Weber' Law in Marketing

Bachelors Thesis

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Abstract

Consumer's perception of different intensity levels of stimuli plays a significant role in understanding consumer behavior patterns. At the beginning of the nineteens century, Ernst Heinrich Weber discovered a model, the so-called Weber's Law, which describes, how individuals perceive physical stimuli. The psychophysical model determines the smallest change in the intensity of a stimulus required to be noticed by an individual. It states that changes in incentives have to be relative to the initial stimulus. In this paper, Weber's Law is applied to understand consumer buying-decisions and buying behavior. The implications of Weber's Law are used to make recommendations, that can be applied by managers to determine the optimal structure and design of company's marketing mixes for a given product dependent on individual goals. Real-world examples are used to explain the proposals in an understandable way. The findings of this paper can be used in practice to pursue different business objectives.

1. Introduction

Consumers are surrounded by a variety of products from which they have to make a choice. In most cases, products differ in prices, product quality or packaging size. Companies have a keen interest that consumers select their products from the variety of products. In order to differentiate their products from competing products and to attract the awareness of consumers, companies use several marketing concepts. To be successful in marketing, companies have to understand consumer behavior patterns and buying decisions. Without understanding consumer behavior theories, companies do not know which stimuli are necessary to evoke a desired behavior of the consumer, for example, to buy and use a particular product.

Consumer's subjective perception of the intensity of a stimulus plays a significant role in understanding consumer behavior patterns. At the beginning of the nineteens century, a psychophysical model was discovered, which describes the perception of physical stimuli by individuals. The theory points out that individuals perceive a change in stimulus if the change in stimulus is above a so-called just noticeable difference. In other words, the just noticeable difference is the smallest change in stimulus necessary to be perceived by individuals. Since then lots of experiments were conducted to challenge the theory and to check the validity, especially in different fields of marketing. For example, Gabor and Granger (1966), Lambert (1978) as well as Kamen and Toman (1970), conducted experiments to determine the consequences of Weber's Law for the pricing of products.

This paper aims to review experiments and literature to get a detailed understanding on the application fields of Weber's Law in marketing. The purpose of the thesis is not to explain the mathematical derivation of Weber's Law and the Weber-Fechner-Law. However, the primary purpose of the paper is to use the implications of the model to give some hands-on recommendations for managers. The proposals are easy to apply in practice and help companies to achieve different entrepreneurial goals such as increasing brand awareness or the profitability

of a product. By the use of simple examples (ceterus pariubus, so under the assumption that all other factors remain constant) it is shown how Weber's Law can be used to achieve these entrepreneurial goals.

In the beginning, the paper explains the theoretical basis of Weber's Law and the modification of the model through Fechner, before pointing out the implications for the marketing mix. In the end, the theory is critically evaluated and the managerial implications, which are the research target of the paper, are summarized and highlighted.

2. Theoretical Foundation of Weber's Law

To understand, how individuals perceive different stimuli is a significant step in order to be able to trace human behavior patterns. The German Professor for Comparative Anatomy, Human Anatomy, and Physiology at the University of Leipzig, Ernst Heinrich Weber has set a milestone in this context with his research on perceptions of physical stimuli at the beginning of the nineteenth century. He discovered a psychophysical model, the so-called "Weber's Law", which describes the ability of individuals to subjectively determine changes in the intensity of different physical stimuli, such as weights on muscles and pressures on the skin (Miller 1962).

Weber's Law helps to describe the least level of physical stimuli which is necessary that a change is noticed by an individual – the so-called "just noticeable difference" (JND). So, for a just noticeable difference, a specific amount of change in the intensity of the stimulus is needed so that one may be able to perceive a different experience of the stimulus (Britt 1975).

For a better understanding of the model, an experiment can be used to describe Weber's Law. At the beginning of the test, a person lifts two equal weights, one in each hand. While the weight, which is held in one hand is not changed, the weight, on the other hand, is increased, until the person can notice a difference between the two weights. Holding a weight of five

ounces in his or her hands, the person can probably detect a difference in the masses, when he holds a six-ounce weight in the other hand. If the experiment is repeated with an initial weight of 10 ounces which remains constant, the person will be able to determine a difference in the weights, when the increased weight reaches twelve ounces. The experiment shows, that the necessary weight increase to notice an increase in weights depends on the initial weight the experiment was started with (the initial stimulus) (Miller 1962).

Weber's Law can be expressed in the mathematical ratio:

$$\frac{\Delta I}{I} = K$$

$$I = Stimulus$$

$$\Delta \mathrm{I} = \text{just noticeable difference}$$

$$\mathrm{K} = \text{constant ratio}$$

The mathematical ratio shows that the law is not about absolute differences in physical stimuli but relative differences. In other words, the stronger the initial stimulus I is, the more significant the change in intensity has to be in order to be perceived by an individual (Ekman 1959). Furthermore, the mathematical ratio states, that there is a positive linear relationship between the initial stimulus and the just noticeable difference. In other words, Weber's Law points out, that the just noticeable difference is in a constant proportion to the initial stimulus. If the initial stimulus is doubled, the just noticeable difference is doubled as well (Laming 2009). At low levels of initial stimulation, a small absolute change in the stimulus is sufficient, whereas, at a high level of initial stimulation, a high total change in the simulation is necessary (Snell, Gibbs, Varey 1995). To describe the linear relationship, the mathematical formula can also be expressed as:

$$\Delta I = I * K$$

Using the results of the experiment above and putting it in the equation, one can see that the results reflect the linear relationship between the just noticeable difference and the initial

stimulus. In the case of the experiment, with the weights, used to explain Weber's Law, the constant k is 0.2 (I = 5, ΔI=1; I= 10, ΔI= 2). The linear nature of the relationship between the initial stimulus and the just noticeable difference can also be observed in *figure 1*, which displays the results of the experiment. The blue line shows, how much the change in the stimulus, in this case, the change in weights, has to be, that the individual determines a difference in the stimulus.

Since the result of perceived stimuli is very important in many different situations and Weber's Law only describes how individuals perceive physical stimuli and not how this is connected to mental events, the German physicist and psychologist Gustav Theodor Fechner (1801 – 1887) dealt with Weber's law in the mid of the nineteenth century in order to discover how Weber's Law is related to psychological stimuli. Fechner believed that mental events are at least very similar to physical activities, if not the same. His goal was to find a guideline that would help him to "take a sensation of a certain strength S and relate it to [a stimulus] I" (Murray 1990). He wanted to find out how a just noticeable difference in sensation S is related to a stimulus change, which is necessary to create the just noticeable difference in sensation S. He speculated that the change in sensation ΔS could be described as a function of the Weber fraction, multiplied by a constant c:

$$\Delta S = c * \frac{\Delta I}{I}$$

In further calculations and experiments Fechner discovered, that sensation strength is a logarithmic function of stimulus strength. In other words, "as stimulus strength increases, sensation strength rises quickly at first then slows down". This is also called the Weber-Fechner Law. Fechner considered Weber's Law as given and did not further investigate the Law itself. He focused his work just on the relationship between physical and psychological stimuli and worked out how Weber's Law had to be justified to also hold for psychological stimuli (Murray 1990).

Although Weber's Law and Fechner's findings do not hold in every case, for example at extremes (very bright or very dim lights), and the theories have often been criticized, the approaches are still used nowadays in psychophysics (Murray 1990).

