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The four P's in social simulation, a perspective on how marketing could benefit from the use of social simulation☆

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Abstract

Marketers employ the four P's — product, price, placement and promotion — in trying to optimize the performance of their products on a market. Both researchers and practitioners in the field of marketing will benefit from increasing their understanding of how the four P's relate to market dynamics and how marketers should employ them in managing dynamic markets. This paper intends to provide a formalization of the four P's for the development of a social simulation model meant for consumer markets. The paper concludes with suggestions for the construction of an experimental design based on such a formalization, and the use of different types of empirical data.

Keywords: Social simulation; Marketing; Consumer behavior; Market dynamics

1. Introduction

Rather than presenting the results of a market-simulation study, this paper aims to contribute to the field of market simulation by providing a framework for simulating consumer behavior in relation to marketing strategies. Because marketing strategies ultimately aim at changing consumers' behavior, the author advocates that for the understanding of market dynamics and the efficacy of marketing strategies the representation of consumer decision-making in simulation models is essential. The framework proposed also provides a guideline for systematically expanding relatively simple simulation models on a less ad-hoc basis than is often done, and thus contributes to the development of the design of simulation experiments aimed at the systematic exploration of market dynamics and the effects of marketing strategies in dynamic markets.

Marketing scientists have extensively studied the effects of marketing strategies by using the General Linear Model (GLM), and have identified many factors that affect the success or failure of different strategies in different markets. In more dynamic, or volatile markets, however, the predictive power of such models has proven to be low. Markets consisting of a very heterogeneous consumer population, where consumption is highly susceptible to social influences such as word-of-mouth, involve complexities resulting in non-linear dynamics that linear models cannot capture. Social simulation, rooted in complexity theory, may provide the means to explore the dynamics of such markets, and hence facilitate the systematic study of marketing strategies in more complex markets. As such, an increasing number of scholars use social simulation — or agent-based models — to study market dynamics. Hence, the simulation of markets is emerging as an important application field of social simulation, as this special issue signifies.

Several scholars have previously used agent-based models to study the role of social networks in processes of innovation diffusion (e.g., Delre et al., 2004), the diffusion (or percolation) of new products in markets (e.g., Goldenberg et al., 2001, 2002; Libai et al., 2005), and the dynamics of markets in relation to decision processes of consumers (e.g., Janssen and Jager, 2001). Whereas these approaches contribute to the understanding of some critical dynamics of consumer markets, their applicability from the perspective of marketing is still at a rudimentary stage.

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Marketers would benefit from having a simulation tool that not only describes the dynamics of certain markets, but is also suitable for testing strategies to influence these markets.

In discussing marketing strategies, marketers generally distinguish among the four P's of marketing (McCarthy, 1960): product, price, place and promotion. Combining these four factors constitutes the so-called marketing mix. The aim of this paper is to enhance the applicability of simulation models considerably by incorporating these four P's into market-simulation models.

Several characteristics determine the final utility level (or satisfaction) consumers experience when buying and consuming a product. Aspects that are mentioned often are brand name, functionality, styling, quality, safety, packaging, repairs and support, warranty, accessories and services. With regard to price, aspects often mentioned are pricing strategy (skimming, penetration), retail price, volume discounts and wholesale pricing, cash and early payment discounts, seasonal pricing, bundling, price flexibility and price discrimination. Aspects relating to place include the use of distribution channels, market coverage, specific channel members, inventory management, warehousing, distribution centers, order processing, transportation and reverse logistics. Finally, promotion refers to promotional strategies (push and pull), advertising, personal selling and sales force, sales promotions, public relations and publicity as well as the marketing communications budget.

Whereas one cannot translate this full complexity of the marketing mix into a transparent social simulation model, the distinction among the main marketing-mix components of product, price, place and promotion would facilitate the development of market simulations suitable for the testing of this marketing mix. This would first require a simplification of the marketing-mix factors in a simulation model, while linking them directly to the rules that determine the buying behavior of artificial agents. Hence the artificial consumers in market-simulation models would have to be sensitive to changes in the marketing mix. Additionally, when simulating more complex markets, one would have to formalize the heterogeneity of populations of consumers as well as the social influence processes between them. The following provides a formalization of some main constituents of such agent rules. This formalization is not conclusive, but in the first place meant for stimulating a discussion about appropriate agent rules.

