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The Sorting Process as a Tool for Promoting the Demand of Heterogeneous Customers

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Abstract: The present study concerns product diversification. The products differ in size, shape, flavor, fat content, etc., so that the producer can more specifically modify the particular product to the unique requirements of nonhomogeneous customers. The mathematical model assumes diversified demands of nonhomogeneous consumers for an initial unsorted item. The sorting process generates a better match between customer requirements and the actual supply of sorted products. Thus, the implementation of sorting costs allows for an increase in customer demands by adopting product characteristics that are closer to customer needs and tastes. The study also considers the pricing policy for diversified products in order to determine if price discrimination is preferable for attaining the manufacturer's goal of profit maximization.

Keywords: heterogeneous customers; heterogeneous population; diversified products; sorting process; sales management

JEL Classification: D2; D21; D4; L12

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1. Introduction

The history of the consumption commodities markets reveals the phenomenon that for decades many innovations have extended the supply of product variety, especially by introducing new products. However, we also find another familiar process, which has introduced very large varieties of products and many kinds of items for each particular product. We can find a product that may differ from another in shape, size, combination of ingredients, qualifications, color or design, etc., yet the two products still have the same fundamental characteristics even though heterogeneous in many other respects. One example of this process is found in the car industry. A hundred years ago, only rich people could afford to buy a Ford car of a very specific quality and only one car model was supplied. Although other competitive car manufacturers later entered the market, Ford itself supplied varieties of cars that included many different characteristics such as engine size, car size, color, and additional differentiating features with respect to shape, design, etc. A different market that contains large varieties of the same product is the cereal market. Various grains differ in their flavors, shapes, and sizes in order to fulfill the desires and specific requirements of different customers according to age, gender etc. [1]. These and several other challenging examples discussed below brought about our decision to investigate the reasons for this development from the perspective of the producer that was probably motivated by profits.

Several kinds of corporate activities may lead to temporary and transient changes in the demands for goods and services and are thus used by many entrepreneurs to promote an increase in sales revenues and generate more profits. For example, the common tool

frequently used for sales promotion in the Western economy is advertising through many network media devices including commercial broadcasts on radio or television, publication in newspapers and, more recently, via the Internet.

It can be identified that the advertising process is used as a tool to channel customer tastes and needs to specific existing product characteristics. This process may on one hand include information about the necessities and importance of a product. On the other hand, it may include persuasion through advertising in order to convince the customer that existing product characteristics are suitable for him and fulfill his requirements. This effort of the seller may positively affect the price that can be charged for the purchase of a specific quantity of product. In contrast, a different approach to achieving the target of sales promotion focuses on the opposite direction. Rather than influencing customer preference for the actual characteristics of an existing product, it modifies the characteristics of a planned product towards the "targeted" customer needs and requirements. This may add to the revenue side but also impose costs on the seller. One tool discussed in the following model is the use of sorting in which the diversification of homogeneous product characteristics may promote the actual price of the product and increase profits.

However, the manufacturer that produces and sells items seeks several different avenues for promoting sales and profits from different angles. These kinds of policies that may have long term, permanent, and sustainable consequences are very often preferred by sellers. We can classify two kinds of sustainable impacts. The first are those that lead to changes along the supply chain side, such as technological improvements that enable the producer and the retailers to supply the product with lower production and delivery expenses. The second kind of sustainable impact results from changes in the ingredients that make up the product characteristics. Both these kinds of policies along the supply chain may induce sustainable price reduction, promote a larger sales volume, and most likely achieve more profit due to the cost savings and larger sales volume.

Several research studies have investigated this issue for decades. We reference some articles that discuss sales promotion and technological changes in production and marketing on the supply chain side. Xiao et al. [2] discuss the example of the "easy to use" characteristic and its influence on digital camera innovation. They conclude that the implementation of this characteristic indeed affects both camera company profits and consumer welfare. Thus, Technological Innovation (TI) is important as well as the market competitiveness that leads to it.

The other changes that promote a sustainable shift on the demand side are due to activities that encourage people to buy and utilize benefits from a specific and well-defined good by adapting its particular characteristics to their special needs. This process positively affects the demand for more specified and well-defined products.

For example, we can take a product in its fundamental form and add supplements to the basic properties of the product. We can attach a complimentary item or change the components of the original basic product, etc.

In the food industry, we find that supplements such as the permanent addition of several vitamins to specific products may indeed lead to a sustainable increased demand for the modified and "improved" product. Other examples from the food industry that also have a sustainable long-term effect on demand are the "accessibility" and the shape and size of a product [3].

While many articles concerning sales department innovations suggest sales methods that may influence customer behavior [4,5], our paper deals with sales promotion through an opposite process of adapting product characteristics to customer requirements. We do not focus on issues such as the salesperson's skills [6] or his work motivation [7] but deal instead with efforts for developing larger varieties of products that meet the particular needs and desires of the customers. In our model, the issue of increasing product modification is a different challenge for sales departments than that of increasing product complexity as described in the works of Jones et al. [8] or [9].

The difference between our current analysis and the previous avenues of sales promotion such as advertising is that advertising primarily uses the product to change and align customer needs and satisfaction with specific product characteristics that positively affect demand.

However, in our current approach, we do not try to change customer behavior or tastes and needs. Instead, we adapt the characteristics of basic products for modified and diversified subproducts that will positively affect customer demand for well-defined products [10,11].

This approach may be demonstrated by the example of the poultry industry products during recent decades. One hundred years ago people had to buy a live chicken and have it slaughtered and cooked immediately, even without the use of refrigeration. Later this was changed into the sale of chicken parts when the sorting process became possible. People with different preferences for certain poultry products were prepared to pay a higher price for specific chicken parts due to the more focused preferences that could result from the sorting process.

Today chicken parts are sold in every supermarket, not necessarily as frozen parts but in a refrigerated form that is fresher, healthier, and tastes better. This kind of sales promotion generates over time a sustainable attitude that increases not only the poultry product but also the specific demands for particular parts of the original product in its "unmodified" initial form. This kind of sorting benefits the public, individually and collectively.

