The Meaning of Firm Demand in Business Simulations

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ABSTRACT

This traditional approach in business simulations to computing firm demand is to first compute a set of weights and then use these weights to compute market share percentages. Demand for each firm then is computed by multiplying market share percentages times industry demand. This approach is analyzed in this paper and the methodology is analyzed and criticized in terms of whether the approach has been logically explained. A new approach to computing firm demand is presented. The new approach does not require that market share percentages be computed. Also, the new approach introduces the concept of potential customers and also introduces average purchases per potential customer as an important value in determining firm demand.

INTRODUCTION

Business simulations are generally simulations involving three or more firms in the same industry. Consequently, the economic term that best describes the market environment of a business simulation is oligopoly. The theory of demand in an oligopoly for the past fifty years has been unsettled and even to this day remains unclear. There is still no generally accepted theory how an equilibrium price is achieved in an oligopoly industry; however, there appears to be a theory within business simulations that explains how this happens.

In economic theory and consequently in business simulations there are two type of demand: firm demand and industry demand (market demand). Liebhafsky (1963) illustrated firm demand as shown in Figure 1.

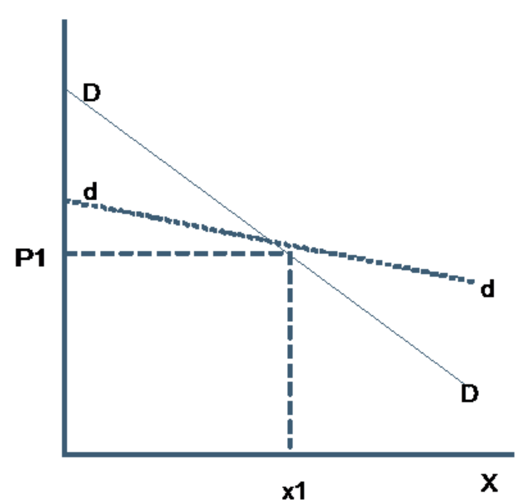
According to Liebhafsky, the dd line shows the firm's belief as to how much it can sell at all possible prices provided that the other firms keep their prices fixed at a given level. In other words even though the firm continually decreases prices, the other firms do not change their price. The DD curve (Demand at the industry level) shows the amount the firm can in fact sell at all possible prices if all other firms always charge the same price as the dd firm.

The problem with this brief explanation of firm demand is that there is no discussion or explanation by Liebhafsky as to what is firm demand if each firm has a different price. However, it appears that in business simulations the concept of firm demand as defined by Leibhafsky has been adopted in businesss simulations. Firm demand in business simulations appears to be based on the assumption of computing firm demand on the basis that other firms do not respond to prices changes and the resulting values are then used as weights to compute market share.

The subject of firm and industry demand has not often been discussed in ABSEL papers. The most notable discussions have been by Gold and Pray (1983), Goosen (1986), Carvalho (1991), Teach (1990), and Thakvikuwat (1988)

Gold and Pray (1983) have chosen to refer to the process of determining firm demand as a "firm demand function" involving three steps.

Figure 1
Industry and Firm Demand Illustrated



1. Computation of a firm demand weights
2. Computation of market share percentages
3. Computation of firm demand

According to Gold and Pray and others, firm demand is determined by the following equation:

$$Q^F{}_i = (Po - P_i)K$$

$Q^F{}_i$ - firm demand of a specific firm
Si - market share percentage of a specific firm
Q^I - Industry demand

The si values (market share percentages) are based on an equation frequently referred to as the firm demand equation.

PURPOSE OF RESEARCH

In ABSEL, the mechanical or procedural steps in computing firm demand as previously referenced have been significantly discussed; however, the theoretical validity of the "firm demand function" has never been seriously analyzed or explained.

While many papers make references to firm demand the underlying theory and complexities of computing firm demand are not discussed. The procedure has just been accepted as being valid because it seems to work. The papers on demand as noted above for the most part have centered around the mechanics of computing firm demand and have not presented or discussed the theory behind the concept.

The purpose of this paper is to analyze the procedures involved in computing firm demand in business simulations and to ask the question: what do the values generated by the firm demand function really mean? The conventional approach in business simulations regards firm demand determination as a process of first computing market share percentages. While this approach has much merit, there is another way of interpreting how firm demand is determined. This paper will present this approach.