3. Implications for the Marketing Mix

Although Weber's Law is more a psychophysical model, it has a lot of important implications for several situations, where the results and the consequences of perceived stimuli play a major role. Changes in stimuli which are not recognized by individuals cannot have the desired change in the behavior of individuals. A situation, where the consequences of Weber's Law are apparent is for example if an employer increases the salary of an employee and hopes that the increase will make the employee feel more appreciated and as a consequence, the employee will be more motivated in the future. But the desired effects of the salary increase will only occur if the employee notices the salary increase. If the change in stimuli, in this case, the difference in salary, is not great enough relative to the initial stimulus (the employee's salary before the increase), the employee will not notice the improvement. So, the just noticeable difference will not be reached in this case. *Figure 2* shows a typical wage structure. The explanation of the wage structure is given by Weber's Law as mentioned before. Empirical studies show that a salary increase of eight to ten percent in each step is necessary to be perceived by employees (Miller 1962).

But the thesis focuses its research mainly on the implications of Weber's Law for marketing activities. Weber's Law influences for example marketing activities in pricing, packaging, product quality, and advertising. The reason for the influence is mainly because different perceptions of stimuli can lead to different buying behaviors and buying decisions (Britt and Nelson 1976).

3.1 Product

For marketing activities regarding the product itself, Weber's Law can be used to determine characteristics of the product, the product-quality and the packaging of a product.

Packaging

Changes in the packaging of products like the size or the weight can have different reasons. A difference in the packaging of a product compared to the packaging of competing products can attract the attention of buyers in a negative or in a positive way. Players in a market can, for example, reduce the size of a package, enlarge the size of a package or change the form of a package without changing the volume.

By how much must a package be changed that buyers perceive the change? In the case of a change in the form of a package to make the product look innovative or new, it is of a great significance, that the buyers notice the difference. If the size of a package has to be reduced in order to increase the margin and to cut costs, the application of Weber's Law can have great advantages for the manufacturer. It can determine up to which size the package can be reduced in size without the majority of consumers noticing it. As long as the change in package size is not perceived by the consumers of a product, the manufacturer can continue to reduce the package and charge the equal price without losing sales. This ensures that the potential of cutting the costs is exploited to a maximum. On the other hand, if the manufacturer wants to enlarge the package size of a product in order to gain an advantage over competing products and to stand out from competition and therefore attract customers, Weber's Law helps to exploit the full potential by determining the smallest increase in size necessary for consumers to perceive the change in package size (Britt 1975).

For example, if a soap manufacturer wants to increase the size of its soaps so that consumers perceive the difference but the production costs for the soap do not increase, and the soap is not harder to hold, Weber's Law can be applied. In order to overcome the challenge, in

the first step, the soap manufacturer has to determine a representative sample of consumers, who become test subjects. These people get a set of different bath soaps and are asked to describe physical differences between the different bath soaps. Then the size of the bath soaps has to be increased until the majority of the test objects notices a difference in the size of the bath soaps. The minimum point of change, where consumers would notice a difference between the old and the new soap size, the just noticeable difference is reached then (Britt 1975).

There are several hands-on examples of companies, who have successfully changed their package sizes with the help of Weber's Law. A candy company, for example, reduced the size of its candy bars fourteen times over a period of twenty-three years without consumers noticing the reduction of the package size, at least in the short-term. There are no long-term studies which can approve, that consumers did not notice the difference in a long-term (Kamen 1977).

Product and product quality

The attributes through which consumer judge quality can be separated into two categories: intrinsic and extrinsic product characteristics. Intrinsic cues are the characteristics "which are intrinsic to the product in the sense that they cannot be changed or experimentally manipulated without also changing the physical characteristics of the product itself", while extrinsic cues are not directly part of the physical product. For example, the sweetness of a drink is an intrinsic attribute, while the price of the drink is an extrinsic attribute for product quality (Wheatley, Chiu, Goldman 1981). In this chapter about product and product quality, the paper focuses on intrinsic characteristics of a product like the taste (sweet, salty, mild…), physical characteristics (weight, sizes, durability…) and extra features of a product (for example cars).

Changing products and therefore, in most cases the product quality, in terms of intrinsic characteristics, can have several reasons. First of all, competitors in a market could have gained a competitive advantage in the market due to price-cutting and the sale of products with a lower

quality level. In other words, a company could have overestimated the level of product quality customers are looking for. Or the other way round, a company could have underestimated the desire of customers when it comes to product quality and competitors who offer products with better quality are more successful in the market. Another reason, especially in economically weak regions and markets, could be a decrease in the income of customers, or generally, the customer could have become more price sensitive. In this case, companies are forced to cut prices. One way to reduce prices is to cut production costs. Production costs can be cut due to the reduction of production quality. Furthermore, material and labor shortages could become a reason for companies in industries like clothing manufacturing or automobile servicing to reduce the quality of products. However, the most common and primary reason for companies to lower the product quality is a desired increase in the profitability of a specific product (Kamen 1977).

But how should a company appropriately reduce the product quality? Or at best, even without customers noticing it?

If a chocolate-producer, for example, wants to cut production costs for its chocolate bars due to a reduction of the amount of used sugar in the production process without the customers perceiving any difference in taste, it has to find out about the just noticeable difference of its customers. According to Weber's Law, the chocolate-producer has to lower the amount of sugar used for the production of one chocolate bar relative to the amount of sugar used before the reduction (Britt 1975). If the average constant k for sugar in chocolate-bars of the majority of consumers of the chocolate-producer is for example 0.1 and the amount of sugar used for one chocolate bar before the reduction was ten grams, the reduction of sugar for one bar has to be one gram.

On the other hand, if the same chocolate-producer wants to improve the product quality, for example, to escape a fierce price competition and to target a different customer segment,

which is not that price sensitive, the company should take Weber's Law into account as well. Let's imagine, that the less price sensitive customer segment prefers sweeter chocolate bars. To attract the less price sensitive customer segment, the amount of sugar used for the production of one candy bar has to be increased. But not in absolute amounts but relative to the amount of sugar used before the change in the recipe. In this case, Weber's Law can be applied to find the just noticeable difference. In order to maximize the profitability, the increase in sweetness must be at least large enough that the majority of consumers receive the change. But if the change is higher than the just noticeable difference, the manufacturer would unnecessarily use too much sugar, which would increase the production costs and decrease the profit margin.

The best way for companies to find out, what the just noticeable difference of its consumers is, is to select a group of customers as a "test group". In this test group, every individual gets two different chocolate bar. One is the standard chocolate bar, in our experiment with 10 grams of sugar, and one is a chocolate bar, which has more than 10 grams of sugar. Then there is more and more sugar added to the second chocolate bar until the majority of the individuals of the test group describe the second chocolate bar as being sweeter than the standard chocolate bar with 10 grams of sugar. Then the difference between the amount of sugar used for the production of the standard chocolate bar and the second chocolate bar is the just noticeable difference (Britt & Nelson, 1976).

In a study about the perception of product quality, Wheatley, Chiu, and Goldman (1981), conducted an experiment, in which 171 females, who bought carpets at least once in their life were asked to rate nine different carpets in different price categories between nine and thirteen dollars. The carpets were grouped into low-, medium-, and high-quality products. The results of the experiment were consistent with the implications of Weber's Law. The increase in quality between the three categories of low-, medium- and high-quality was constant, but *figure 3* shows, that the test subjects perceived the increase between the low- and the medium-

quality carpet as significantly higher than the increase between the medium- and the high-quality carpet. The reason for the different perceptions of the improvements can be explained with Weber's Law because even when the increase between the three categories was constant in absolute figures, it was not the same increase in relation to the initial stimulus. (Wheatley, Chiu, Goldman (1981).

We showed a lot of ways, how Weber's Law affects changes in products and product quality. But what role does the theory play when it comes to new products, which have not been on the market yet? How can marketing executives use the approach to gain a competitive advantage before entering a new market?