We want to take the last point and extend the positive and permanent effects on the demand for a good or service. Another device that has become very popular today is the use of the sorting factor of debundling products. Instead of selling basic homogeneous products to heterogeneous populations that have varied tastes, the producer and the marketer adapt the characteristics of different kinds of products to the consumer demands and tastes. This may result in more benefit for consumers, more profit for producers and marketers, and consequently may also lead to a sustainable Pareto improvement for the society as a whole. This occurs when the marginal social cost of the sorting procedure is less than its marginal extra benefit to society as a whole.

The present paper deals with the classification of products into production groups and subgroups with the objective of adapting it to the special and diverse needs of different consumers.

The current paper emphasizes that the sorting process is based on consumer preferences and needs. Its purpose is to match a suitable product to consumer needs and utility. The producer adopts the sorting process with the understanding that the consumer desires it, unlike the approach, above, in which producers and marketers seek to influence consumer decisions, wishes and needs. Let us expand in more detail the different sorting processes.

The regular procedure of sorting many products, such as agricultural products, very often uses grading systems to sort the product according to size, color, shape, taste, durability, etc. and by doing so to determine different prices for the sorted subproducts. The efforts and the costs of the sorting process should be compared to its benefit for marketing activities and revenues. In this kind of sorting the sellers of the product do not change the basic product characteristics such as citrus fruits that may be lemon, orange, or tangerine, as explained by Khojastehnazhand et al. [12]. They thus create differentiation among the sorted fruits instead of supplying them unsorted. Similarly, diamonds and other minerals are sorted according to size, shape, color, etc.

We develop in our model a contrary scenario in which we may have an unsorted and homogeneous product such as natural orange juice that is sold to a population with heterogeneous tastes. The seller purposely initiates a sorting process and generates different kinds of orange juice according to the specific characteristics and tastes of the heterogeneous population. Here the sorting cost is directed towards specific and different demands of the heterogeneous customer groups.

The motivation for this paper arose when we found that in many industries an entire diversification of products has developed in recent years. Included among such products

are milk and other dairy products with different fat levels or flavors, with or without vitamin supplements; cheese and cream cheese products with different flavors and fat contents (as seen for example in the paper of Ares et al., [13]); orange juices with different levels of pulp that are sold in supermarkets; or ice cream with various flavors, fat levels, and other ingredients such as nuts or chocolate chips, with or without sugar, etc. Instead of the original milk with a certain percentage of natural fat, numerous kinds of milk can be found with various percentages of fat and with different supplements and flavors. These products are thus adapted to heterogeneous tastes of different individuals (children and adults) according to gender, age, health, and other socio-economic characteristics. Sometimes the price of each kind of product is different, while sometimes all kinds of products are sold at the same price. We try to explain under which conditions the various policies can be justified. In our current paper, we use the example of the orange juice industry that supplies diversified products. Instead of selling natural orange juice with a specified level of pulp as was done in the past, an entire diversified range of orange juice has recently been made available. Some orange juice is 100% natural, some pulp-free, some with lots of pulp, and some with extra vitamin supplements e.g., calcium and vitamin D, etc. In most cases, the processes are the same and the sorting process is most likely due to the producer's desire to adapt the orange juice supply to the specific tastes of heterogeneous customers.

The goal of many industries today is to guarantee a broad spectrum of a large variety of goods in the interest of heterogeneous customer satisfaction and in order to maintain sales volume. The present paper investigates the benefit for firms that implement this diversification by adjusting product characteristics rather than by changing customer tastes. It also considers the expenses arising from the sorting process and the variety of customer tastes.

The next section introduces a literature review of sales promotions using tools that may affect demand as well as other tools that adjust supply to heterogeneous demand. Section 3 provides the general model and presents various cases that consider optimal differential pricing and the same pricing. A numerical example in Section 4 is followed by a general discussion in Section 5 regarding the benefit of adjusting supply towards customer needs. Section 6 concludes the article with a summary of the results.

2. Literature Review

Some of the papers referenced below deal with the marketer learning processes rather than with the adjustment of the production process to customer behavior and consumption of products. Those papers do not address the producer's initial categorization of products in order to encourage purchasing and thereby increase sales and profits. For example, descending sorting can promote online sales of high-quality products [10]. Another study examines the strength of cross-category choice dependence within a customer's purchase history [14]. In addition, Lee et al. [15] deal with product categorization based on the objectivity of product evaluation standards.

The papers described below present a marketing intention to influence consumer behavior, unlike the present paper in which manufacturers seek to fit the product to the needs and preferences of consumers.

Fader and Lodish [16] analyze cross-category differences among grocery products and test several hypotheses associating category structure with promotional activity. This approach differs from the classification of products into groups and subgroups with the objective of adapting it to the special and diverse needs of consumers, as discussed in the present study. Similarly, several other papers address market basket choice, a decision process in which consumers select products from different product categories on a shopping list. Russell and Petersen [14] develop a new approach to constructing market baskets, based on the assumption that choice in one category affects choices in other categories.

Degeratu et al. [17] examine how online and traditional store environments differently affect consumer choices. They develop a framework that explains the possible differences between online and offline choices, and the reasons that they vary.

Cai and Xu [10] discuss the issue of product sorting as a sales promotion tool affecting consumer decision-making. Their study also considers the question of how sorting impacts the average perceived quality and price. Cai and Xu [10] present a sorting process that influences consumer behavior, unlike a process that sorts products according to consumer needs and desires. Cai and Xu [10] extend the literature by investigating the simultaneous effects of sorting on quality and price [18,19].

Product differentiation and market segmentation have been examined in the literature. Shaw [20] indicates that product differentiation meets human needs, and thus results in a demand for possibly more expensive products.

Chamberlin [21] and Porter [22] acknowledge the importance of how the consumer perceives product characteristics. Real differentiation could be reflected, for example, in distinct products or packaging, while imagined product differentiation might be associated with a trademark or trade name. According to Chamberlin [21] and Porter [22], different buyer preferences result in different demand curves. Samuelson [23] asserts that product differentiation is generally "artificial" and that segmented market demand is primarily caused by the supplier. However, he also states that product differentiation could provide a good response to certain consumer needs. Similarly, to Samuelson [23], Smith [24] suggests that product differentiation seeks to change the shape of the demand curve.