CONVENTIONAL APPROACH TO COMPUTING INDUSTRY AND FIRM DEMAND

In most business simulations, there are two demand equations involved in the total demand algorithm. Both equations are essentially identical except that the parameter values assigned to each are not the same. Assuming the use of a straight-line demand curve, these two equations are as follows:

$$Q^1 = (Po - Pa)/K \qquad (1)$$

Q^I - Industry demand
Po - Y-intercept value for price
K - Line slope coefficient
Pa - Average industry price

$$Q^F{}_i = s_i(Q^1) \qquad (2)$$

Q^Fi - Firm demand weight for each firm

Equation 1 computes industry demand and equation 2 computes values which the conventional viewpoint calls firm demand weights (Gold and Pray, 1983). The lower the firm price and for a given firm, the greater is the firm demand weight.

It would appear that the values generated by the use of equation 2 are firm demand in units. But technically this is not correct. These values as explained by Gold and Pray are used as weights in business simulations to compute market share percentage for each firm which are then used to compute market share percentages. In order to illustrate this point, let us assume the following demand parameters.

Industry Demand Schedule	Firm Demand Schedule
Po - 110	Po - 80
K - .1	K - .05

Example 1

From this assumed values, we cane easily prepare the

Industry		Firm	
110	0	110	0
100	100	100	0
90	200	90	0
80	300	80	0
70	400	70	200
60	500	60	400
50	600	50	600
40	700	40	800
30	800	30	1,000
20	900	20	1,200
10	1,000	10	1,400

following price/quantity schedules

To simplify the illustration, let us also assume that there are only two firms in the industry, Firm 1 and Firm 2. If both firms, Firm 1 and Firm 2, set price at $60, then average industry price is also $60 and industry demand is 500. At prices of $60, the firm demand weights generated are 400 and 400 for firms 1 and 2 respectively. Total firm value weights would be 800. The allocation percentages (market share percentages) for Firm 1 and Firm 2 respectively are .5 and .5.

The problem then is this. It would appear that the values generated by equation 2 of the firm demand function represent some type of demand and more than simple numbers to be used as weights. In principle, equations 1 and 2 are identical. Clearly, equation 1 generates overall or industry demand. However, equation 1 does not indicate how much of the 500 industry demand belongs to Firm 1 and Firm 2. In our example though, it appears obvious that if both firms have the same price, the industry demand should be allocated equally. However, what if price is not the same?

To create a more dynamic example, let us now assume the following:

Example 2:

Given these price values and using the same parameters as before, the following may be computed

Industry		Firm	
Industry demand	500	Firm 1 demand weight	600
Average price	$60	Firm 2 demand weight	200

Based on the above values, market share percentages are .75 and .25 for firms 1 and 2 respectively. Allocated industry demand is then:

F-1	500 x .75 =	375
F-2	500 x .25 =	125

At the moment, the question of the validity of equation 2 is not under scrutiny but rather the question being asked is: what is the meaning of the values generated by equation 2? To simply call these values demand weights does not seem adequate. More specifically, how do we interpret the 600 value generated for Firm 1 and the 200 value generated for Firm 2? Are they units of product or something else? It appears that the conventional approach treats them as units of product that would be purchased under certain circumstances. However, the issue as to what they represent is avoided by simply referring to them as weights or numbers used in a proportional manner to compute market share percentages and then firm demand.

If we look at the end results of the price changes, we see that Firm1 increased its sales from 250 to 375 units or an increase of 125 units. Firm 2's sales decreased by 125 from 250 to 125. If the firm demand of 375 for Firm 1 and the demand of 125 for Firm 2 represent firm demand, then what do the values of 600 and 200 represent? It seems obvious that these two values represent some type of demand since the equation that generated these values is in fact a demand equation. However, to simply describe these values as numbers or weights needed to compute market share does not seem adequate. Surely, there is some more logical explanation.

A NEW THEORY OF EQUATION 2 GENEARATED VALUES

It will now be proposed that what is commonly called as market share weights may be called "potential customers". For the moment, let us accept this proposition as being true. Then initially when both firms had identical prices of $60, the potential customers of each firm was 400 each. Now when Firm 1 lowered its price to $50 and Firm 2 increased its price to $70, Firm 1 gained 200 additional potential customers and firm 2 lost 200 potential customers. The underlying idea then is that the firm which can generate the greater number of potential customers logically would have a greater market share. Because what we are calling potential customers can be greater than firm demand it is apparent that not all potential customers actually purchase.

The term "potential" obviously implies that a potential customer may elect to buy or not buy. In fact, it is unrealistic to assume that all potential customers will purchase. Also, it seems quite normal to expect that for each firm the number of potential customers can greatly exceed the actual number of customers buying. Also, for the industry as a whole, it likewise seems logical that the total number of potential customers can exceed the number of customers actually buying.