For a new product of the market, which consumers will try for the first time, it is especially important, that the product gets some special recognition when tried by consumers. When managers of a firm have figured out, what should be unique about the new product to be launched compared to other products, which are already on the market, it is essential to find out, whether the consumers perceive the differences to other products on the market or not. The advantage of Weber's Law and the just noticeable difference is that managers can find out, to which degree the new product has to be better on special characteristics in comparison to existing products in the market in order to attract new customers (Britt 1975).

Weber’s Law can also have valuable recommendations for the formation of different product-lines in order to serve different customer segments and meet the requirements of each customer segment. It is essential for a company to determine the extent to which its customers can differentiate between levels of product quality (Wheatley, Chiu, Goldman 1981).

The next section describes how prices play an important role in buying decisions, but also in judging about product-quality, since prices are also used as quality-indicators of products.

3.2 Price

Consumers have to make decisions about which products to buy and which products not to buy. Since there are more and more variations of products available and it is difficult for the decision-maker to get sufficient information about products and the product-quality to make an appropriate decision. Therefore, the price as one of the criteria for evaluating product quality is gaining in importance. Except in some circumstances, the information about the price is the most comfortable information for the consumer to obtain (Monroe 1971a). In a set of studies, researchers have found out, that buyers have an upper and a lower price limit, within which they consider products as relevant. If prices are above the upper price limit, prices are seen as too high, while products are deemed to be poor in quality if their prices are below the lower price limit. For example, in the case of a consumer who wants to buy soap and his upper limit for soap is $6, he thinks that "no bar of soap can be worth more than [$6]", and he would therefore not buy any soap that costs more than 6 Dollars. *Figure 4* shows the probability, that a consumer considers a price for a certain product as too low on the curve L(P) and the curve H(P) shows the probability that a consumer considers the price for a certain product as too high (Gabor, Granger 1966).

As competition and therefore the variations of products rises, prices play an especially important role in marketing, since it is getting harder and harder for consumers to obtain sufficient information about products and the product quality. Even if the consumer can get information about the product-quality, he or she cannot be sure, if the degree of completeness and reliability of the data is sufficient. This is the reason, why prices are used as quality-indicators (Monroe 1971a). If consumers are able to get complete and correct information about the quality and the utility of items, the role of the price as a quality-indicator becomes useless (Gabor, Granger 1966). So, in a world of non-complete information, one of the most effective

ways for companies to stand out from the competition and to attract customers is to focus on their price-setting strategy.

There are different price-setting-strategies used in marketing to determine prices with the consideration of psychological aspects. One of these psychological pricing methods is the so-called customary pricing. This method describes a single price point which is not changed. Companies, which are using this method do not change the price of a product, but they change for example their cost structures to cut production costs, or they change the packaging size of their products to improve their margins. Another method is the odd pricing, which assumes, that prices ending with odd numbers attract more customers than prices ending with even numbers. This is the reason, why prices are usually ending with odd numbers, like 14.99 Dollars (Monroe 1973).

One important aspect which should not be underestimated is the psychological aspect of how consumers perceive prices. Consumers may, depending on "their demographics, shopping behavior and price knowledge characteristics", perceive same prices as different and therefore respond differently to the same price (Sirvanci 1993).

To take the importance of perceived prices into account, the application of Weber's Law in the price-setting process is of vital importance. The psychological model describes the relationship between a stimulus and the response to a stimulus. If we consider the price for a product as a stimulus and the purchase quantities for the product as the response to the stimulus, Weber’s Law describes the relationship as logarithmic (Monroe 1971a).

Managers of firms should take Weber’s Law into consideration when they want to launch a new product on the market to determine how the price is perceived by buyers on the market in comparison to prices of competing products. In this case, it is of vital importance for managers to understand how buyers perceive and memorize prices. Are buyers able to recall the prices they paid previously for other brands of the product? For Weber's Law, the encoding

of prices plays a major role when it comes to the price-setting of newly launched products on the market. Will consumers consider the price of a new product as lower, equal or higher than prices of competing products? How buyers perceive the price of a new product depends on the price of competing products (Mazumdar, Monroe 1990).

But the perception of prices is especially important when it comes to prices changes of an existing product in a long-term as well as in the short-term. Either way, the amount, by which the price is reduced plays a major role, as well as the advertising campaign used to make buyers aware of the price reduction.

If a company decides to reduce or to increase its prices, it is important, that prices are lowered and raised in a smart way. But what is an intelligent way of changing prices?

One of the most important rules which have to be followed when reducing prices is that consumers have to recognize the price reduction. There is a rule of thumb often used in retail, which says, that price reductions must amount to at least 20% of the old price. The reason for the rule, which is used for a very long time, is the buyer's ability only to notice significant price reductions. But researchers observed that the brand-image plays an important role in this rule as well since well-known branded products need a lower rate of decrease than less famous branded products would need. This rule of thumb is in keeping with Weber’s Law, which states, that price reductions have to be considered in relation to the old price, not in an absolute amount (Miller 1962).

One big mistake which is made very often is that prices are reduced but not to a degree, that consumers recognize the price reduction. If consumers do not recognize any changes in the price, they will not change their buying behavior. This results in stagnating sales figures since consumers do not have any incentives to buy higher quantities of a product, which has the same price as before in their view. But on the other hand side, the company lowers its sales as well as its margin.

If the price of a product is reduced from 20 Dollars to 19 Dollars, it is very unlikely that the price reduction is noticed by the majority of buyers. Therefore, the sales figures will remain constant. In this case, the company would lose 1 Dollar for every sold item.

If we look at the other way round and a company wants to increase the price for a product, it is important that the price increase is only to the point that consumers do not notice the price increase (Britt 1975). If the goal of a company is to increase the price of a product by 20%, it should consider to raise the price with small steps and extend the target of the price increase over a longer period of time (Miller 1962). In this case, the consumer would probably not notice the price increase and therefore would not change his or her buying behavior of the product, at least in the short term. The sold quantities of the company would remain constant while its sales and margin would increase over time (Britt 1975).

In a study, Kamen and Toman (1970), have developed a theory, the so-called fair price theory, which is contradictory to Weber's Law and was mainly observed in research in gasoline prices. The fair price theory states that consumers have some predetermined ideas about what a reasonable price for a given product would be and what they are willing to pay for the product. In the study, Kamen and Toman considered two different types of gasoline companies. First of all, a group of major, well-known brands like American, Humble and Texaco, which operate in almost across the country, and several hundred local companies which operate in some regions of the country. The local companies were not that well-known like the Majors and were termed as Independents. On average, the prices of gasoline per gallon was usually lower at Independents compared to Majors.

In the study, 1400 individuals have received a questionnaire and were asked to fill out the survey, which asked about preferences of buying at Independents or Majors for different initial prices and price differences between Majors and Independents. From the 1400 individuals who received the questionnaire, some didn't have a car, didn't want to join the study

or didn't respond for other reasons. In the end, 219 individuals participated in the study and filled out the questionnaire. The test subjects were then divided into two groups: regular-grade users, who usually preferred Independents in the past, because of the lower prices, and premium grad users, who were not that price sensitive. *Figure 5* shows the results of the study when the difference in price between Independents and Majors is three cents per gallon. The figure shows that as the price of a gallon of gasoline increases even the premium-grade users tend to prefer Individuals.