Market segmentation frequently refers to the development of a marketing plan to match multiple demand functions [25]. Mahajan and Jain [26] consider market segmentation as a type of research analysis. It focuses on recognizing and designating resources among market segments. Market segmentation is regarded as a method for observing the market. Rosen [27] and Lancaster [28] further develop an economic demand theory that relates to the characteristics contained in products. They regard product differentiation as diversity in the characteristics of alternative products.

In the literature, one can find an approach that is closer to our discussion of adapting sorting to consumer needs. The wide variety of customer needs and their rapidly increasing changes require replacing mass production of products with customized manufacturing suited to particular consumer requirements. According to Tarar and Mazilu [29] (p. 21), "customized products can be unique having a high degree of personalization and mass customized products, where the customer adds to a base version of the product a set of options provided by the developer, resulting in a unique product which satisfies the customer's needs." One basic aspect of product customization is involving the customer in the process. Such involvement assists in identifying customer requirements and transforming them into characteristics. It also provides client satisfaction with the product. It should be emphasized that mass customization includes aspects of both mass-produced products and personalized tailoring. The process modifies production to meet particular consumer requirements, and thus each product is different. Tarara and Mazilu [29] explain the mass customized and unique product design process, which includes tools for designing customized products.

Randall et al. [30] discuss the potential benefits to manufacturers that emerge from taking into account consumer preferences as well as desires and needs in the production process. The producer responds to consumer desires and needs by implementing the process of personalization. In the present model, however, the producer changes the properties of a basic product in order to create additional products that suit the various needs and desires of different consumers.

Goldsmith and Freiden [31] discuss the theoretical, managerial, and methodological implications of the strategic approach called "mass customization" or "personalization" that involves modifying the product differently for each consumer. The authors do not deal with sorting products but customizing them to consumer preferences and desires. This approach may increase production costs and therefore increase the price of the product.

Arora et al. [32] consider the market sorting process. They present one-to-one marketing, which adapts aspects of the firm's marketing mix to the individual customer [33–35]. Personalization and customization are the different kinds of marketing in this system. In

personalization, the firm usually uses customer data to suit the marketing mix to the individual. The practical advantages are increased customer satisfaction and higher profits [36]. In contrast, one concern is an invasion of privacy. Personalization is also expensive since it requires data and costly software for implementation. In customization, the customer first indicates one or more elements of his marketing mix. Thus, customization has the clear potential for and immediate advantage of greater customer satisfaction. Another potential strategic advantage is suggested by the examples below. Customization frequently occurs in very competitive markets such as restaurants, financial institutions, clothing, and information technology. In these industries, the differentiation among products is essential, while challenging and expensive. This kind of product differentiation and the creation of heterogeneity can be achieved by a unique production process used for all consumers by different manufacturers. In such a case the manufacturers do not create a heterogeneous range of product characteristics for all types of consumers, as presented in our study. A possible disadvantage is the cost of customization. The question for consideration is whether the incremental volume and strategic advantages overcome this cost. Similarly, in our study, diversification results in the additional costs of sorting. Customization can also create very complex choices that add difficulty to the purchase decision. Huffman and Kahn [37] and Dellaert and Stremersch [38] examine the challenge of attaining more satisfaction from product customization, while also having to make more complicated choices. An additional difficulty may also result from raising customer expectations. The present paper eliminates the element of difficulty in making choices.

The present paper assumes that the consumer is well aware of the differences among products and that his objective is to select a particular type of product that maximizes his utility. Another dimension for consideration is sales management from the perspective of the sales manager [8]. The authors deal with product complexity and technological innovation that affect customer demand. These elements necessitate more efficient and sophisticated sales promotion. Similarly, Goad and Jaramillo [39] draw upon empirical evidence to offer insights into the previous approaches and the consequences of both customer orientation (CO) and selling orientation (SO). Maier and Saunders [40] develop a model of segmentation implementation for sales management. They recommend improving sales effectiveness through customer classification. For each group of customers, appropriate sales tactics are adopted.

Customization allows producers to supply products that meet particular customer requirements. This is often achieved through the change, assembly, or modification of standard products to meet customer requirements [41].

The issue of mass customized products that have been discussed in recent years is used and analyzed in Section 5 below, with citations from recent research. (See Park and Yoo [42], Srinivasan et al. [43], Chen-Yu and Yang [44], and a very recent paper of Zhang et al. [45] dealing with the efficient and affordable costs of customized products.)

Manufacturers do not need to give up the efficiency of mass production for the flexibility of customization. New technologies (e.g., flexible manufacturing systems (FMS), computer-aided design/manufacturing (CAD/CAM), and just-in-time (JIT)) have increased product customization without significantly raising the production cost. Such manufacturing enables offering a significant variety for almost every type of product imaginable. A Federal Reserve Bank of Dallas [46] study also indicates a very substantial increase in product varieties since the 1970s. On average, the varieties offered by a single producer have also expanded. Many producers supply different products adapted to different consumer preferences. Thus, they also focus on those areas of the market requiring greater availability of product variety. Customization also enables firms to charge higher prices for their products. Cavusoglu et al. [47] find that while customers pay higher prices for products, on average their situations improve when firms adopt customization. Customers are very often ready to pay a higher price for the increased satisfaction from personalized solutions [21]. Some manufacturers provide several product varieties, while others provide every possible type of product within their realm of customization [48].

Although advanced technologies enable different kinds of customization, it is unclear whether firms can benefit from them since competitors can also adopt similar customization strategies. Customization strategies also have some disadvantages. A greater number of product varieties can undesirably impact expense and quality in a manufacturing environment [49,50]. Therefore, the cost and benefit of customization should be investigated before investing in such technologies. Cavusoglu et al. [47] find that unless the customization is very inexpensive, firms that choose to customize cannot generate greater profits than when they offer only a single product. This conclusion differs from those in the model set forth below.

The present paper is based on the understanding presented by several researchers [51–54] that there is a positive relationship between product proliferation and firm performance. Using a simple mathematical model, the present paper shows that firms that become generalists and draw on broad resources implement a product strategy that tries to ensure a diversified product. They supply products appealing to a wide variety of customer preferences and are more efficient by implementing the advantages of economies of scale and scope.

The model is presented in the following section.