It is possible for a the same customer to be a potential customer of both Firm 1 and Firm 2? The answer is yes. At a minimum, a potential customer is somewhat who is

- Aware of the business
- Aware of the product
- Is debating in his mind whether to buy or not buy
- Is price conscious
- May consider two or more firms to purchase from
- Has not yet made a decision as to which firm to purchase from

Originally, at a price of $60, firms 1 and 2 had the same number of potential customer--400. Of this number only 250 customers actually made a purchase. For each firm, 150 potential customers did not purchase. At the moment the assumption is that each buying customer bought only one unit. Now when Firm1 lowered price from $60 to $50 (see example 2) it appears that 200 of the potential customers of F-2 became also potential customers of F-1. Some of the potential customers of Firm 2 could not accept Firm 2's price increase from $60 to $70. Consequently, the decrease in price by Firm 1 from $60 to $50 caused some potential customers of Firm 2 to seriously consider buying from Firm 1, which in fact happened. Of the 200 that switched, 125 or 62.5% did purchase.

The question needs to be asked: did in fact, some of the potential customers of Firm 2 really switch to Firm 1? Could it not be logically argued that the increase in the potential customers of Firm 1 are totally new individuals that have never been potential customers before? Could it be argued that the decrease in potential customers by F-2 were individuals that totally lost interest and did not even consider buying from F-1? The answer is yes. A decrease in price can have two effects:

1. Cause potential customers of one firm to become potential customers of another firm.
2. Attract new individuals that can be classified as potential customers.

Let us now assume the following: Firm 1 decreases price from $60 to $50 but Firm 2 lets price remain at $60. Then we have the following results:

Example 3

Industry

Industry demand	-	550
Average price	-	$55
Firm 1 price	-	$50

Firm

Firm 1 demand weight	-	600
Firm 2 demand weight	-	400
Firm 2 price	-	$60

Based on the above values, market share percentages are .6 and .4 for firms 1 and 2 respectively. Allocated industry demand is then:

F-1	550 x .60 =	330
F-2	550 x .40 =	220

When both firms have the same price at $60 as in example 1, potential customers would be 400 for each firm. Now we see that Firm 2 did not lose any potential customers which remained at 400 but Firm 1 did gain 200 potential customers. If Firm 2 did not lose any potential customers, why then did Firm 2's sales decrease from 250 to 220? Remember that a potential customer is not necessarily a purchasing customer. A potential customer may cease to be regular customer and become a standby customer. Also, the same person can be a potential customer of more than one business. Therefore, some of the firm's potential customers may have also become potential customers of Firm 1 because Firm 1 now had a lower price. Of this number that also became potential customers of firm 1, a certain percentage decided to buy from Firm 1 rather than Firm 2.

In terms of firm demand, it is clear that the purpose of lowering price or increasing advertising is to initially attract new potential customers. Each firm will deliberately seek to make potential customers of one firm their own potential customer.

Based on the conditions specified and the assumptions made, a potential customer is definitely not someone who has never heard of the firm. Knowledge or awareness of the firm seems essential. Potential customers can be created by advertising, There are two ways two ways advertising can create new potential customers, Advertising can attract potential customers from another firm or bring in new potential customers. However, it is beyond the scope of this paper to deal directly with the effect of advertising on potential customers and firm demand.

A NEW APPROACH TO UNDERSTANDING AND COMPUTING FIRM DEMAND

Theoretically, total potential customers can outnumber the customer actually buying. How in a business simulation can potential customers be converted to actual customers that purchase? Can this be done without treating the so-called firm demand weights as values necessary to compute market share? As almost always done, is it necessary to actually compute market share of each firm and then multiply these allocation percentages times industry demand? Surprisingly, the answer is no! Computing market share of each firm is not necessary. How this is possible will now be illustrated:

The conventional approach is to compute firm demand as follows:

$$FD_i = \frac{FDW_i}{TFDW} Q^1 \qquad (3)$$

FD_i - Firm demand of a specific firm
FDWi - The firm demand weight values generated by used of equation 2
TDFW - Total of the individual firm demand weights
Q^I - Industry demand

This conventional approach involves actually the following steps:

1. Compute of the demand weight of each firm in the industry using equation 2.
2. Compute total firm weights
3. Compute market share percentages by dividing each weight by total of all weights.
4. Compute firm demand by multiplying the market share percentages times industry demand

This conventional approach for the remainder of the paper will be called method 1. There is a second approach that may be used. This approach apparently has apparently never been discussed in ABSEL papers. No articles could be found that described or even mentioned this approach. The significance of this approach is that is gives validity to the notion to the idea that the market share weights are more appropriately described as potential customers.