Generally, the fair price theory predicts that consumers prefer the Independents when the price for gasoline is very high, for example, 42 cents for Majors and 40 cents for Independents, while consumers prefer the major brands, when the price for gasoline is relatively low, for example, 28 cents for Majors and 26 cents for Independents. In contrast, Weber's Law predicts that consumers tend to choose well-known, major brands when the price for gasoline is high, while consumers tend to select Independents when the price for gasoline is very low because the difference in price is higher in percentage. Consumer would not notice a difference in price when the price is relative high (Kamen, Toman 1970). Monroe (1971b) refers to several papers and considers two conclusions on the perception of prices by individuals as given. First, "the subjective price scale of the buyer seems to follow a logarithmic scale", and second, "there is a range of acceptable prices for certain products". While the second conclusion is consistent with the fair price theory of Kamen and Toman, the first conclusion is consistent with Weber's Law. Since Kamen and Toman's determination of a fair price theory was derived from a guess, that assumes an inverse price-demand relationship and there is empirical evidence for both conclusions, both conclusions are compatible. Furthermore, Monroe (1971b) states, that Kamen and Toman did not present evidence, that Weber's Law does not hold for prices since they just tested for preferences but not for the ability of the test subjects to discriminate between different price levels as the price level increases (Monroe 1971b).

Summarized, Price as a stimulus is essentially different than stimuli like size or weight, since prices are very precise and can only be presented in currencies, but size or weight rely on imprecise sensory processes. It is easier for individuals, even with little knowledge, to detect even a small difference in the price than in other stimuli. For example, Stapel (1972), points out, that consumer can detect even differences as small as one cent. This is one of the reasons why some researchers believe, that there is no just noticeable difference in price and Weber's Law does not hold for prices (Lambert, 1978). In his paper Stapel (1972) states, that as mentioned before, of course consumers can detect the difference between $80.00 and $80.50, but it is not all about the perception and the notice of a difference but more about evaluations of the perceived price differentials.

3.3 Place

The applications of Weber's Law to the "place" variable of marketing is limited. Place describes the general availability of a certain product or service. Consumers of a product want to have products and services, they are interested in, to be available. For example, an oil company stated, that its stations were "more available" than those of its competitors. Weber's Law explains, that it is not really about the "real" numbers of station the company has and therefore the availability for the consumer, but more about the perceived availability. In this case, a question that can be answered with the psychophysical model observed by Weber is: "How many stations must the oil company have before consumers perceive, that the oil company has more stations than its competitors and is thus more available?" In other words, how large has the difference in the number of a company's gas compared to its competitors to be, before consumer perceive, that the company has more stations than the competitors (Britt 1975).

3.4 Promotion

Another field, where stimulus-response relationship, and therefore Weber's Law and the just noticeable difference plays a major role, is in promotion and advertising. The model can be used to make sure, that the promotion for a product or a service causes the attention of potential buyers. Especially, when it comes to the determination of the effect of scale and frequency effects of advertising as well as the advertising budget, Weber's Law should be taken into account in order to make sure, that the consumers perceive what companies desire them to perceive.

The former Manager for Marketing Research at IBM, Robert S. Weinberg, has developed a mathematical model that determines the necessary advertising spending in order to achieve a desired share of the market. He uses a ratio of advertising cost per Dollar of sales of the company and the entire competition to measure the competitive advertising effectiveness. The mathematical model, which was set up by Weinberg shows, that "in order to achieve an arithmetic increase in the share of the market, a geometric increase in expenditure is indicated as necessary" (Miller 1962). This finding is consistent with Weber's Law, since it states, that proportionally greater increases in advertising expenditures are necessary, the higher the current amount of advertising expenditures is. In other words, the higher the initial stimulus, in this case, the frequency of advertising consumer is confronted with, is the higher the increase in the frequency has to be in order to be perceived by consumers (Britt 1975).

But Weber's Law is not only applicable to determine the changes in advertising frequency for a product or service necessary that consumer become more aware of a product or a service, but also to determine how the advertising should be explicitly built up.

For example, Weber's Law can be used to find out, what the optimum ratio between the amount of text and the headline or pictures in an advertisement should be in order to maximize the effectiveness of the ad. One important aspect that influences the perception of a commercial

is the used contrast because it offers the opportunity to make things seem different. Contrast in size, form, color, and brightness. In an experiment, a blank space was printed between other commercials in a newspaper. The purpose of the study was to find out, whether readers of the paper would notice the empty space or not. About 18 percent of the individuals, who got the newspaper did not notice the blank space. Afterward, they were asked about the reasons why they did not notice the empty space. The readers mentioned that it was not meaningless to them and therefore, the blank space did not attract their attention (Britt 1975).

Within the advertisement itself, the perception of individuals plays a significant role as well. When an advertisement incorporates various messages, the advertiser must adopt the principles of Weber's Law to make sure, that the reader pays special attention to the main point of the display. Several actions, like the increase of the size of the printed message, the repetition, or a unique positioning of the main signal can be undertaken to be sure, that the main message is perceived by the reader (Britt 1975).

To put it all in a nutshell, Weber's Law can be applied in order to determine the optimal advertising budget of a company, the frequency of the advertisements as well as the structure and design of the ad with consideration of the entrepreneurial goals of a certain company.

4. Discussion

The fourth chapter summarizes the findings in the previous chapters and evaluates Weber's Law and its application for the marketing mix. Furthermore, the implications for every field of the marketing mix (Product, Price, Place, and Promotion) is summarized for a better overview, and the future applications of the theory are shown.

4.1 Critical Evaluation

Since Weber's Law is an elementary and fundamental theory, it can be used in several fields where the perception of the intensity of a stimulus plays a major role, like in marketing. But there are also critics of the theory, especially when it comes to the application of Weber's Law for pricing decisions. Kamen and Toman (1970), for example, criticized the validity of the just noticeable difference, at least for gasoline prices and used a so-called fair price theory rather to explain the results of their study than Weber's Law. But they used, for example, the assumption of logarithmic sales, which is consistent with the implications of Weber's Law (Stapel 1972).

Stapel (1972), points out, that consumers are able to perceive even the smallest changes in prices, since prices are, in contrast to sensory like smell or test, which are unprecise, about precise numbers. But as Lambert (1978) also mentions in his paper, I believe that Weber's Law also holds for prices, since consumers in the marketplace are not asked to focus on only one stimulus (for example price) like in laboratory psychological experiments, but there are more attributes, consumers have to concentrate on. For this reason, consumers may not recognize every small difference in prices. But it is also true, that prices are more comfortable to compare since it is about precise numbers in dollars and cents than for example the weight of an item (Lambert 1978).

The simplicity of Weber's Law makes the rule, especially in marketing, in some cases unprecise. Lots of important factors like the brand image of a product and the available information about a product are not considered by the Law (Stapel 1972).

Summarized, Weber's Law offers very significant implications for the design of the marketing mix and should definitely be considered. However, sometimes the implications are very unprecise, and it often requires lots of effort to find out the just noticeable difference, since the constant factor k for every product and every person is different. Therefore, the constant k has to be determined for every product, and a set of representative consumers have to be taken

into account in order to determine the just noticeable difference for the majority of consumers (Sirvanci 1993). Other factors that might influence consumer behavior, like brand image, should definitely be taken into account when Weber's Law is applied (Stapel 1972).

4.2 Managerial Implications

Product

The just noticeable difference can be used in terms of "product" to attract customers due to different looking packaging forms or due to the enlargement of package sizes. Furthermore, the package size can be decreased, without the customer noticing it in order to boost the profit (Britt 1975).

Another managerial implication of Weber's Law is that the product quality of a product can be reduced without consumers noticing it or managers can determine the smallest improvement in product quality necessary, that consumers perceive the improvement (Britt, Nelson 1976)

Price

Often managers make a mistake to reduce the price of a product, but the reduction is below the just noticeable difference. In other words, consumers do not perceive the price reduction and therefore do not have incentives to change their buying behavior. In such a case, the company reduces its profit margin, and its sold quantities remain constant. On the other hand, prices for goods are raised too high, above the just noticeable difference. Consumers perceive the increase in price and therefore change their buying behavior by buying lower quantities of the product. Weber's Law can be applied to determine the just noticeable difference in order to decrease prices above the JND and increase prices below the JND. (Lambert 1978).