3. The Model

3.1. Methodology

The method used in our paper assumes diversified demands of heterogeneous consumers for an initial unsorted item. This may result in a lower demand when the unsorted item differs from an item more specialized to consumer tastes. The highest demand for the unsorted item is that of the median representative customer. The unsorted product characteristics "completely" match his requirements.

The demands of other customers are rectangularly distributed, demonstrating diminishing demand due to the gap between their requirements and the actual characteristics provided by the unsorted product. The sorting process closes this gap by generating a better match between customer requirements and the actual supply provided by the sorted products. Thus, the implementation of sorting costs allows for an upwards shifting of customer demands by adopting product characteristics that are closer to customer needs and tastes.

The sorting process benefits both parties with better adjustment to consumer tastes, more significant revenues, and thus profits for the producer. We conclude that the sorting process leads to different pricing strategies. It may lead to either price unification for all customers or to pricing diversification. Both are possible. However, profits and social optimum can be achieved, indicating a Pareto improvement. A simple numerical example demonstrates our claims.

3.2. Theoretical Model

The model concerns the demand among heterogeneous customers for natural orange juice with a regular level of pulp. These customers differently utilize the various levels of pulp contained in orange juice. Any deviation in the actual level of pulp from a consumer's optimal desired level reduces the demand so that the aggregate demand of all consumers depends on the specific demand distribution of the heterogeneous customers. This indicates that for any quantity of products demanded by heterogeneous customers, any deviation from the characteristics desired by customers reduces the price that they are willing to pay.

We assume in our model rectangular distribution of demand for natural orange juice with different values of pulp. In this distribution $(n + 1)$ customers demand orange juice. For an individual $\left(\frac{n}{2} + 1\right)$ who is a median customer, the pulp level in the natural orange juice is the optimal level. Thus, his demand for orange juice, Q, is:

$$D_{\left(\frac{n}{2}+1\right)} : P = A - Q$$

where P is the price of each unit of orange juice and A is the highest reservation price for natural orange juice. However, any given change towards more or less diversified pulp levels equally reduces the demand for Q by one dollar per unit level of pulp. This means, for example, that the demands of both customers $\left(\frac{n}{2}\right)$ and $\left(\frac{n}{2}+2\right)$ are the same as follows:

$$D_{\left(\frac{n}{2}+2\right)} \equiv D_{\left(\frac{n}{2}\right)} : \; P = (A-1) - Q$$

and in the extreme case of customer 1 who extremely dislikes pulp and customer $(n + 1)$ who extremely likes pulp, their demands for natural orange juice are again the same and equal to:

$$D_{(1)} \equiv D_{(n+1)} : \; P = \left(A - \frac{n}{2}\right) - Q$$

If we want to generalize our discussion, we could identify in Figure 1 the distribution of i individuals when

$$i = 1, 2, 3, \ldots\ldots\ldots, \frac{n}{2}, \frac{n}{2}+1, \frac{n}{2}+2, \ldots\ldots\ldots, n+1.$$

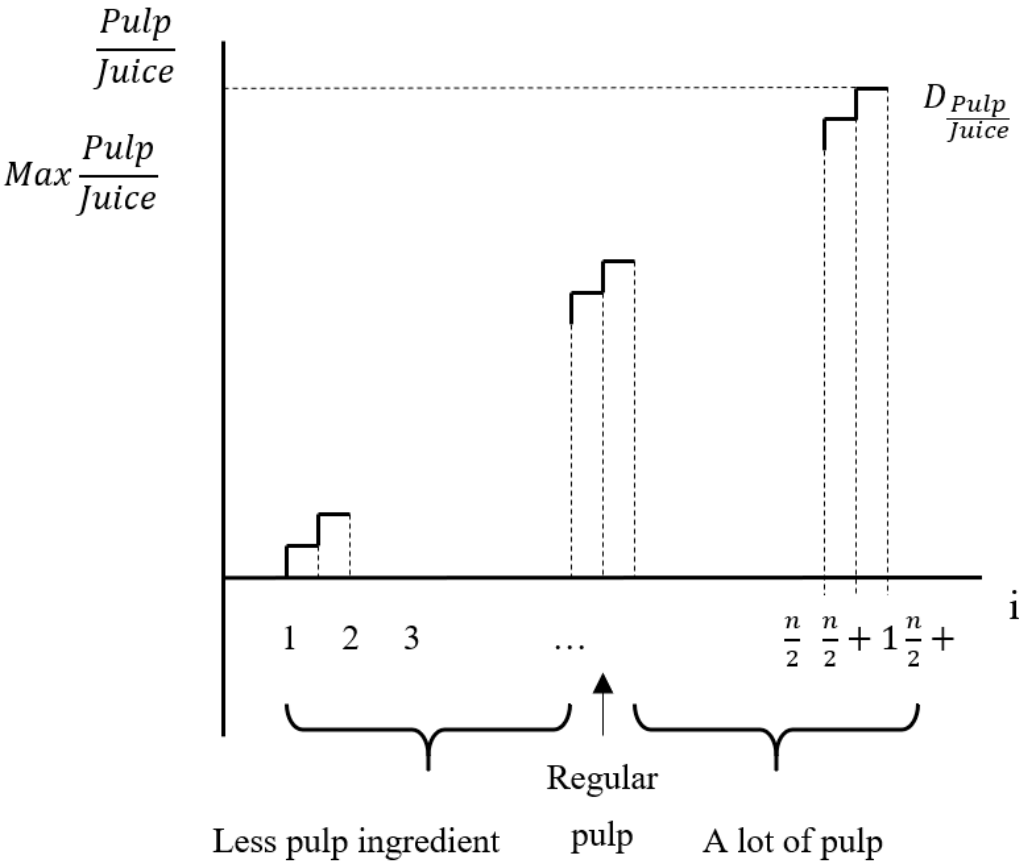

Figure 1. Distribution of the population according to pulp consumption preferences.

For simplicity, we assume a group of $(n + 1)$ consumers who prefer different levels of pulp in their orange juice drink. Consumer 1 prefers an orange juice free of pulp. Consumer $(n + 1)/2$, the median consumer, prefers natural orange juice with the regular level of pulp without any pulp supplement. The last consumer, "customer" $(n + 1)$, likes orange juice with maximum pulp.

