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Modeling innovation diffusion patterns

Ruiz Conde, Maria del Enar

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Document Version

Publisher's PDF, also known as Version of record

Publication date:

2005

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Ruiz Conde, M. D. E. (2005). *Modeling innovation diffusion patterns*. s.n.

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Chapter 7

Summary and discussion

Firms make continuous improvements and renewals of their products. New products have to be developed, tested and successfully introduced into markets with intense competition. This is one of the major tasks of innovation management. Given the complexity, risk and highly dynamic nature of this kind of work, managers need the right tools to adequately develop their work. Diffusion models provide an important instrument to understand the dynamics of the diffusion process of innovations. Since the seminal work by Bass (1969), diffusion models have played an important role in marketing science for more than three decades, and research into diffusion modeling continues to be an active area of study. Many studies have been developed with a focus on different products, countries and situations.

Our aim in this thesis is to contribute to the methodological and substantive evolution of diffusion models by relaxing a number of restrictions of the classical diffusion models so that their application potential is increased.

We develop a review of the theoretical and empirical background of diffusion models in marketing (Chapter 2). We evaluate the body of research on diffusion modeling and discuss models that relax the assumptions -limitations- of the classical diffusion models:

- Assumption 1. The diffusion process is a binary process and population is homogeneous.
- Assumption 2. The population of adopters does not vary.
- Assumption 3. The parameters of external and internal influence do not change.
- Assumption 4. Only one adoption per adopter is permitted.
- Assumption 5. Geographical frontiers do not alter.
- Assumption 6. The innovation is diffused in isolation.
- Assumption 7. The characteristics of an innovation and its perception do not change.

Assumption 8. There are no supply restrictions.

Assumption 9. The impact of marketing strategies is implicitly captured by the model parameters.

A number of summary-tables have been included after identifying some key dimensions, which are used to characterize the models. The diffusion of innovations over time is a highly dynamic and complex problem. The classical or traditional diffusion models of innovations lack important details and Chapter 2 shows how these models can be extended to incorporate additional elements. We discuss a considerable number of diffusion models that relax the nine restrictive assumptions inherent in the traditional models. The extended diffusion models represent an important improvement in the understanding of the structure and forces driving the diffusion process of innovations.

In the subsequent chapters, we discuss specific extensions of the classical diffusion models and apply them to different contexts. In Chapter 3, we introduce the empirical applications we carry out on the diffusion of movies in Spain, France and Italy (Chapter 4), on the diffusion of franchising in Spain (Chapter 5) and on the diffusion of prescription drugs in the United States of America (Chapter 6). In Chapters 4 through 6, we develop extended diffusion models that overcome specific limitations of the classical models and hence allow for more realism in the modeling of the diffusion of innovations.

Although many normative diffusion models have been proposed in the literature, there is relatively little empirical work (Chatterjee, Eliashberg and Rao, 2000) that has attempted to validate the model specifications assumed by normative researchers. Parker and Gatignon (1994) provide a start in the descriptive validation of diffusion model specifications to enhance the relevance and value of the normative models. Their study shows that asymmetries in the diffusion process exist across the brands in the category of products they analyze. This implies that normative models, which are usually employed by the Bass model as the demand model, should recognize these asymmetries in order to provide appropriate optimal marketing strategies. We have followed this direction by developing three empirical applications. The models we present are descriptive and do not incorporate normative factors, such as the optimal launch time for each product or the optimal time for a product to enter or leave the market.

In the remainder of this chapter, we present the conclusions and contributions of our study and discuss limitations and directions for future research.