Place

Contradictory to the implications for the price, product, and promotion, the consequences for the variable “place” are limited since Weber's Law can just be applied in order to determine whether consumers perceive, that products or services of a company are more available than products and services of competitors (Britt 1975).

Promotion

Weber’s Law can be used for the variable “Promotion” of the marketing mix to make advertising more efficient. It helps to make sure, that commercials cause potential buyers attention. Of course, the fact that an advertisement gets individuals attention does not guarantee, that the advertisement is effective. But on the other hand side, an advertisement is useless, if it does not attract consumer’s attention (Britt 1975).

With the help of Weber's law, managers can determine to what extent the frequency of their advertising must be increased in order to be perceived by consumers. If the frequency is increased, but not to the extent that the difference above the is just noticeable, the company only burns money because consumers will not notice any difference. On the other hand, the change in frequency can be reduced below the just noticeable difference to save money without consumers noticing a difference (Britt 1975).

In summary, Weber's Law in terms of advertising can be applied to determine the optimal advertising budget and frequency of an advertisement as well as the structure and design of ads.

4.3 Future Applications and Research

In a networked world with increasing digitalization, in which the buying behavior of consumers changes, for example, from in-store shopping to online-shopping, there will be further fields of application for Weber’s Law.

Nowadays, the availability of services and products shifts into a stronger focus. Using the example of mobile apps, consumers prefer mobile apps that work around the clock and have

a few technical failures as possible. But how much has the technical infrastructure of a software developing company be better than the technical infrastructure of competitors that its apps are perceived to be more available than that of its competitors?

Future research in the field of Weber's Law should be focused on the differences in perception between the "real world" and the "online world". How does the role of the price as a quality-indicator change, when consumers are not able to even see the product in real life? How does the role of packaging change, when consumers are not able to see the different packaging of several brands next to each other in stores but rather see pictures of the packaging? Are prices encoded the same way when seen just online on a screen?

I think that the implications of Weber's Law and the way how consumers perceive stimuli in an online world offer a lot of new insights and suggestions for managers.

5. Conclusion

The results of the research show, although Weber's Law is a very fundamental and basic model, it has lots of useful and promising implications for the marketing mix of companies. Furthermore, the recommendations made for each field of the marketing mix can be used in practice to optimize the marketing strategy.

However, there are some limitations to Weber's Law, since it does not hold for extremes and does not consider lots of other factors which influence consumer behaviour and decision-making. Additionally, the implications of Weber's Law in a connected world, where online-shopping and Internet of Things become more and more important, is an area which is not well-researched. More research is definitely needed in this field.

But all in all, the paper offers lots of hands-on recommendations for the daily work of marketing managers, which should definitely be taken into consideration, since they are beneficial. Nevertheless, the importance of other factors should not be neglected and included in the evaluation.