Equation 3 may be mathematically expressed as follows:

$$FD_i = \frac{FPC_i(Q^1)}{TPC} = \frac{Q^1}{TPC}(FPC_i) \qquad (4)$$

FD_i - firm demand of a specific firm
FPC_i - potential consumers of a specific firm
TPC - Total potential customers
Q^I - Industry demand

In this approach the ratio of QI to TPC is computed The denominator is now called total potential customers instead of the total weights.

This approach involves the following steps:

1. Compute the potential customers of each firm by using equation 2.
2. Compute total potential customers in the industry.
3. Compute average units purchased by each potential customer in the industry
4. For each firm multiply, average units purchased times the potential customers in each firm.

In example 2, we had the following values:

Q^I	500
F-1 demand	375
F-2 demand	125
Firm 1 market share weight (now called potential customers)	600
Firm 2 market share weight (now called potential customers)	200

If we use these values previously computed, then we may compute firm demand as follows:

For Firm 1 we would have:

$$FD1 = \frac{500}{800}(600) = .625 \times 600 = 375$$

For Firm 2, we would have:

$$FD2 = \frac{500}{800}(200) = .625 \times 200 = 125$$

This approach which we will now call method 2, computes QI/TPC, which represents the average purchase in units per potential customer. Computing firm demand is then simply a matter of multiplying average purchase size times the number of potential customers per firm as opposed to method 1 which computes market share. Method 2 does not require at all that market share be computed and if market share is desired then that is simply a matter of dividing firm demand by total industry demand.

Now is should be noticed that both interpretations give exactly the same results; that is, allocated industry demand is the same. In other words, firm demand for each firm is the same regardless of which method is used. However, the traditional approach requires computing market share percentages before firm demand can be computed. It is somewhat illogical to know market share before knowing the demand of each firm. Intuitively, one would think that it is the relationship of firm demand to total demand that determines market share. Consequently, it seems more logical that firm demand should be computed before market share is computed. The traditional approach reverses this procedure and assumes that market share is known before firm demand is known.

Given that the results between method 1 and method 2 are the same, the question becomes then which interpretation is the most meaningful. Should the results of equation 2 be interpreted as market share weights or as potential customers?

While not necessarily important, method 2 involves less computations. Assuming an industry of eight firms, the following computations are necessary:

1. Compute the potential customers for each firm
2. Compute the total potential customers
3. Divide the industry demand by the total potential customers
4. Multiply the potential customers of each firm by the value computed in step 3.

Consequently, given an industry of 8 firms, 18 computations are required.

If the conventional technique is used, the following steps are required:

1. Compute the market share weights of each firm
3. Compute the total of the market share weights
4. Compute the market share allocation percentages
5. Multiply industry demand by each market share allocation percentage

In this approach, 25 computations are required.

A possible weakness of the proposed approach is that average sales per potential customer is the same for all firms regardless of differences in price.. If Firm 1 has a lower price, then is seems reasonable to assume that the average purchase rate for Firm 1 should be greater than for Firm 2. Whether this is a serious problem can not be examined here; however, an examination of this issue in the future might prove to be profitable.

To illustrate, assume that Firm 1 has lowered price and as a result potential customers are now 1,000. Firm 2 does not change price and its potential customers remain at 500. Assume industry demand is 1,000. If the average sales rate per potential customer to convert potential customers to firm demand is .67, then firm demand for Firm 1 is 667 (.67 x 1,000) and 333 for Firm 2 (500 x .67)?

If Firm 1 had the lower price, would it not be reasonable to expect that the average units purchased by potential customers of Firm 1 would be greater than the purchase rate of potential customers in Firm 2? This is an issue that should be explored in another paper.

It should be pointed out that the average purchase rate can be less than one or greater than 1. For example, assume that industry demand is 1,000 and the total number of potential customers is 500. The average purchase rate per potential customer then would be 2 (1,000/500). However, if the industry demand is 500, then the average purchase rate is .5 units (250/500). In this instance, it can be assumed that 50% of the potential customers did not purchase.

One of the weaknesses of the conventional approach is that there is no measure of market size or the number of customers in the market. If allocated demand to a specific firm, for example, is 10,000, then how many buying customers did the firm have. The answer, of course, depends on how many units each customer buys in a given period of time. If the average number of units purchased were 5, then the number of buying customers would be 2000 (10,000/5). The new approach proposed in this paper then makes relevant the number of units purchased per potential customer and the number of potential customers.