Diffusion of movies in neighboring Mediterranean countries (Chapter 4)

This research focuses on marketing decision variables and introductions into different markets, two of the multiple concerns that managers have regarding the diffusion process of innovations. Although research on price and advertising is

extensive in diffusion modeling, distribution is rarely incorporated. Scarce availability of data on this decision variable is mainly responsible for the current state of affairs. This research contributes to modeling literature on new product diffusion models by extending the models proposed by Jain and Rao (1990) and Bass, Krishnan and Jain (1994) to explicitly incorporate distribution. Researchers believe that both the socio-economic environment and time lags in introducing new products into the market are relevant factors in explaining differences among the diffusion processes of the same product in different geographical areas. Hence, this study also adds to the literature on international diffusion by analyzing the importance of the *country* and *time effects* to give a better understanding of the differences in diffusion patterns between countries that are geographically close. These questions have motivated us to analyze these phenomena in the context of the diffusion of movies, in three Mediterranean European countries -Spain, France and Italy-, based on data for the period 1997-1999. Thus, the empirical application extends the use of Bass-type diffusion models to products other than the classical consumer durables, i.e. to entertainment and experience products. The model framework proposed in the Spanish context is extended to other settings: France and Italy.

Main results and conclusions

We demonstrate that there is no single common model that describes the diffusion patterns in all the analyzed markets. However, in general terms, the Generalized Bass model that accommodates the effects of distribution turns out to be as the preferred model. Results show that the diffusion processes of the analyzed movies are largely determined by three factors: two clear trigger factors are internal knowledge that consumers have about the movies (assumed through advertising, critic reviews or their innate innovativeness) and word-of-mouth interactions (assumed through social contagion among friends, colleagues or other close people who have already seen the movie), with another possible factor being the intensity distribution of the movie in the country concerned.

We also found a *country effect*, i.e. there are significant differences in revealed preferences between Spain and France and between Italy and France, although not between Spain and Italy. The cultural, economic, social or other differences between Spain and Italy do not seem to be large enough to provoke a significant difference between their diffusion processes. In this sense, these findings reinforce existing knowledge in the area, which points out the importance of country characteristics in the commercialization of innovations. However, whereas the *country effect* seems to be one reason for differences in the diffusion processes of the selected movies between some of the three countries, the *time effect* appears not to play an important role. We could not detect lead and lag patterns that suggest “sprinkler” strategies of introduction. One possible reason for this result is that as the differences in time between the moments of entrance of the movies in each country are very small, it is not easy to detect any effect on the diffusion processes.

Assumptions relaxed

As we pointed out in Chapter 3, the study discussed in Chapter 4 relaxes three of the nine limitations -assumptions 2, 3 and 9- of the Bass model. First, we allow the potential market to be dynamic; in our model we allow distribution to affect the size of the potential market (assumption 2). Second, we allow the parameters of external and internal influence to vary over the diffusion process of the innovation; more explicitly: we assume that distribution affects the adoption rate (assumption 3). And third, we explicitly consider a marketing variable: distribution (assumption 9).

Limitations and future research

Apart from the other assumptions pointed out in Chapter 2, which we do not relax (Table 2B in Appendix 2B shows that none of the extended diffusion models relax all nine assumptions and most relax just one or two), this study identifies other limitations that deserve consideration in future research. First, even though distribution has long been recognized as a relevant variable in a product's commercialization process, our results show distribution to be a weakly significant factor affecting the diffusion processes in the three analyzed countries. However, other possible ways of measuring and incorporating this variable into the model need to be considered. Second, it would also be worthwhile to include advertising in the diffusion models to improve their use for planning purposes. In our case, weekly data on advertising expenditures for each movie in the three analyzed countries are not available. Third, although this study reveals differences in the diffusion processes of movies in different geographical areas, it is helpful for managers to know the specific factors that account for this country effect. Specifically, this requires a second analysis to detect which social, economic, political, demographic and/or cultural factors affect this country effect. This implies obtaining disaggregated data on adopters from the three Mediterranean countries that are not yet available. Fourth, our empirical application explores and gives insight into designing marketing strategies for the introduction of just one product category in three countries, which poses a clear limitation for generalizing the results. Hence, it would be valuable to extend the study to other categories and countries within the same observational period. Fifth, the nature of the new products analyzed -movies- obliges us to study short data series, as has been done, for example, by Jones and Ritz (1991).