Appendix

Figure 1: The linear relationship of initial stimulus and JND

Source: self-made, from data of Miller, 1962

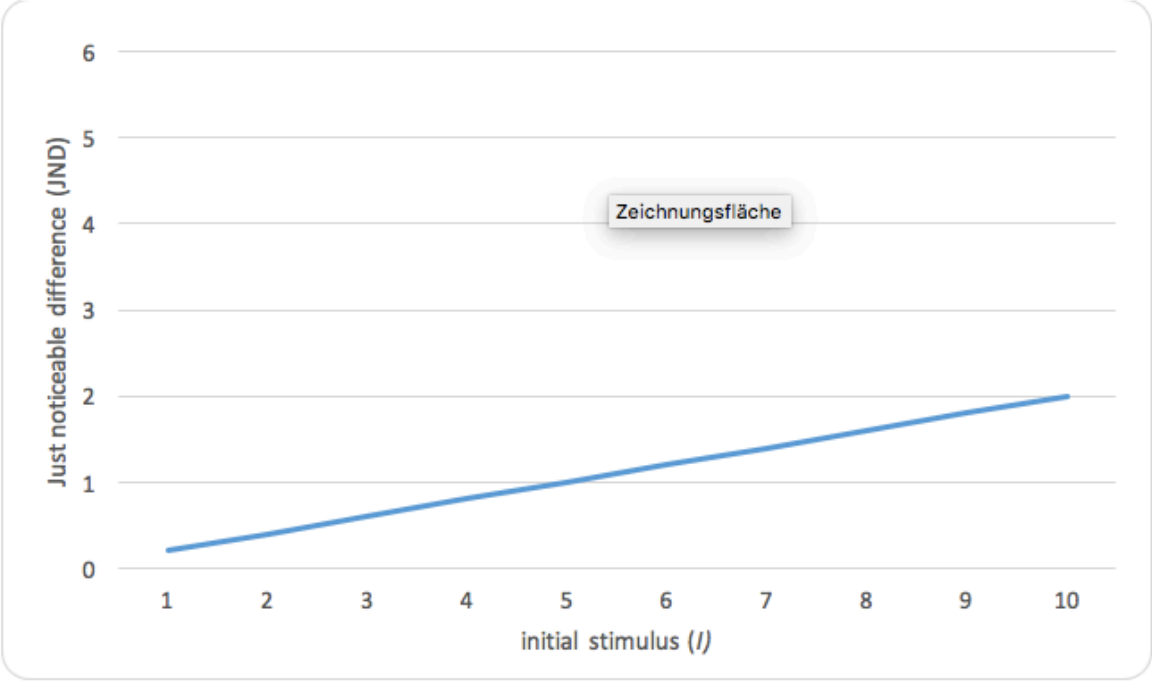


Figure 2: Typical wage structure

Source: Miller, 1962

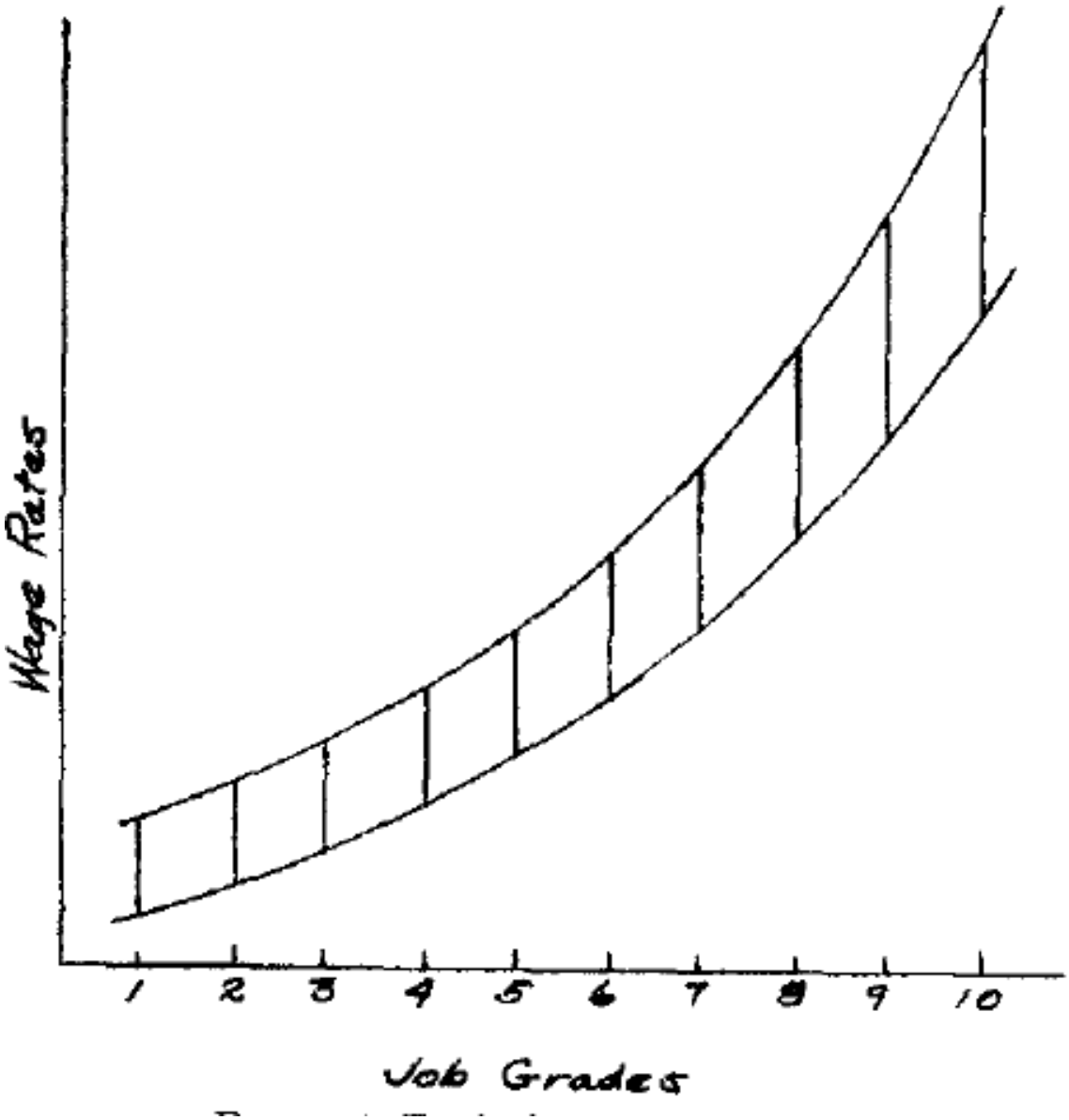


Figure 3: Perceived Quality as a function of Physical Quality

Source: Wheatley, Chiu, Goldman (1981)

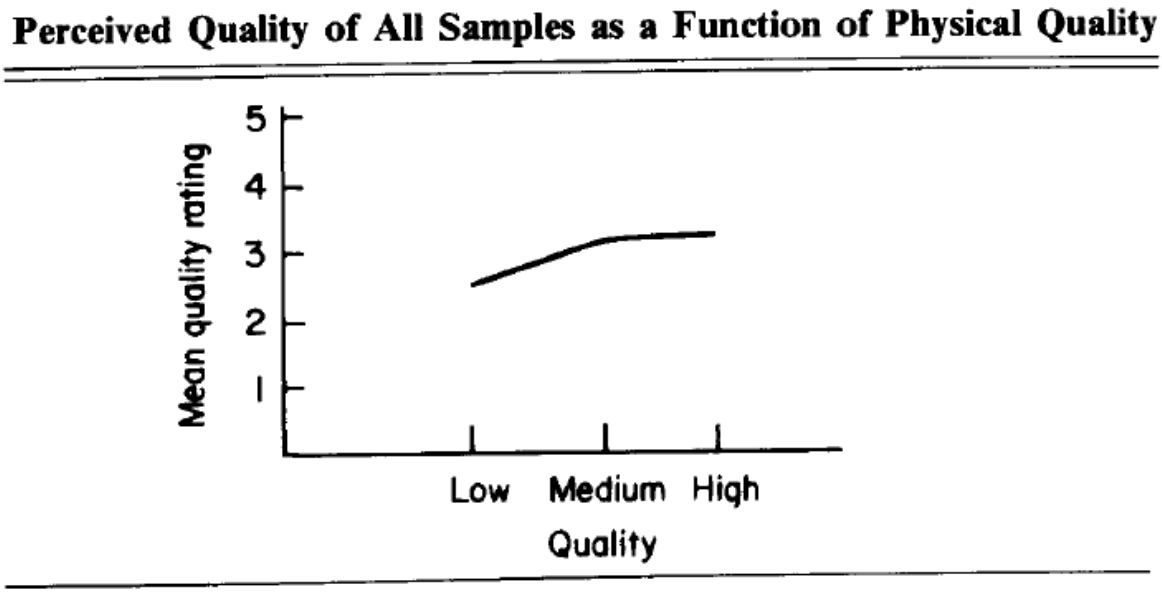


Figure 4: Probability of considering prices as too high or too low

Source: Gabor and Granger (1966)

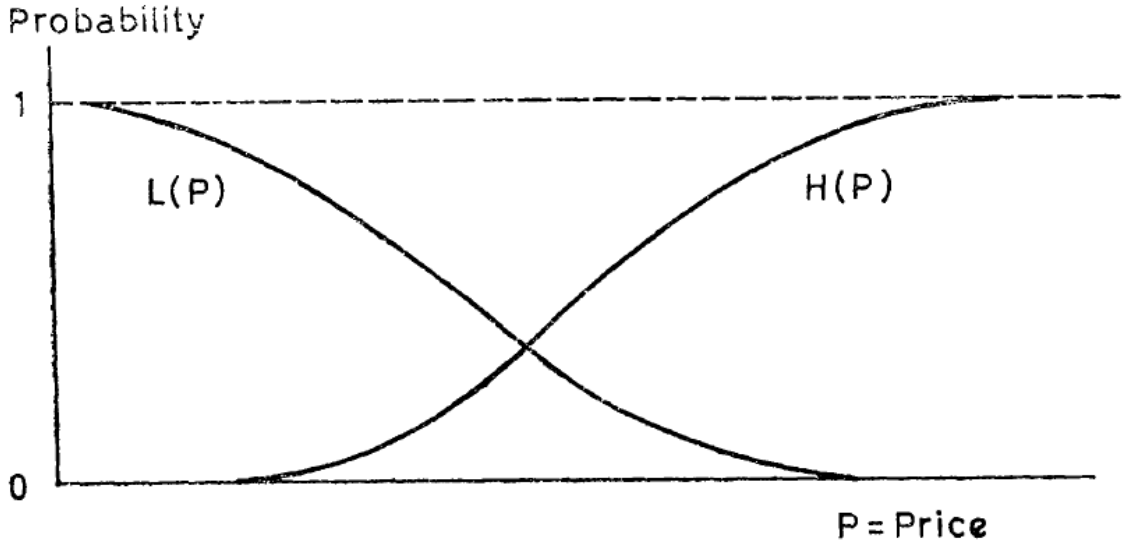
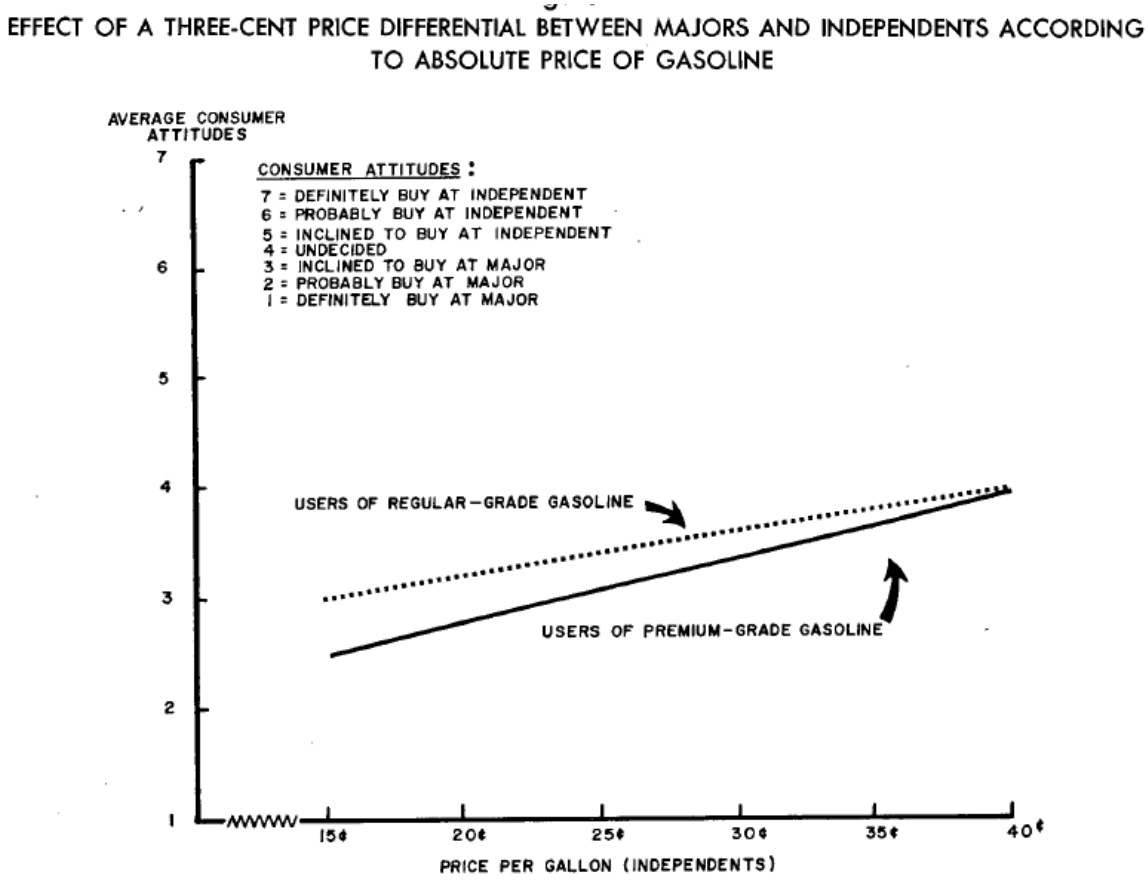