2. Product

A basic assumption about products is that agents strive toward being satisfied with a product. This implies that products have need-satisfying capacities — or utilities. The utility of any product would depend on how well the characteristics of a product match the individual preferences of an agent. One may consider this individual preference as a weighed multi-attribute composite of product characteristics, such as brand, functionality, styling and quality (e.g., Lancaster, 1966).

2.1. Individual preferences

One could distinguish two different kinds of individual preferences. This distinction dates back to the work of Thurstone (1931). First, an individual preference may take the shape of the more, the better. One usually addresses this preference as a vector model of preferences. This kind of preference relates to factors such as quality, service, flexibility and reliability (e.g., as measured with SERVQUAL: Parasuraman et al., 1995, 1998). The basic formulation for this type of product preferences is:

$$U_{inj} = A_{jn}$$

With:

U_{inj}	Utility for consumer i of attribute n for product j
A_{jn}	Score of product j for attribute n

Formalizing A_{jn} as a value between 0 and 1 results in a utility score between 0 and 1.

The second type of individual preference relates to a relative position on a scale, which implies an ideal point type of preference. This kind of preference refers to e.g., design, color, taste and the like, which may have an optimum utility for a consumer on a more arbitrary position of the scale. This can be formalized as follows:

$$U_{inj} = 1 - |A_{jn} - P_{in}|$$

With:

U_{inj}	Utility for consumer i of attribute n for product j
A_{jn}	Score of product j for attribute n
P_{in}	Preference of consumer i for attribute n

Formalizing both the product attribute score and the consumer's preference as a value between 0 and 1 results in a utility score between 0 and 1. Including the heterogeneity of the consumers in P_{in} allows a modeling of markets where (segments of) consumers have different preferences (taste). Within the fields of marketing and psychology researchers often use Multi Dimensional Scaling techniques to measure consumers' preferences and construct perceptual maps of them (e.g. Kruskal, 1964; Shepard, 1962a,b). An important assumption this study makes is that preferences are not fixed, but may change due to new information and social influence, as the author will discuss in the section on promotion. An increasing number of economists have discussed the relevance of preference change for economic research, and have incorporated these ideas in their studies (Akerlof, 1984; Bowles, 1998; Bowles and Gintis, 2000; Güth and Yaari, 1992; Kahneman et al., 1986; Pollak, 1978; Tversky and Kahneman, 1974; Witt, 1991). Also within the field of marketing many scholars accept the concept of preference change.

2.2. Social preferences

Besides individual preferences, consumers also express social preferences for products, as the utility of a product often depends on which other agents use the product. Here the Veblen effect, referring to conspicuous consumption (Veblen, 1899) — or keeping up with the Joneses (Duesenberry, 1949) — becomes manifest, and consumers weigh their individual and

social preference for a product when deciding what they aspire (see e.g., Chao and Schor, 1998). In order to simplify matters this study proposes that this social utility is considered as one of the product attributes. However, social utility does not depend on product attributes, but on the number of other people in one's environment that are using the product. This can be formalized as follows:

$$U_{inj} = N_j/N$$

With:

U_{inj} Utility for consumer i of attribute n (here the social attribute) for product j
N_j Number of neighbors consuming product j.
N Number of neighbors

This formalization is very simple, but one may envisage social influences that are more complex. For example, similarity among consumers may play a pivotal role in the susceptibility to social influence (e.g., Festinger, 1954). Here, similarity may relate to using the same products/brands, and having about the same financial means, social status, principles, attitudes and skills. This implies that similarity is a multidimensional concept, which may focus on different dimensions depending on the issue at stake. For example, when considering sports drinks, consumers are most likely to compare their preferences with those of people engaging in the same type of sport, whereas other dimensions, such as social status or political beliefs, are less influential.