Diffusion of franchising in Spain (Chapter 5)

Research on the application of new diffusion models to organizational innovations is very scarce and underdeveloped. Insights into whether and how diffusion theory can be applied to such an innovation diffusion context is much needed. This study fills this gap by focusing on an organizational innovation, namely franchising. We consider the diffusion of franchising by firms (inter-firm

diffusion) in Spain during the period 1974-1999. The adoption of this system of commercialization has important consequences for the adopting organization (the franchisor). The organizational benefits of franchising contribute to improvements in management and distribution channels. Franchising is a mechanism that reduces the divergence of interest between the two parties (franchisor and franchisee), reducing agency problems and allowing the possibility of reaching common goals. We apply well-known diffusion models to detect how many firms are influenced by firms that have adopted the franchising concept (“imitators”) and how many firms are not influenced by the timing of the adoption by other firms (“innovators”). We develop a four-step approach to select the most appropriate diffusion model. After visual analysis of the data, we test whether the adoption follows a purely random process or whether firms imitate the adoption of the franchising concept. In the second step, we re-examine the imitation hypothesis, i.e. the ratio of inter-firm diffusion is governed by imitative behavior between adopters and non-adopters. In the third step, we compare some nested and non-nested models and the final selection is based on parameter stability and predictive validation criteria (fourth step).

Main results and conclusions

Our results suggest that the long-run diffusion process of franchising in Spain is appropriately captured by several Bass-type diffusion models taken from a family of models. However, the traditional Bass model presents better properties in terms of parameter stability and predictive validity. Results show that the adoption of franchising in Spain is only slightly affected by external influence whereas Spanish franchisors present strong imitating behavior. This suggests that if the Spanish Government, Spanish Franchising associations or Spanish Franchising fairs want to stimulate the adoption of franchising among Spanish firms, external influence should be enhanced by marketing efforts. Additionally, the results show the suitability of the imitation hypothesis of the diffusion models to explain the diffusion process of franchising in Spain, which was questioned by Mahajan, Sharma and Bettis (1988) regarding organizational innovations.

Assumptions relaxed

We note that for this organizational innovation -franchising- the decision maker is not the consumer, but the firm. In this application, we relax the first three assumptions of the Bass model. We relax assumption 1 by allowing for a heterogeneous population of adopters through the incorporation of a new parameter into some of the models. We also allow the potential market to depend on the number of Spanish firms in the marketplace during the diffusion process of the innovation (assumption 2). And, assumption 3 is relaxed by having a non-uniform parameter of internal influence in some of the diffusion models.

Limitations and future research

Apart from other assumptions mentioned earlier that we do not relax, this study has an especially relevant limitation that affects the application setting in which the

study is conducted. In this study we do not distinguish different industries or sectors. It would be informative to address that distinction. However, the appropriate data necessary to calibrate the models in different industries or sectors is not yet available. These limitations deserve attention in future research. Our results show that, among the proposed family of diffusion models, the traditional Bass-model (a diffusion model with a fixed potential market) shows better proprieties than those with a dynamic potential market. However, other possible ways of measuring and incorporating a dynamic potential market into the model need to be considered, especially when a distinction among different industries or sectors is incorporated. Furthermore, although this study represents a valuable starting point for the reexamination of organizational innovations with diffusion models, other useful studies for managers are those that answer questions such as:

- which of the characteristics of a franchising system have mainly favored its diffusion?, or
- what is the role played by the competitive environment in the diffusion of franchising?.

Diffusion of prescription drugs in the United States of America (Chapter 6)

In this research we employ diffusion modeling to investigate the longitudinal and cross-sectional effects of marketing expenditures on the diffusion of new prescription drugs from three product categories. Pharmaceutical marketing has been criticized as wasteful and excessive and for contributing to the overuse, misuse and misprescription of drugs. However, marketing also serves as a key communication channel for continuing physician education regarding pharmaceutical products and for exposing consumers to information that may improve health outcomes. We use a trial-repeat purchase diffusion model calibrated for each new drug introduced in the categories of rhinitis, osteoarthritis-rheumatoid-arthritis and asthma drugs in the US market within the period 1993-2000. We extend the model proposed by Hahn et al. (1994) to incorporate the effect of the company's and competitors' promotional efforts separately. In contrast to studies that either use aggregate measures for marketing expenditures or expenditures for a single instrument, our model accommodates heterogeneity in the effects of the different marketing instruments. Thus, our model allows for the analyses of the effects of marketing directed at physicians ("push" strategy) and direct-to-consumer advertising ("pull" strategy). Following existing literature, we assume that longitudinal marketing efforts affect the trial rate. We propose a family of trial-repeat diffusion models to determine whether marketing affects the trial rate either through external effects or via internal effects. We investigate the cross-sectional effects by performing a second-stage analysis on the estimated parameter of the diffusion model.