Figure 5: Effect of the price differential between Majors and Independents

Source: Kamen and Toman (1970)



References

- Britt, S. Henderson (1975), "*How Weber's law can be applied to marketing*", Business Horizons, 18
- ___ and Nelson, Victoria M. (1976), *"The Marketing Importance of the 'Just Noticeable Difference'"*, Business Horizons, 19
- Ekman, G. (1959), *"Weber's Law and Related Functions",* Journal of Psychology, 47, 343-352
- Gabor, A., and Granger, C. W. (1966), "*Price as an Indicator of Quality: Report on an Inquiry",* Economica, 33 (February), 43-70
- Kamen, J. M. (1977), *"Controlling 'just noticeable differences' in quality"*, Harvard Business Review, 55 (November-December)
- ___ and Toman, R. J. (1970), *"Psychophysics of Prices"*, Journal of Marketing Research, 7 (February), 27-35
- Lambert, Z. (1978), *"Differential Threshold in Consumer Perception of Retail Prices"*, The Journal of Psychology: Interdisciplinary and Applied, 100, 139 – 150
- Laming, D. (2009), *"Weber's Law"*, Oxford University Press, 13
- Mazumdar, T. and Monroe, K. B. (1990); *"The Effects of Buyers' Intentions to Learn Price Information on Price Encoding"*, Journal of Retailing, 66, 15-32
- Miller, R. L. (1962), *"Dr. Weber and the Consumer"*, Journal of Marketing Research, 26, 57-61
- Monroe, K. B. (1971a), *"The Information Content of Prices: A Preliminary Model for Estimating Buyer Response"*, Management Science, 17 (April)

- ___, (1971b), *"'Psychophysics of Prices': A Reappraisal",* Journal of Marketing Research, 8 (May), 248-251
- ___, (1973), *"Buyer's Subjective Perceptions of Price"*, Journal of Marketing Research, 10 (February), 70-80
- Murray, D. J. (1990), *"Fechner's later Psychophysics"*, Canadian Psychology, 31, 54-60
- Sirvanci, M. B. (1993), *"An Empirical Study of Price Threshold and Price Sensitivity"*, Journal of Applied Business Research, 9, 43-50
- Stapel, J. (1972), *"'Fair' or 'Psychological" Pricing?"*, Journal of Marketing Research, 9 (February), 109-110
- Wheatley, J. J., Chiu J. S. Y and Goldman A. (1981), *"Physical Quality, Price and Perception of Product Quality: Implications for Retailer",* Journal of Retailing, 57(2), 100 - 116

Literature Review Tables

Author/s (Year) [*Journal*]	Research Focus	Theoretical Background	Method/ Analysis	Main Findings
Britt (1975) [*Business Horizons*]	• How can Weber's Law be applied to the Marketing Mix and what implications does it have for the practice?	• Weber's Law • Just noticeable difference	• No experiments; uses just the findings in the field of Weber's Law	• Implications of Weber's Law for Products, Packaging, Price, Distribution, and Advertising.
Britt and Nelson (1976) [Business Horizons]	• How Weber's Law and the constant stimuli method can be used to improve products.	• Constant stimuli method • Just noticeable difference • Weber's Law	• No experiments; uses just the finding in the field of Weber's Law	• Constant stimuli method can be used to improve products in a way, that consumers notice the improvements.
Ekman (1959) [Journal of Psychology]	• The validity of Weber's Law and the Weber-Fechner Law	• Weber's Law • Weber-Fechner-Law • Absolute and differential sensitivity	• No experiments; Just Literature Review	• The just noticeable difference is directly proportional to the JND • Relationship of absolute and differential sensitivity
Gabor and Granger (1966) [Economica]	• Investigate whether there is a lower and an upper limit in pricing, which every consumer is willing to pay for a certain product • Price as an indicator for product quality and costs for a product	• Consumers have price bracket in mind before entering a market	• Survey with different prices for different products and test subjects have to evaluate whether the price for a product is too low, too high or acceptable.	• Concept of limits for prices is realistic and an effective tool in understanding customer behavior • Confirmation of the theory that logarithmic nature of subjective price scale

Author/s (Year) [*Journa*l]	Research Focus	Theoretical Background	Method/ Analysis	Main Findings
Kamen (1977) [Harvard Business Review]	• Just noticeable difference in product quality • Causes and reasons for changes in product quality • Methods for controlling changes in product quality	• Just noticeable difference • Weber's Law	• No experiments; uses just the findings in the field of Weber's Law in terms of product quality	• Product quality improvement have to be done in such a way, that consumers notice the improvement • Degradation of product quality have to be done in a way, that customers do not notice the change in product quality.
Kamen, Toman (1970) [Journal of Marketing Research]	• Limitations to application of Weber's Law on prices • Validity of the fair price theory	• Weber's Law • Fair price theory • Consumer behavior	• Conducting a survey, which used 36 pairs of prices, using six price levels and 6 Price differentials. Then the 36 pairs were divided into two set of each 18 pair of prices. Every participant in the study got 18 pair of prices. So there were two forms A and B. The pair of prices were representing prices of a gallon of gasoline at so-	• For gasoline prices, the fair price theory better describes the consumer behavior regarding prices, than Weber's Law

			called Majors, which were well-known gasoline companies and at Independents, which represent less-known regionally available gasoline companies. • Sample = 219 individuals divided into groups of regular-grade users and premium-grade users	
Lambert (1978) [Journal of Psychology]	• Empirical investigation on the existence of price thresholds • Relationship between perceived price changes and initial price	• Weber's Law • Fair Price Theory • Consumer behavior	• Sample = 46 females, enrolled at a larger university • Set of slides with price, product information and brand name were presented to test subjects. • Then the individuals should choose one of the products and answer the question, what differences there are between the chosen product and the brand/product they usually buy. The individuals had one minute to view each slide and list any noticeable difference. The items in the experiment offered to the consumers were soaps, hair dryers, and bicycles.	• Confirmation the implications of Weber's Law concerning the presence of price thresholds • Perceived stimulus is dependent on initial stimulus