The social networks constituting the infrastructure for these social influences may differ considerably with regards to size and shape. The calculation of the proposed social attribute is very susceptible to the type of network being formalized. Earlier work (Delre et al., 2006; Janssen and Jager, 2003) demonstrates that different formalizations, such as a regular lattice, a small world network or a scale-free network, have major impacts on both the speed and the degree to which a new product gains market share. This underlines the importance of understanding what comparison dimensions are being used when consumers socially interact on a given product type. Due to the covert nature of many social processes, one generally prefers interviews to surveys to identify the type and shape of social influence processes in a given product market.

2.3. Weighing of preferences

Different attributes will be weighed differently, on both the market as well as on the individual consumer level. Some markets display a high sensitivity of consumers to what other consumers are doing (e.g., clothes, furniture and other fashionable goods), whereas other markets are less dominated by social preferences (e.g., many groceries). Also, in some markets the quality of a product may dominate consumers' preferences (e.g., books, music), whereas in other markets the service level may play a more prominent role (e.g., computers, software, (used) cars). In markets where consumers are highly involved, consumers are likely to consider more attributes than in a market typified by low consumer involvement. For example, when buying a lap-top computer a typical consumer will use more criteria to rate the alternatives than when buying an mp3-player. The number and weights of the respective attributes therefore represent the amount of cognitive effort and social orientation that determines the consumer decision-making process.

To model markets that differ with respect to the importance of attributes (including markets that differ in terms of the social relevance of products) and consumer decision-making processes, a weighing function can be attached to each U_{inj} that captures the utilities of separate attributes:

$$U_{ij} = \frac{\sum_{1}^{n} (\beta_n * U_{ijn})}{n}$$

With:

U_{ij} Utility for consumer i of product j, ranging from 0 to 1
β_n Weighing of attribute n, ranging from 0 to 1
U_{ijn} Utility for consumer i of product j for attribute n

One can set the values of β according to the type of market/product and the attributes taken into consideration by consumers (decision-making process), thereby allowing a simulation of markets that differ in terms of consumer involvement and social susceptibility. One can use empirical data to assign values to β when simulating a particular type of market.

Whereas regression weights related to various product attributes could be used to assign values, such functions do not account for individual differences. Particularly volatile markets will display the heterogeneity of consumers concerning the attribute scores and weights. Besides heterogeneity among consumers, also within consumer groups these scores and weights may fluctuate over time. Hence, the author recommends the use of individual data, e.g. gathered from surveys and/or interviews, as a means to estimate the distribution of the weights that consumers attach to different attributes.

In addressing heterogeneity at the consumer level, one can formalize the β values on an individual level:

$$U_{ij} = \frac{\sum_{1}^{n} (\beta_{in} * U_{ijn})}{n}$$

With:

U_{ij} Utility for consumer i of product j, ranging from 0 to 1
β_{in} Weighing of attribute n for consumer i
U_{ijn} Utility for consumer i of product j for attribute n

Including heterogeneity in the formulation of consumer utility enables one to compose a market where consumers attach different weights to attributes, and which facilitates the representation of consumers' decision-processes that differ in terms of invested cognitive effort (weighing of attributes) and social susceptibility (β for the social attribute).

Another aspect of importance is that in many markets where consumers buy products repetitively (e.g., groceries), the consumer decision-process takes the form of a habit, especially when people use simple scripts to buy a product and their cognitive effort is low (e.g., Wood et al., 2002). Whereas the first purchase may be based on a deliberate choice, or may have been instigated by social influences, later purchases will be more automated. One may formalize such processes by manipulating the frequency of scanning the market for (alternative) products. The more satisfied a consumer is, the stronger a habit will be, and therefore the assumption is that the frequency of scanning is related to the utility of the product. Hence, the higher U_{ij} is, the lower the frequency of scanning becomes. This implies that new products, which in principle could result in a higher U_{ij}, are not being perceived as such. Obviously, as the agent will experience U_{ij} of the habitually consumer product each time-step, a decrease in this U_{ij} will immediately result in a more frequent scanning, which may lead to a change of consumption.