Main results and conclusions

We find support for the hypothesis that changes in own marketing expenditures are positively related to changes in the trial rate. We also find support for the hypothesis that the trial rate is negatively affected by competitors' marketing expenditures. The results indicate that each brand can follow a specific diffusion process and that the impact of marketing efforts can vary for each brand. However, in general terms, the external influence formulation is revealed as the most appropriate specification to incorporate marketing variables in the trial-repeat diffusion model for the three categories analyzed. Besides these longitudinal effects, we also find cross-sectional effects. We find that the mean level of marketing expenditures is positively related to the basic propensity to try the new product and to the repeat rate but apparently not related to internal influence. These results hold for all three drug categories analyzed, except in the case of rhinitis, where marketing expenditures are negatively related to internal influence. This implies that marketing expenditures have both an informative and persuasive influence on the diffusion of new pharmaceutical products.

The cross-sectional analysis also reveals insights into the order of entry of the new drugs in the market and the importance of branded versus generic drugs. Order of entry is found to play an important role in the launch strategy of the new products in the rhinitis category, which has only branded drugs. Branded drugs launched early seem to have a better opportunity of occupying a preferential position in the physicians' product space. However, when we consider the other categories, order of entry becomes less important. In this analysis we also find that for generics, there is a higher basic propensity to try, a larger effect of internal influence and a higher repeat rate than for branded drugs. Finally, the results of this study lead us to perform an in-depth analysis of the impact of the different marketing instruments on the time-varying diffusion parameters. We introduce a different approach -a recursive time window approach- and show some preliminary results for the rhinitis category. These results show that marketing efforts directed at physicians, especially detailing, but also physician meetings, are a key factor in determining the temporal pattern of the diffusion parameters. There seems to be no clear pattern for both medical journal advertising and direct-to-consumer advertising.

Assumptions relaxed

As we discussed in Chapter 3, in the study on prescription drugs -frequently purchased consumer products- the decision maker is not the consumer, but the doctor. In this application, four assumptions in the Bass model are relaxed. We relax assumption 3 by assuming that marketing variables affect external and/or internal influence over the diffusion process. We relax assumption 4 and incorporate repeat purchases into the diffusion model. We also consider the effect of competitive variables on the diffusion process (assumption 6) and we incorporate marketing

variables, such as detailing, medical journal advertising, physician meetings and direct-to-consumer advertising (assumption 9).

Limitations and future research

Although the model proposed in this study relaxes some limitations of the earlier trial-repeat diffusion models making it more realistic, several simplifying assumptions of the models remain. First, the number of physicians in the product category is fixed. Second, all consumers are assumed to purchase a product in the product category in each period. However, Hahn et al. (1994) point out that relaxing this assumption adds considerable complexity to the model, and this is not a highly problematic assumption for monthly data. Additionally, this assumption deals with the presence of an outside good, which allows for category expansion. Third, all the physicians are assumed to belong to the same class. Lilien, Rao and Kalish (1981) point out that this can be relaxed by constructing a series of parallel processes for each class of doctors. Fourth, the usage rate of the new products is the same as that of mature products. Fifth, the repeat rate is not affected by promotional efforts. Considering promotional efforts affecting both trial rate and repeat rate leads to econometric problems (multicollinearity). These limitations deserve attention in future research.

In conclusion, we point out the benefit of continued research pertaining to theoretical and empirical extensions of the diffusion models. Theoretical extensions may be directed towards the relaxation of the limitations identified in each of our studies and the assumptions presented in detail in Chapter 2.