Author/s (Year) [*Journa*l]	Research Focus	Theoretical Background	Method/ Analysis	Main Findings
Laming (2009) [Oxford University Press]	• Validity of the Weber-Fechner-Law • Historical procedure of the findings of Weber and the findings of Fechner	• Weber's Law • Weber-Fechner Law	• No experiments; uses just the findings in the field of Weber's Law	• Linear relationship between the JND and the initial stimulus • "Logarithmic transform of the interface between outer psychophysics and inner psychophysics (Weber-Fechner Law)
Mazumdar, Monroe (1990) [The Journal of Retailing]	• How buyers receive and retain price information • The ability of buyers to recall specific prices of previously bought brands • The role of brands in the decision making	• Intentional learning • Human learning and memorizing process	• Sample = "ninety adult shoppers with a median age of 34 years and a median annual household income between $25000 to $40000" • Test subjects had the choice between 6 different brands for different products like margarine, canned soup and salad dressing. • The subjects were asked to choose one brand from each category for a friend. For one group the friend was a health-conscious person, the second group	• There are two types of price memory: absolute and relative price positions • When buyers attempt to memorize brand prices for later use, they tend to recall the specific prices but not the price ranks of a brand • If the memorizing happens simply in the decision-making process, buyers tend to remember the price ranks of a brand

			had a friend whose preference was the most nutritional brand with a minimum price, and the third group had a hypothetical friend who was price-conscious • After choosing the brands. The subjects were asked to visit another store, where no prices were. And the subjects were asked to remember the prices they chose from the first store.	
Miller (1962) [Journal of Marketing]	• Implications of Weber's Law for prices, quality, and advertising	• Weber's Law • Consumer behavior	• No experiments; uses just the findings in the field of Weber's Law	• Historical classification of Weber's Law • Implications of the Law for the practice in pricing, advertising and the change of product quality
Monroe (1971/a) [Management Science]	• Relationship between price and imputed quality • Price as an indicator for production costs • The perception of price by buyers	• Price theory • Weber-Fechner-Law • Consumer behavior • Profit analysis	• No experiments; uses just the findings in the field of Weber's Law and the fair price theory	• Price serves as an indicator for quality and cost of production • Buyers have an upper and a lower price limit. Only products with prices between the limits are considered by buyers.

Author/s (Year) [*Journa*l]	Research Focus	Theoretical Background	Method/ Analysis	Main Findings
Monroe (1971/b) [Journal of Marketing Research]	• Validity of fair price theory from Kamen and Toman • Validity of Weber's Law for prices	• Consumer behavior • Weber's Law • Fair price theory	• No experiments; uses just the findings in the field of Weber's Law and the fair price theory	• Weber's Law holds, and Kamen and Toman did not bring up the evidence that Weber's Law did not hold for gasoline prices, because they tested preferences not tested whether the test subjects were able to discriminate the price changes or not.
Monroe (1973) [Journal of Marketing Research]	• Influence of price on buyer's purchase decisions • Role of psychology in price-setting • Buyer's subjective perception of price	• Absolute Price thresholds • Weber's Law • Psychological Pricing	• No experiments; uses just the use of existing researches in the field of price perception	• Different psychological price-setting strategies • Relationship between price and quality of a product • Existence of differential price thresholds, and therefore the confirmation of Weber's Law

Author/s (Year) [*Journa*l]	Research Focus	Theoretical Background	Method/ Analysis	Main Findings
Murray (1990) [Canadian Psychology]	• Fechner's findings in the area of psychophysics • Fechner's extensions to the Weber's Law	• Weber's Law • Weber-Fechner-Law	• No experiments; uses just the use of existing researches in the field of Fechner's psychophysical research	• Sensation strength is a logarithmic function of the stimulus strength • Mental events are similar to physical events • Weber-Fechner Law does not hold for extremes
Sirvanci (1993) [Journal of Applied Business Research]	• Empirical investigation of price laws, such as Weber's Law and the Weber-Fechner-Law	• Adaption-level theory • Assimilation-contrast effect • Weber-Fechner Law • Weber's Law	• Survey of supermarket shoppers • Sample was randomized by selection every nth shopper of a supermarket • Data was collected over a two-week period in different cities	• Price sensitivity depend on buyer and the product • When price is not changed to an amount higher than the JND, consumers do not notice the price drop or do not perceive the price drop as significant enough to change their buying behavior; so the Weber-Fechner Law holds
Stapel (1972) [Journal of Marketing Research]	• Validity of Weber's Law • Validity of the Fair Price Theory	• Fair Price Theory • Weber's Law	• No experiments; uses just the use of existing researches in the field of the Fair Price Theory and Weber's Law	• Consumers are able to determine even the smallest changes in pricing like one cent. • It's not just about the perception of price changes but also about the evaluation of perceived price differences

Author/s (Year) [*Journa*l]	Research Focus	Theoretical Background	Method/ Analysis	Main Findings
Wheatley, Chiu, Goldman (1981) [Journal of Retailing]	• Relationship between intrinsic and extrinsic attributes of a product when it comes to product quality • The relationship among price, physical quality cues, and quality perception • Which attribute has the greatest influence on the perceived product quality	• Weber's Law • Consumer behavior	• Sample = 171 females, who have purchased carpets at least once • Interview • Subjects had to rate nine identically colored samples of nylons carpeting with different product quality on a scale between one and five. • The carpets' prices were between nine and thirteen dollars.	• The joint effect of a high price and high physical cue has a greater effect on the perceived product quality than the sum of their separate effect. • Test subjects consider high prices as an indicator for high quality • High-quality carpet was perceived to have only slightly better quality than medium-quality carpet (consistent with Weber's Law) • The effects of physical attributes on product quality is higher, especially between the low- and the medium-quality carpets than the effects of price on product quality. • The relationship between price and product-quality was observed to be linear, while the relationship between the physical attributes and product-quality was observed to be non-linear.• The joint effect of a high price and high physical cue has a greater effect on the perceived product quality than the sum of their separate effect. • Test subjects consider high prices as an indicator for high quality

				• High-quality carpet was perceived to have only slightly better quality than medium-quality carpet (consistent with Weber's Law) • The effects of physical attributes on product quality is higher, especially between the low- and the medium-quality carpets than the effects of price on product quality. • The relationship between price and product-quality was observed to be linear, while the relationship between the physical attributes and product-quality was observed to be non-linear.

Comparative Literature Table

Author	Year	Marketing Mix				Experiment	Literature Review	Weber's Law	Weber-Fechner-Law
		Product	Packaging	Price	Promotion				
Britt	1975	x	x	x	x		x	x	x
Britt and Nelson	1976	x					x		
Ekman	1959						x		x
Gabor and Granger	1966			x		x		x	
Kamen	1977	x					x	x	
Kamen and Toman	1970			x		x		x	
Lambert	1978			x		x		x	
Laming	2009						x		x
Mazumdar and Monroe	1990			x		x			x
Miller	1962	x		x	x		x	x	
Monroe	1973	x		x			x	x	
Monroe	1971a	x		x			x	x	x
Monroe	1971b	x		x			x		
Murray	1990						x		x
Sirvanci	1993	x		x		x		x	x
Stapel	1972			x			x	x	
Wheatley, Chiu, and Goldman	1981	x		x		x		x	