2.4. Substitutable versus non-substitutable attributes

Whereas for substitutable attributes the above-mentioned formalization suffices, non-substitutable attributes require the formalization of consumer thresholds that indicate beyond which score (more is better) or deviation (taste) a consumer will not take a particular product into consideration for consumption. One can use this formalization in modeling the selection of an evoked set of products. The Elimination-by-aspects model of Tversky (1972) is an efficient tool for this purpose:

To the-more-is-better type of preferences applies:

If $T_{in} > A_{jn}$, then product is not considered.

With:

T_{in} Threshold of consumer i for attribute n
A_{jn} Score of product j for attribute n

Setting T_{in} at high levels (close to 1) implies that only products with a very high score on attribute n will be accepted for that attribute.

To taste preferences applies:

$$T_{in} > 1 - |A_{jn} - P_{in}|$$

With:

T_{in} Threshold of consumer i for attribute n
A_{jn} Score of product j for attribute n
P_{in} Preference of consumer i for attribute n

Setting T_{in} at high levels (close to 1) implies that only small deviations of product j with regards to attribute n will lead to an acceptance of the product for that attribute. This reflects a high degree of consumer involvement, and high standards concerning satisfactory product characteristics.

In simple experiments, one can set the thresholds equally amongst the simulated consumers to model markets that differ with respect to generic consumer preferences and involvement. However, consumers display heterogeneity in their thresholds, and hence one can also formalize individual thresholds, allowing the formulation of consumer segments that differ not only in terms of preferences, but also with respect to consumer involvement.

2.5. Product development

For reasons of simplicity, the model strives for a simple (aggregate) formalization of an agent's individual preference for a product. Assuming heterogeneity in preferences, producers may change the characteristics of a product to target certain groups of agents with particular preferences (segments).

Product development focuses exclusively on the attribute values of the product (A_{jn}), which can be designed by the producer. Obviously, neither the consumers' perception of the attribute value and its weighing, nor the social attribute can be designed by the producer, although promotional strategies are available aimed at changing these attributes and weighings. The section on promotion will discuss these strategies.

3. Price

In valuing products or services, consumers typically make a trade-off between what they receive and what they have to give up to acquire and use them (e.g., Woodruff, 1997). When focusing on price, the concept of value-for-money may be useful in a model (e.g., Sirohi et al., 1998; Sweeny et al., 1999), indicating that consumers may act on the basis of a trade-off between the price and the utility of a product. Weighing of the price will depend on the consumers' budget, which implies that higher income consumers will be less sensitive to price than low-income consumers. This, however, is mainly of importance in markets where the products are more expensive. In many markets — e.g., groceries — the available budget hardly affects the decision-making process, which can be formalized as:

$$V_{ij} = U_{ij} * B_i * (1 - P_j)$$

With:

V_{ij} Value for money of product j for consumer I
U_{ij} Utility for consumer i of product j
P_j Price of product j, ranging from 0 (free) to 1 (expensive)
B_I Budget of consumer I, ranging from 0 (no budget) to 1 (unlimited)

According to this formalization, the value for money V_{ij} will be closer to the utility of product U_{ij} the lower its price P_j and the higher the consumers' budget B_i.

Assuming that value for money indicates the consumers' likeliness to buy a product, linking V_{ij} with P_j gives an indication of the price elasticity of product j, given a particular

market with many competing products. The more products provide about the same U_{ij}, the more sensitive consumers will be to price differences. Moreover, elasticities will differ as consumers have different budgets, indicating that the lower a consumer's budget, the higher the price elasticities will be. The information available on the price elasticities of the various product categories provides a point of departure for assigning values to price and budget for different markets. Within a social simulation context a logical step would be to include heterogeneity of the agents with regards to their price elasticities, thereby expressing differences in available budget. This also applies to the segmentation of a market, where the price characteristics of the marketing mix may be used to attract specific types of consumer — in this context based on income. Hence, products may be assigned a price, and agents may differ in terms of their willingness to pay.

Simulation experiments may reveal how different segments of consumers — differing in attribute preferences and price sensitivity — respond to pricing strategies. They may also reveal whether and how the existence of different price segments affects the dynamics of the overall market.