The relaxation of assumptions may involve such appealing issues as the stochastic modeling of the diffusion process of innovations and modeling the adoption process at the micro-level, based on reasonable behavioral hypotheses. Empirical extensions may be directed towards examining other innovations to assess the generalizability of the results obtained in this thesis and in other studies; in particular, examining the way marketing decision variables affect diffusion model parameters and the shapes of these variables' functions. We focus our three empirical applications (Chapters 4, 5 and 6) on new products that have scarcely been studied in the literature of diffusion models. Most applications of diffusion models are on new durable consumer products, such as blenders, calculators, clothes dryers, dishwashers, disposers, freezers, irons, refrigerators, color and black and white TVs, whereas few applications are on other kinds of consumer products, non-durable products, services or organizational innovations. Future research on other categories of new products will enhance our understanding of how diffusion models work in different situations. As Chatterjee, Eliashberg and Rao (2000) suggest, the findings would indicate appropriate model specifications for normative research that could be used as an aid in developing suitable initial strategies for new products.

This thesis contributes to the stream of research on Bass-type diffusion models in which restrictions are relaxed in their specifications to allow the models to become more useful tools for managers in solving problems regarding innovation decisions in different situations (products and contexts). A better understanding of the dynamics of diffusion models and their applicability to managerial problems favor their usefulness. The present study has explored specific issues behind the diffusion process of innovations and therefore provides a better understanding of how to manage this process. Several managerial implications are identified.

Interpersonal communication (internal influence) is confirmed as the main driver in the diffusion process of different types of innovations: organizational forms (franchising), experience consumer products (movies) and frequently purchased consumer products (prescription drugs). Although non interpersonal communication (external influence) is also confirmed as a main driver for consumer innovations, when adopters are firms (such as in the case of franchising as an organizational innovation) external influence becomes less relevant. This could be caused by the higher risk inherent in the adoption of organizational innovations.

The managers of the motion picture industry should take into account the fact that both external and internal influences drive the diffusion process of movies in the analyzed European countries. However, they have to proceed with caution in the use of information on the diffusion process of movies in other countries, since the level of internal influence varies across countries, despite their geographical proximity. The idiosyncrasies of individual countries could lead to these differences. Additionally, managers should also take into account the fact that the number of screens where a movie is exhibited enhances its diffusion process, although modestly.

Although Bass-type diffusion models are traditionally not used for analyzing organizational innovations, our findings show the applicability of these models to the diffusion of franchising. In particular, the implantation of the franchising system in Spain is appropriately captured by three diffusion models: a diffusion model which considers only internal influence, a diffusion model which considers external and internal influence and another which considers time-varying internal influence. Interpersonal communication among firms is revealed as the determinant factor in the diffusion process of franchising.

The diffusion process of frequently purchased consumer products, such as prescriptions drugs, is modeled as a process of trial and repeat. The incorporation of marketing instruments in the diffusion model improves the understanding of the diffusion process of prescription drugs. Managers can improve the trial rate of their new drugs by investing in own marketing instruments, but the trial rate decreases with competitors' marketing expenditures.

We show that pharmaceutical marketing has both an informative and persuasive influence on the diffusion of new prescription drugs. Specifically, the “informative” function of pharma marketing influences the diffusion of new drugs through trial rate and the “persuasive” function through repeat rate. The differentiation between direct-to-physician marketing (“push” strategy) and direct-to-consumer advertising (“pull” strategy) is a relevant factor to be considered for managers. Direct-to-physician marketing clearly affects the trial and repeat rates whereas direct-to-consumer advertising seems to affect the trial rate through internal influence during the first year and the repeat rate during the complete period. However, direct-to-consumer advertising has no demonstrable impact on the trial or repeat rates when the drug categories include both branded and generic drugs. Furthermore, in the particular case in which the category has only branded drugs, earlier entrance in the market creates barriers of entry. Finally, the pharmaceutical companies can increase the propensity to try new brands and also the repeat rate from the first year after introduction by intensifying their marketing activities. This allows these companies to favor the trial of new drugs and to protect themselves from competitors’ products from the first year after introduction.