The sorting process occurs based on a rectangular pulp demand distribution where the first $n/2$ drink orange juice from which a certain level of pulp is removed and added

to the orange juice with a pulp supplement that the other $n/2$ consumers drink. The last consumer $(n+1)$ desires orange juice with a maximum pulp level.

Let us emphasize this in a technical way as follows:

Where $i = \frac{n}{2} + 1$ is a median customer, all customers i, in the region of $1 < i \leq \frac{n}{2}$ are the pulp averters who dislike various degrees of pulp. These are on the left-hand side of Figure 1. All customers i of $(\frac{n}{2} + 1 < i \leq n + 1)$ are pulp lovers who like various levels of the pulp ingredient. These are on the right-hand side of Figure 1.

The demands in general terms of all customers i can be written algebraically as follows:

$$P_i = \begin{cases} A - \frac{n}{2} - 1 + i - Q_i \; for \; 1 \leq i \leq \frac{n}{2} \text{ pulp averters} \\ A - Q_i \qquad\qquad for \; i = \frac{n}{2} + 1 \text{ the median customer} \\ A + \frac{n}{2} + 1 - i - Q_i \; for \; \frac{n}{2} + 2 \leq i \leq n + 1 \text{ pulp lovers} \end{cases} \tag{1}$$

Due to the rectangular and symmetric distribution of demands of various customers, we can calculate and present the aggregate demand curve of all customers for homogeneous and natural orange juice supplied to all consumers without sorting as follows:

$$P = \begin{cases} A - i + i^2 \cdot \frac{1}{1+2i} - \frac{1}{1+2i} \cdot Q \qquad for \; i^2 \leq Q \leq (i+1)^2 \\ \frac{1}{n+1} \cdot \left[\left(2A - \frac{n}{2} - 1 \right) \cdot \frac{n}{2} + A \right] - \frac{1}{n+1} \cdot Q \; for \; \frac{n^2}{4} < Q \leq \left(2A - \frac{n}{2} - 1 \right) \cdot \frac{n}{2} + A \end{cases} \tag{2}$$

where $Q_{\max}$ at price zero is measured as follows:

$$Q_{\max} = \frac{\left(A - \frac{n}{2} + A - 1 \right) \frac{n}{2}}{2} + A + \frac{\left(A - \frac{n}{2} + A - 1 \right) \frac{n}{2}}{2} = \left(2A - \frac{n}{2} - 1 \right) \frac{n}{2} + A \tag{3}$$

and $\overline{Q}$ is measured as follows:

$$\overline{Q} = Q_{\max} - \left(A - \frac{n}{2} \right) \cdot (n+1) = \frac{n^2}{4}. \tag{4}$$

The marginal revenue (MR) is:

$$MR = \begin{cases} A - i + i^2 \cdot \frac{1}{1+2i} - \frac{2}{1+2i} \cdot Q \qquad i^2 \leq Q \leq (i+1)^2 \\ \frac{1}{n+1} \cdot \left[\left(2A - \frac{n}{2} - 1 \right) \cdot \frac{n}{2} + A \right] - \frac{2}{n+1} \cdot Q \quad \frac{n^2}{4} < Q \leq \left(2A - \frac{n}{2} - 1 \right) \frac{n}{2} + A \end{cases} \tag{5}$$

(See also Figure 2.)

We assume further that the total production cost (TC) of natural orange juice is:

$$TC = C \cdot Q \tag{6}$$

where C is the marginal cost of each additional output of an orange juice unit.

At equilibrium, we equate marginal revenue (MR) and marginal cost (MC), $MR = MC$

Case I: Homogeneous goods

In this case, in which the sorting of different pulp levels does not exist and only homogeneous natural orange juice is available, the solution is at the point at which the marginal revenue is equal to the marginal cost i.e., Equation (7):

$$MR = MC \tag{7}$$

or

$$MR = \frac{1}{n+1} \left[\left(2A - \frac{n}{2} - 1 \right) \frac{n}{2} + A \right] - \frac{2}{n+1} \cdot Q = C. \tag{8}$$

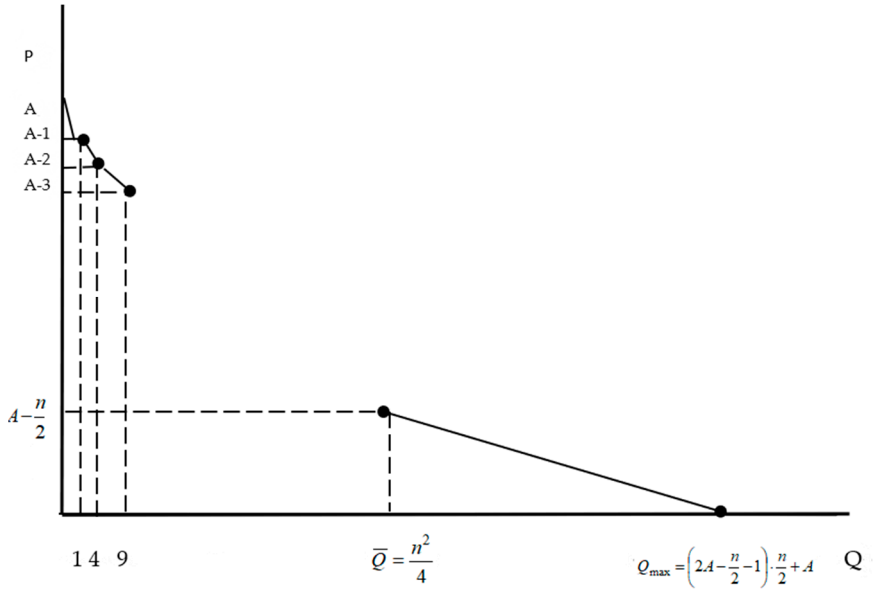

Figure 2. Horizontal summation of demands.