4. Place

A critical aspect of place is the spatial availability of the product. This aspect can be translated in terms of effort required to buy a particular product. When two equally good products are available, consumers generally prefer buying the product at a nearby shop to traveling to a distant shop. This implies that a spatial dimension should be included in the simulation model, which takes into account that products differ with respect to the average effort required to obtain them.

Assuming heterogeneity of agents — here in terms of their location in relation to the outlet of different products — the agents also differ in evaluating the place element. Basically, one could interpret a denser distribution network as agents having to make a more equal — and on the average lower — effort in buying the product. Products having fewer outlets would cause a larger heterogeneity among agents concerning effort, also resulting in a higher average.

A simple formalization would be including distance as one of the model's additional attributes to calculate the overall utility for the consumer (U_{ij}). This attribute may have different values for different consumers, thereby expressing the distance to the place in a simple manner. For some markets distance is a more important attribute than for others. For example, for products frequently bought, such as groceries, people generally prefer a nearby shop, whereas for durables, such as furniture, distance may play a less prominent role. For products sold on the Internet distance will be irrelevant. Weighing this distance attribute (by a β) would determine its importance.

Obviously many more factors constitute the heading of place. Besides distance, also aspects such as quality and image of the shops that vend the product, time-slots available for buying the product (e.g., compare 24/7 Internet shopping with the often limited opening hours of service providers, such as banks and brokers), and the other products that can be bought at the same location (creating synergy) play a role. Factors such as these could all be captured in a series of attributes designated to formalize the place-factors of the overall utility function.

In more complex spatial models a spatial density of the location of the agents could also be included, enabling one to distinguish between more rural and urban areas. This would lead to a more sophisticated approach to the availability factor. Such sophisticated models may, however, be more appropriate in addressing issues such as shop location planning than in modeling typical product markets.

5. Promotion

Marketers use promotion to keep the product in the minds of the consumers and to stimulate the demand for products. Whereas pricing campaigns are often also referred to as consisting of promotional campaigns, this paper defines promotion as advertisement and publicity activities aimed at informing the consumers about the product. Hence, informing consumers about a price-cut typically involves a combination of promotion and pricing strategies. Promotion can take the shape of a planned action to inform (groups of) consumers about a product, but may also involve consumers informing one another about (new) products. The latter process is addressed as word-of-mouth (WOM).

5.1. Promotion by the producer

The promotion of the producer involves informing consumers about the producer's products. In the context of the proposed formalization one can distinguish between addressing the relative weight of attributes and the attribute scores. Hence promotion strategies could either focus on convincing consumers to attach more weight to a particular product attribute by which a product scores well (increasing the β), or on convincing them that the utility of attribute n is actually higher than they currently believe (increase U_{inj}). An additional strategy might be to inform consumers about other consumers (famous role models) that already use the product, thereby affecting the social attribute.

A major issue here is who to address. The classic Bass model (Bass, 1969) makes a distinction between mass media influences and word-of-mouth effects. However, this distinction seems to be obsolete, as the increase in media channels has changed the mass-media more into a multitude of channels that targets specific segments by adopting viral-marketing strategies to utilize the processes of word-of-mouth. Therefore, in a simulation context a more practical approach would be to formalize (and test) promotional strategies that differ in terms of the number of people addressed as well as the degree to which they address a particular type of consumers (segment). This formalization would allow a more sophisticated study of the efficacy of promotional strategies.

The current practice is for marketers to spend a great deal of effort in addressing specific segments of markets, thus aiming their promotional activities at specific types of consumers.

These segments may be based on a combination of the attributes discussed above and on income groups. As such the formalization of the product and price factors allows one to select groups of consumers as targets of promotional strategies. Simulation experiments may reveal what kinds of strategies are the most effective to persuade particular segments of consumers. For example, some consumers are more sensitive to communication regarding product features (attributes), whereas others are more likely to respond to information about price-cuts.

