market and the advertising required to reach all potential customers is known. However, what is not known even in the real world is at what point additional advertising ceases to be profitable. Attempting to inform 100% of the market potential may not be desirable, even though the additional advertising increases the number of informed potential customers. The additional cost of informing the remaining uninformed potential customers may not be profitable

One problem not directly addressed in this paper is how many units of product an informed potential customer will purchase at different prices. For some products, is it reasonable to assume that as price decrease more units will be purchased by the same customer? In equation 5, this problem is partially addressed because one of the variables is uppc (units purchased per potential customer). It would be fairly easy to create a function such that as price decreases the number of units purchased by an informed potential customer increases. .

SUMMARY

A complete demand algorithm has been presented based on the concept that the number of potential customers in a marketplace is important information in computing industry demand and allocating the resulting industry demand to the firms in the industry. The analysis of the price and advertising decision should be improved by the explicit recognition of potential customers. The realism of a business simulation is increased by the introduction potential customers. The demand algorithm presented in this paper has proven to be valid in terms of expected results. A complete simulation based on this demand algorithm was constructed and the results were considered more than satisfactory. What needs further action is research on whether knowledge of potential customers results in better decision-making in business simulations.

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