From (8) we find the quantity at equilibrium Q_I sold and price Q_P of the homogeneous juice as:

$$Q_I = \frac{\left(2A - \frac{n}{2} - 1\right)\frac{n}{2} + A - C(n+1)}{2} \tag{9}$$

and

$$P_I = \frac{\left(2A - \frac{n}{2} - 1\right)\frac{n}{2} + A + C(n+1)}{2(n+1)}. \tag{10}$$

and from (9) and (10) we define and measure of profit at maximum, Π_I as follows:

$$\Pi_I = (P - C) \cdot Q = \frac{\left[\left(2A - \frac{n}{2} - 1\right)\frac{n}{2} + A - C(n+1)\right]^2}{4(n+1)} \tag{11}$$

Case II: Sorting process with different prices for the non-homogeneous goods

Previously we did not allow a sorting process that we discuss below. In this second case we want to analyze the situation in which due to the distribution of demands for different levels of pulp within the orange juice industry, the monopoly adjusts the demand by sorting the optimal pulp ingredients for each customer and reallocating some of the pulp to certain customers due to their preferences. Technically pulp is delivered from pulp averter customers towards symmetric pulp lover customers. Due to the rectangular distribution of customer demand by the delivery cost of a unit of pulp, d, the demands of all customers can be made identical and equal to the following demand of each individual customer i.

$$D_i : P_i = A - Q_i, \tag{12}$$

where Q_i represents quantity demanded by customer i with his optimal amount of pulp and therefore the market demand of all customers is:

$$P = A - \frac{Q}{n+1}. \tag{13}$$

and

$$Q_i = \frac{Q}{n+1}$$

is the identical optimal quantity of each customer i.

Figure 3, below, demonstrates the market demand for orange juice when the orange juice units have different levels of the pulp ingredient.

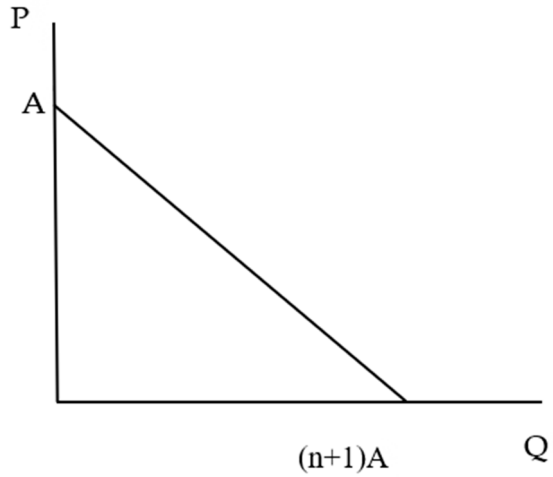

Figure 3. Horizontal summation of adjusted demands.

The monopoly that desires profit maximization by sorting has to pay d dollars per unit for sorting and delivering the pulp for n customers as follows, while there is no delivery cost for the median customer $Q_i = \frac{n}{n+1} \cdot Q$.

The profit function in the case of the sorting process is:

$$\Pi_{\Pi} = (P - C) \cdot Q - d\left(\frac{n}{n+1}\right)Q, \tag{14}$$

or

$$\Pi_{\Pi} = \left(A - \frac{Q}{n+1} - C\right) \cdot Q - d\left(\frac{n}{n+1}\right) \cdot Q. \tag{15}$$

The First Order Conditions (FOC) for maximization is:

$$\frac{d\,\Pi_{\Pi}}{dQ} = A - C - \frac{2\,Q}{n+1} - \frac{dn}{n+1} = 0 \tag{16}$$

and from (13) and (16) we find the optimal quantity, price and profits in Case 2 as follows:

The quantity is:

$$Q_{\Pi} = \frac{(A - C)(n+1) - dn}{2}. \tag{17}$$

The price is:

$$xP_{\Pi} = \frac{A + C}{2} + \frac{dn}{n+1}. \tag{18}$$

The profit function is:

$$\Pi_{\Pi} = \left(P_{\Pi} - C - d\frac{n}{n+1}\right) \cdot Q_{\Pi}, \tag{19}$$

or

$$\Pi_{\Pi} = \frac{(A - C)^2(n+1) - d \cdot n(A - C)}{4}. \tag{20}$$

From Equations (11) and (20) we can comper Π_I and Π_2 see Appendix A.

4. Numerical Example

How does a monopoly "generate" implicit price discrimination by using the sorting process and affecting the reservation price or price elasticity of customer demand?

In this section, we demonstrate numerically the profit advantages of the sorting process, by comparing profit with and without the sorting process.

A Case Study: Demand for squeezed natural orange juice, including juice + pulp by fixed proportion is:

$$D_2 \equiv D_1 : \ P = 140 - Q$$

D_1 and D_2 represent the demand of two individuals out of three in the market. Individual 1 very much likes the concentrated pulp juice, and Individual 2 does not like pulp at all. The third individual, Individual 3, likes the original natural juice. We assume further that for all three individuals any deviation (increase or decrease) in the amount of pulp that is not desired leads to parallel downward changes in the demands for all three individuals as follows:

For Individual 3, who likes natural orange juice, the demand is:

$$D_3 : P = \begin{cases} 140 - Q_3 \text{ for no pulp} \\ 160 - Q_3 \text{ for regular pulp} \quad (\text{natural orange juice}) \\ 140 - Q_3 \text{ for a lot of pulp} \end{cases} \tag{21}$$

For Individual 1, who likes a lot of pulp in the orange juice, the demand, D_1, is:

$$D_1 : P = \begin{cases} 160 - Q_1 \text{ for a lot of pulp} \\ 140 - Q_1 \text{ for regular pulp} \quad (\text{natural orange juice}) \\ 120 - Q_1 \text{ for no pulp} \end{cases} \tag{22}$$

For individual 2, who likes no pulp at all, the demand D_2 is:

$$D_2 : P = \begin{cases} 160 - Q_2 \ for \text{ no pulp} \\ 140 - Q_2 \ for \text{ regular pulp} \quad (\text{natural orange juice}) \\ 120 - Q_2 \ for \text{ a lot of pulp} \end{cases} \tag{23}$$

where P is measured in dollar terms.

Furthermore, we assume that the regular marginal cost, MC, of squeezing regular orange juice units from oranges without sorting and affecting more changes of the pulp ingredient is \$20 per unit.

However, reducing or supplementing the normal pulp level contained in the natural orange juice costs an extra \$10 per unit. We want to compare the sales and profits with a pulp sorting procedure to the case with no sorting at all, by "allowing" the sale of only one type of natural orange.