The response of consumers to promotional activities may range from accepting the information completely to rejecting the information and even developing a more negative perception of the product. People may spend more or less cognitive effort in elaborating the information promoted. The *Elaboration Likelihood Model* (*ELM*; Petty and Cacioppo, 1986) captures this notion. The model discerns a *central* and a *peripheral route* to attitude change. The central route pertains to the elaboration of pure arguments in a persuasive message and/or new information. People are capable of processing the arguments of the message and motivated to do so. Peripheral processing is more likely when people's motivation to elaborate information is low, or their cognitive processing ability is limited (i.e., complex issues). The peripheral route concerns the elaboration of form aspects or cues of a message, such as the number of arguments and the credibility and attractiveness of the source. Social Judgment Theory (Sherif and Hovland, 1961) offers points of departure for modeling central processing (see Jager and Amblard, 2004 for an example). Consumers may move toward the position advocated by the producer (e.g., attribute value A_{jn} or weight of an attribute i of product j β_{ij}) if this position is relatively close to their own. In comparison, if the position advocated is very remote, the consumer may react by further distancing him/herself from this viewpoint. In the case of mediocre differences, however, the consumer may not respond at all.

In addition to the direction, the degree of change may also be modeled. This enables one to model the susceptibility of consumers to changing their opinions after receiving a promotional message. The change of consumers' opinions, e.g. their perception of a product attribute, is thus a function of the difference between their own position and the promoted position, weighed by their susceptibility to change.

Source effects often occur in peripheral processing. This implies that if one likes the source, one is more willing to accept the position promoted by this source. Jager and Amblard (2005) have modeled such effects in the context of opinion dynamics. One can formalize processes such as these, relevant in the context of product endorsement by famous people, quite simply in market simulations.

Because marketers have a limited budget for promotional activities, determining which consumers to address is an important issue. Consumers are linked in social networks, and promotional campaigns directed at specific clusters of consumers (or segments) may generate word-of-mouth effects which, due to the establishment of a local critical mass, further contribute to their efficacy. Hence, including a perspective on WOM effects in promotional campaigns is a useful measure.

5.2. Word-of-mouth

Word-of-mouth relates to how consumers inform one another about a new product. Earlier work demonstrates that the size and the shape of networks are crucial with respect to the speed and degree to which information is being spread and new products are being adopted (Delre et al., 2004; Janssen and Jager, 2001). Based on empirical data from surveys, one can obtain indications of both the type and the use of social networks in particular markets. For products that are more complex by nature (many attributes) and have more social relevance, consumers may be more likely to use others to come to a decision.

Different types of information are exchanged through social networks. First, consumers may exchange information concerning product utilities (U_{inj}). This social informative strategy implies the communication of the attributes of a specific product, e.g., the fuel consumption of a particular brand of car. On a more generic level, consumers may discuss the importance of certain attributes, such as e.g. the importance of the safety of a car. Consumers exchange information on their weighing of the attributes, and may change their β's accordingly. Finally, a normative strategy only considers the number of neighbors that consume a particular product without including further information. The social attribute as defined in the product section captures this social normative process.

In addition, one can formalize central and peripheral processes by modeling in which direction and to what degree consumers are likely to change their attributes and/or attribute weights following social interaction.

Recent work (Delre et al., 2006) shows that the efficacy of promotional strategies strongly depends on these WOM effects. First simulations indicate that an optimal effect can be obtained when random promotion and promotion directed at clusters of consumers are carefully balanced. Also the timing of additional promotional strategies is crucial in boosting a diffusion process. Whereas the results are still at a preliminary stage, they offer a modeling perspective on exploring the efficacy of promotional strategies in relation to which consumers to address, when to address them, and what type of information to approach them with.

6. Competition

As many companies produce products that are substitutable, many markets exhibit a strong competition among companies. This competition may relate to competing companies, but also to the situation where a particular product within the portfolio of a producer cannibalizes upon the sales of another product in that portfolio. Hence, marketing strategies developed for one product may affect the market shares of competing products. A typical product market involves a number of products competing for market shares, supported by strategies aimed at maintaining and increasing these market shares. This involves strategic decision-making by producers, e.g. in developing products for specific consumer segments (preferences and attribute weights), and in addressing specific groups of consumers — e.g. those using the

product of a competitor — with promotional strategies. Here producers may display different degrees of innovativeness, taking the initiative in either conquering market-share or responding to marketing strategies of the competition.