DISCUSSION OF POTENTIAL CUSTOMERS IN ABSEL PAPERS

A word search in ABSEL papers of the term "potential customers" revealed that the term appeared at least once in sixteen papers. Of these sixteen papers, the term "potential customer" appeared only one time in fourteen of these papers. The use of the term was more or less just a casual use of the term and played no significant importance in the overall purpose of the paper. The only paper that significantly discussed the nature of "potential customers" was by Goosen (1995).

The concept of "potential customers" does not appear to be an important decision-making number in business simulations. No evidence was found that the concept of "potential customers" is employed in business enterprise simulations or that information on potential customers is provided. Neither is information on potential customers provided in the output results of business enterprise simulation.

It seems logical to the author of this paper, that knowledge of potential customers would be helpful in making decision concerning the following:

1. Helpful in determining the dollar size of the advertising budget
2. Helpful in determining how many sales reps to hire
3. Providing useful information on the need for future production capacity
4. Helpful in developing a strategic plan.

A knowledge of potential customers at the industry level and also at the firm level should provide a better data base foundation for decision-making.

PROBLEMS OF DEFINING FIRM DEMAND WEIGHTS AS POTENTIAL CUSTOMERS

Consider the industry demand schedule in example 1. Price ranges from \$110 to \$10. At a price of \$10, industry demand is 1,000. Let us assume that this represents maximum sales. At a price of \$10 and assuming each firm charges a price of \$10, then the total weights (label used in method 1) would be 2,800 (assuming only two firms). Does the 2,800 value mean that there are 2,800 individual potential customers. The answer is no because of overlap. An individual can be a potential customer of more than one firm.

Another problem involved in the term potential customer as used in this paper is that a customer that has purchased is still considered a potential customer and included in the count. Determining the number of potential customers that have never purchased is not necessarily easy. However, the 2,800 value used above does tell us what value that potential customers can not exceed.

In current simulation development and design, the demand weights by each firm are never communicated to the simulation participations. How firm demand is actually computed is never explicitly revealed. If the interpretation of the values generated by equation 2 as potential customers is of value, then how can the knowledge of potential customers be of value to simulation participants. If knowledge of this value does not enhance decision making, then method two is not any better than the conventional method.

One of the problems of current simulations is that how much to budget for advertising is never clear. There are never any clues as to how much advertising is too much and how much is not enough. If a student were told that total potential customers based on price alone is 2,800 and the cost of reaching each potential customer through advertising is \$2.00, then it is apparent that at a minimum advertising should be approximately equal to \$5,600. Some knowledge of potential customers should provide boundaries for advertising.

Also, most simulations allow sales people to be an important marketing decision. If sales people make calls, then how many sales people are needed to reach all potential customers. Again, some knowledge of total potential customers should be of value in making the sales people decision.

The theory proposed in this paper needs further development and analysis. It may eventually turn out that the suggested method involves too many difficulties to allow it to be implemented. However, in the process of critical analysis, some useful refinements in simulation design in the demand algorithm may result.

SUMMARY AND CONCLUSIONS

1. The interpretation of the results of the equation 2, $Q^F{}_i = (Po - P_i)/K$, as simply providing weights for computing market share seems inadequate.
2. The idea of computing market share percentages before computing firm demand seems illogical. It seems rather odd that the demand equation, equation 2, determines market share rather than firm demand of some type.
3. It has been proposed that a more logical interpretation of the results of this equation is that it generates potential customer values.

4. If the values generated by equation 2 are interpreted as potential customers, then it is not necessary to compute market share to first determine firm demand.
5. It is logical and quite simple to compute the average purchase rate per potential customer? The average sales (or purchase) per potential customer, QI/TPC, may be used directly to convert potential customers to firm demand. QFi = (QI/TPC) x PCi
6. While the traditional approach of first computing market share percentages and the new approach presented in this paper give the same results, the new approach advocated in this paper seems more logical to the author of this paper.
7. If the interpretation of equation 2 as either generated "weights" or potential customers, and the use of either method 1 or method 2 results in the same answer, (which is the case) the argument could be made that that the interpretation of the results of equation 2 as potential customers is unnecessary. However, the introduction of the concept of potential customers could stimulate new research and some new ideas in the creation of business simulation demand algorithms.

The introduction of the concept of potential customers gives a simulation more realism and makes the concept of advertising and marketing strategy more relevant. Marketing is often defined in terms of potential customers. For example, "Marketing is the process of interesting potential customers and clients in your products and/or services. " (http://www.yournorthhills. com/blog/rev-marketing/many-hats-marketing). Furthermore, the purpose of advertising is to cause potential customers to become actual customers. However, how to introduce advertising in terms of potential customers must be the focus of a separate paper.

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