Let's start with the cases of a simple monopoly. The first case is selling orange juice with and without "sorting" between juice and pulp. A second case is selling milk either as homogenized milk with a natural fat level or as other kinds of milk with 1–4% fat levels. A third possibility considers the profit from selling only one kind of cream cheese with natural fat as compared to an enriched level of fat as well as a cream cheese that is fat-free or has different fat levels.

Case 1: No sorting process

In the case of no sorting process with an identical price of natural orange juice (milk or cheese), the aggregate demand of all three individuals can be split into two regions:

$$P = \begin{cases} 160 - Q \text{ for } 0 < Q < 20 \text{ where only individual 3 buys} \\ \\ \frac{440-Q}{3} \text{ for } 20 < Q < 440 \text{ where all three individuals buy} \end{cases} \tag{24}$$

When MR is derived from (24) we get the following:

$$MR = \begin{cases} 160 \ - \ 2 \cdot Q \text{ for } 0 < Q < 20 \\ \\ \frac{440}{3} \ - \ \frac{2Q}{3} \text{ for } 20 < Q < 440 \end{cases} \tag{25}$$

Assuming marginal cost, MC = 20, we get optimal profit at the quantity where $MC = MR$.

Thus, at equilibrium we get:

$$MR = \frac{440}{3} - \frac{2}{3}Q = 20 = \ MC \Rightarrow Q = 190,$$

and $P_E = 83.33$.

The profit Π_I is:

$$\Pi_I = (P - M_C)Q = (83.33 - 20)190 = 12,033.33.$$

Case 2: Sorting process with different prices for the non-homogeneous goods

By using a sorting procedure for generating three kinds of juice: (1) full-pulp juice; (2) pulp-free juice; and (3) natural juice, the following three new demand curves are identical for different kinds of juice:

$$\begin{array}{l} P_1 = 160 - Q_1 \\ P_2 = 160 - Q_2 \\ P_3 = 160 - Q_3 \end{array} \quad (26)$$

The total profit function of the juice producer is:

$$\begin{array}{l} \underset{P_1,\, P_2,\, P_3}{\text{Max}}\, \Pi_{II} = (160 - P_1)P_1 + (160 - P_2)P_2 + (160 - P_3)P_3 - 20[480 - P_1 - P_2 - P_3] - \\ \qquad -10(320 - P_1 - P_2) \end{array} \quad (27)$$

where the fourth term presents production costs and the fifth term presents the sorting cost.

The FOC for each of the three prices is:

$$\frac{\partial \Pi_{II}}{\partial P_1} = 160 - 2P_1 + 20 + 10 = 0. \quad (28)$$

From (28) we get P_1 = 95, Q_1 = 65.

$$\frac{\partial \Pi_{II}}{\partial P_2} = 160 - 2P_2 + 20 + 10 = 0. \quad (29)$$

From (29) we get P_2 = 95, Q_2 = 65.

$$\frac{\partial \Pi_{II}}{\partial P_3} = 160 - 2P_3 + 20 = 0, \quad (30)$$

and from (30) we get P_3 = 90, Q_3 = 70.

The total profit is summarized as follows:

$$\Pi_{II} = (P_1 - 30) \ \cdot 65 + (P_2 - 30) \ \cdot 65 + (P_3 - 20) \cdot 70 = 13,350. \quad (31)$$

The profit after the sorting process for the three different items adds up to 13,350, which is larger than 12,033.33 and is achieved without sorting. In this special example, the diversified prices of different types of orange juice lead to increased profit due to the sorting process.

5. General Discussion Regarding the Benefit of Adjusting Supply towards Customer Needs

The last section developed a model illustrating with numerical examples that supply diversification is beneficial under certain demands and sorting costs. The present section applies these useful ideas of supply adjustments. The paper examines product diversification and states that the adjustment of supply towards customer needs and demand is the main reason for generating diversified products. An important aspect is that the paper

takes a different path, moving away from the traditional marketing intention to influence consumer behavior. It instead moves towards manufacturers seeking to fit the product to the needs and preferences of consumers.

The study of Park and Yoo [42] concludes with theoretical and practical implications for mass customized products. Mass customized products enable an individual to exactly find a particular product requirement at a reasonable price [48]. The producer faces costs that we refer to as sorting costs to channel the supply of various and more favorable products. Such sorting encourages the consumers' willingness to pay a higher price and promotes the utility of consumers as well as the profit of producers. Consequently, as found by Endo and Kincade [55], producers are able to offer a highly personalized shopping experience. Today the use of Internet technology allows more practical benefit for retailers and their customers through customization. Park and Yoo [42] indicate that customization has been implemented in several industries, including among them computers, apparel, home furniture, cars, luxury brands such as designer clothing, etc. The advantages of customization in comparison to regular or standard production depend upon two main aspects. The first one is the required extra cost of customization. In the sorting process, a greater variety of requirements sometimes very significantly increases the production cost. The second aspect is the importance and degree of necessity of the specific qualifications required by the customers. In the discussion below, several examples relate to the issue of specification today. Included among them are personalized medicine, in vitro meat production, and organ implantation using a 3D printer.

During recent decades, the sorting process has approached an extreme situation in various fields of medicine. The supply of medical treatment is adapted to very specific and unique requirements through the application of personalized medicine. As shown in recent decades, patients respond differently to treatments and medications, so that doctors need to "bundle" a specific package according to a patient's condition, risk, genetic structure, and several additional personal characteristics. In the Nature Medicine journal, Chin et al. [56] published their findings that such personalized medical treatment increases the survival rate of cancer patients and their abilities to control their lives. The personalized treatment helps supply the appropriate medication. This process saves treatment costs and lives. The results published by Chin et al. [56] were also suggested by Schilsky [57] and Fernald et al. [58].

The use of personalized medicine that has been developed in recent years /implements a large database that enables doctors to identify the specific characteristics of the patient, including individual biological, molecular, and behavioral indicators rather than using average values for the entire population [59].

The ability to channel the supply towards exact needs and specific requirements has been extended by the technological innovations of the 21st century (also referred to herein as "TI"). One of the tools is 3D printing technology [60]. Ali et al. [61] have recently discussed the benefit of this new technology and its application in different areas of medicine as well as in various industrial sectors.