To understand the dynamics of markets and to explore the effects of marketing strategies one has to include competition into simulated markets. This first requires the formalization of a number of competing products in a simulation model. For each of the products one can formalize different marketing strategies. This allows the interactions of different marketing strategies to be tested and enables the identification of effective strategies in a competitive market. For example, ways can be tested in which a new product, tailored to a specific segment of the market, is introduced, or responses can be assessed to the promotional campaign of a competitor.

Because marketing strategies target consumers, one should represent the key elements of consumer decision-making in a model before testing such strategies in a simulation environment. Although the framework of consumer behavior sketched in this paper provides a set of generic rules that facilitate such a modeling, a key question is how to parameterize the model in order to represent a real-world market. Empirical data on consumer decision-making provide the information to select the values of the variables and functions discussed in the previous sections.

7. Empirical data

The description above indicates some of the possible ways to include the four P's in simulations of market dynamics. A central question to be addressed relates to the use of empirical data in such a context. Markets differ in terms of the importance of factors, such as the speed of product development, the relative importance of social information and price elasticities. A logical choice would be to select different markets as cases to be modeled. This would imply that a simulation model should be capable of replicating empirical data on existing market dynamics. However, here problems arise. First because, although many data are available on aggregate sales, individual sales data are less accessible. Whereas data exist on individual sales over time (e.g. customer cards), these are generally not available for research purposes. Additionally, the substitutability of products constitutes a problem due to the difficulty — or even impossibility — of selecting a subset of products beyond which substitutions do not take place. For example, when one is interested in studying the market of ice cream, substitutions may relate to different brands of ice-cream, but also to other desserts, and perhaps even to the components of a full meal, as many consumers (implicitly) select a menu on the basis of a fixed price. Rather than focusing on a specific product market, a fruitful approach might be to model consumer markets on a more abstract level.

By means of aggregate data one can distinguish between more volatile markets and stable markets. Individual survey data might indicate whether individual consumers behave more habitually, are social susceptible and thus use their social network, or display variable preferences. This may show, for example, if a market that is relatively stable on an aggregate level is characterized by stable or variable individual behavior, which has consequences for the consumers' sensitivity to the marketing mix. Hence, empirical data could be used to develop more abstract prototypical product markets. Of course, agents should be equipped with a behavioral/decision repertoire that enables them to model decision strategies, such as habits and different preferences, individual and social preferences (linked with underlying needs), and social networks. Researchers could use these parameters to formalize prototypical markets.

The resulting dynamics generated by the simulation model would provide general insights into the different dynamics that typify these prototypical product markets, and the way in which changes in the marketing mix affect these dynamics. Obviously, such an approach should also include the marketing efforts of competing firms, and thus might include a co-evolutionary perspective on market dynamics. The results obtained with such a simulation model would subsequently be useful in interpreting the processes observed in empirical cases. In this way, social simulation may contribute to the understanding of how variations in the marketing mix affect market dynamics.

8. Conclusions

This paper has sketched a large number of opportunities to formalize the four P's — product, price, place and promotion, and offers suggestions for formalizing agent-based models to study market dynamics. The rationale behind this approach is that for marketers and scholars studying market dynamics, the inclusion of a perspective on strategies that influence markets is important. This requires the incorporation of a perspective on consumer decision-making as introduced in this paper. Including all the formalizations presented in a single simulation model would result in a very complex model, unsuitable for systematically exploring the effects of the various factors. To maintain transparency in simulation experiments, the full set of formalizations serves as a conceptual framework that guides the process of developing an experimental design. Hence, researchers should build very simple models of consumer markets and consecutively extend them along the lines as depicted by the conceptual model. In conducting such a series of experiments, the author recommends to use micro-level data to initialize the parameters of the model, and macro-level data to validate the simulation results. In this way one can make causal inferences on how macro market behavior —i.e. dynamics — relates to specific consumer behavior in a particular market.

Such experiments would contribute to the understanding of how marketing strategies interact with and determine market dynamics, and provide a perspective on developing competitive market strategies in more volatile or complex markets, thereby serving both marketing practitioners and marketing scientists.

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