The TI development of recent years very significantly influences the ability to specify supply according to the special needs of an individual. It enables supplying the smart home industry according to the resident's specific characteristics and requirements. The use of 3D technology also enables the supply of clothing and shoes in specific sizes, styles, and designs. Even the diet of an individual has recently become more personalized.

Another product that demonstrates a different kind of personalized supply is described by Bhat et al. [62] as in vitro meat (also referred to herein as "IVM"). The meat production uses stem cell technology when the meat is grown in a laboratory. This kind of production process is more moral, safer, tastier, and more environmentally friendly than conventional meat production. IVM avoids cruelty and slaughter. It is also safe and avoids the global warming issues raised by the conventional production of meat. With IVM the product supplied exactly matches the requirements of each individual in terms of fat control and vitamin supplements. Another factor that distinguishes between IVM

and conventional meat production is the shorter duration of the IVM process. In contrast, conventional chicken production requires a couple of months, while preparing cows or pigs for slaughter sometimes requires years of production. An additional factor that should be considered is that with IVM a specific animal part such as goose liver can be separately produced in the laboratory, while conventional production requires the production of the whole goose. In such conventional production, only the liver is utilized while the leftover parts are discarded.

The development of TI includes 3D printing and laboratory innovations that can be directed towards personalized supply, which may improve the welfare of both producers and consumers in society.

6. Implications and Conclusions

This paper identifies new tools differing from other existing promotion tools used by agents that target profitability. The most popular devices developed by economists and marketers to promote profits deal with the demand side of the equation. The other side of the equation has tools that promote profitability on the supply side. These latter tools include technological improvements and innovations that reduce the production cost, while the changes on the demand side include advertising or technologies of persuasion to convince the customer to buy more products and benefit from the high utility. This last device causes the customer to recognize that he indeed needs and enjoys the specific promoted item. These policies have recently become very conventional and popular among "practitioner" economists and marketers.

However, in recent years we find a different kind of promotion practice. The goal of the marketers and producers is again to promote sales and customer demand, but the method is different. Instead of promoting and channeling the needs and wants of the customers towards existing products including ingredients and characteristics, we suggest promotion in the opposite direction. Thus, when sellers or producers know or identify the specific needs and desires of customers, they look for new avenues to adjust basic product ingredients to meet the diversified customer needs. Both in cases of channeling demand towards the supplied product and in adjusting the supplied product towards the demand, the gap between the two decreases. Our suggestion is that adjustment of supply towards demand is the main reason for generating diversified products that fall under the category of "general products" and more specifically refining them to more closely meet the particular needs of the customers. The process of sorting general product into several diverse kinds of the same product should be regarded as a tool for achieving sales promotion. This kind of policy is investigated in the present paper. For example, the general product called "milk" may be refined and redefined more specifically as a very certain kind of milk with a specific level of fat, with or without added vitamins, in specific sizes, or with different sugar levels. The products are all listed under the general product name "milk," but they specify each kind of milk product according to the various tastes and particular needs and desires of the heterogeneous population.

The benefit in revenues or profits for producers and sellers, combined with higher satisfaction and utility for customers, lead to the conclusion that Pareto improvement situations may result at least when the spending cost of the sorting process is relatively low. In such cases, different economic agents may benefit from activating the sorting process.

Another conclusion we derive from our work is that due to the sorting cost that may generate some kind of segmentation between customer groups, it is possible that price discrimination may follow the sorting process. However, it is also possible that the sorting occurs without charging different prices for a variety of products. This means that an entire variety of products is offered without charging different prices for that variety, although the products contain different ingredients or additional supplements such as vitamins. For example, in our model and in the numerical example we demonstrate that sorting among different orange juice products with different levels of the pulp can generate more benefit to customers and more revenues and profits for the sellers. Nevertheless, an identical price

is maintained for all kinds of orange juice, even though diversifying the pulp levels may cost the producers more due to the reallocation of pulp among the different kinds of juice. The examples of milk or orange juice sorting can be applied today to modern and advanced fields of economic activity. The issue of customization of supply towards specific needs should be investigated during the coming years. The areas of personalized medicine and 3D printer technology open up various new avenues for further research. For example, 3D printer technology is already used for producing customized clothing and for preparing organs for future implantation [63].

In conclusion, the promotion of diversified products is an important tool for more efficient markets that may benefit the consumers and the producers, and thus may simultaneously lead to a sustainable positive effect on their welfare in our society. This kind of policy can sometimes be more valuable than other methods for the promotion of profits such as production innovation or advertising.

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Appendix A

Let us calculate the profits in each case and compare between Π_{II} with sorting and Π_I without sorting:

Profit without sorting Π_I is:

$$\Pi_I = \frac{\left[(A-C)\,(n+1) - \frac{n}{2}\left(\frac{n}{2}+1\right)\right]^2}{4\,(n+1)}$$

With sorting the profit Π_{II} is:
where

$$\Pi_{II} = \frac{(A-C)^2\,(n+1) - dn(A-C)}{4}$$

$$\Pi_I = \frac{\left[(A-C)\,(n+1) - \frac{n}{2}\left(\frac{n}{2}+1\right)\right]^2}{4\,(n+1)} \underset{<}{\geq} \frac{(A-C)^2\,(n+1) - dn(A-C)}{4} = \Pi_{II}$$

or

$$(A-C)^2\,(n+1)^2 - 2\frac{n}{2}\left(\frac{n}{2}+1\right)(A-C)(n+1) + \frac{n^2}{4}\left(\frac{n}{2}+1\right)^2 \underset{<}{\geq} (A-C)^2\,(n+1)^2 - dn(n+1)\,(A-C)$$

$$\frac{n}{4}\left(\frac{n}{2}+1\right)^2 \underset{<}{\geq} (A-C)\,(n+1)\left(\frac{n}{2}+1-d\right)$$

For relative low value of sorting cost, d,

$$\left(\frac{n}{2}+1\right)^2 < (n+1)\left(\frac{n}{2}+1-d\right)$$

Therefore

$$\Pi_{II} > \Pi_I \text{ if } \frac{n}{4} < A-C$$

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