Socioeconomic Factors Influencing Digital TV Diffusion in Brazil

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The aim of this paper is to present an analysis of the socioeconomic factors which may affect the terrestrial Digital TV diffusion in Brazil. Such an ex ante analysis is supported by system dynamics models that represent non-linear relations influencing users' interest for this new media. The model inputs are derived from market surveys which reflect users' demand and expectations for Digital TV services. The basic model evaluates penetration of terrestrial digital TV according to the number of households with Digital TV receiver.

Although the proposed simulation model is based on Bass diffusion model, other factors influencing diffusion of digital TV were implemented, due to deployment alternatives and Brazilian socioeconomic conditions, specifically the disposable income per socioeconomic class. Furthermore, it is shown how this and other conditional variables, such as attractiveness of new services, might affect digital receiver adoption in the Brazilian society.

Keywords: Digital TV, innovation diffusion process, socioeconomic factors

1. Introduction

This paper analyzes the socioeconomic factors which may affect the DTT[2] diffusion in the Brazilian society. Such analysis, supported by diffusion models, is based on soft systems thinking (Jackson, 2000) – since the main area of concern is also related to subjective factors such as perceptions and interests – and the computational support is powered by systems dynamics. The analysis and discussions herein summed up is part of a comprehensive decision-making process which is being carried out for defining the Brazilian DTT reference model.

In the modeling process, the perspectives of all agents involved are taken into account, using, for instance, discursive methods. Such approach has been more adequate for

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[2]Digital Terrestrial Television.

dealing with complex and heterogeneous systems, whose emergent phenomena are poorly analyzed by means of reductionist methods (*cf.* Sterman, 2000).

The model presented is a Bass diffusion which has incorporated the disposable income (i.e., total income less fixed costs and expenditures with non-durable services and goods). Such socioeconomic factor has quantitative nature and is obtained from official data sources, such as PNAD (an annual national household survey) and consumer expenditure surveys.

Besides the disposable income, there is another important factor which may affect the DTT diffusion, that is the users' interest in acquiring DTT receivers. This factor is predominantly subjective, influenced by a range of qualitative aspects.

These two socioeconomic factors as well as the network effects have significant impact on the diffusion process and consequently on the demand and supply sides of the DTT value chain.

The following section focuses on the modeling process as well as on the main assumptions adopted. Special attention is dedicated to present the cause and effect diagrams related to Bass model and to the socioeconomic factors being modeled.

Income and price issues are dealt in the subsequent section, seeking to highlight how these aspects may be hindrances to the DTT diffusion in a country with huge social inequalities and low purchase power of its inhabitants.

Section four is dedicated to the sensitivity analysis of another socioeconomic factor, that is the users' interest in the services provided by the new media. The assumption that the interest has influence on the market behavior is a consequence of subjective factors which depend on new services and features, such as interactivity and portability, and are key-elements in terms of users' preferences and attitudes. In order to be used as model inputs, such factors are identified by means of qualitative and quantitative data gathered from market surveys.

Finally, some considerations are woven from the results and the analyses shown in the previous sections. In the conclusion, the authors also point out some issues which may be addressed in further studies.

2. Modeling the diffusion process

2.1 General approach

As the present modeling process is based on soft systems dynamics, the human dimension and the multiple perspectives of actors involved in the model elaboration have a great importance.

Addressed by Venix (1996), the group model building may be used to obtain a system description and a model created from perspectives of different specialists and of all agents involved. The members of such group should have diverse types of education, combined in an interdisciplinary way, in order to allow a great diversity of points of view. Moreover, the participation of different specialists contributes to “legitimate” the

parametrization of subjective factors that will be included in the dynamic simulation model.

Innovation diffusion models aim to explain the mechanisms through which an innovation is communicated over time to the members of a social system (Rogers 1995). These models are employed in analyses of consumer behavior when an innovation is introduced. According to Sterman (2000), innovation diffusion processes have the logic of an S-shaped growth: they present an exponential growth at the beginning due to a positive feedback (the spread of rumors about the new product or service), but such effect is overlapped by a negative feedback as the limits to growth approach (i.e., the potential market size).

Different approaches have been applied to predict the market behavior when new products and services are introduced. The logistic curve and the Bass diffusion model (1969) are among them.

Some studies based on the logistic approach have been conducted to investigate a new product diffusion into the market. In this sense, Van den Bulte (2000) analyzes the diffusion speed for the US market, based on the logistic modeling applied to household electronic durables.

Regarding to the logistic curve, it is observed that it overestimates the role of marketing through word of mouth, emphasizing the endogenous product propagation processes represented by a parameter which reflects an imitation factor among individuals.

It also unsatisfactorily explains a fundamental element acting on diffusion process, that is the newness (Sterman 2000, 331). The newness, which originally initiates the diffusion process, constitutes an essential factor not considered in the logistic model. Newness is related to the network effect (also known as Metcalfe's law), which states that the utility (or value) of a network increases with the square of number of users. A variation of this effect is the so-called indirect or market-mediated network externality, when the usefulness of a technology product or service for an end-user is indirectly affected by the availability of complementary products and services (Gupta *et al* 1999, 397). Both direct and indirect network effects imply that at the beginning the new product or service perceived value tends to be low. These aspects address to some extent the startup problem, in a sense that the network utility for an individual depends on the previous existence of a critical mass (Madden *et al.* 2004).

Therefore, although imitation is a fundamental process inside global diffusion process, it does not explain the startup problem, i.e., it is no longer appropriate to explain the arising of initial adopters due to a value perception. So, there is the inevitable question: how to overcome this initial difficulty to launch a new product or service.

The Bass diffusion model has been used for forecasting sales of new products and it was proposed to deal with the problem of initial adopters. This modeling approach assumes that potential adopters become aware of an innovation by means of external events, for instance, marketing efforts. Bass introduced the idea of dividing the innovation adoption rate into two factors, one endogenous, usually called “imitation factor”, and the other exogenous, commonly referred to as the “innovation factor”. The Bass model causal

loop diagram is presented in Figure 1, where B and R represent the balancing (equilibrium) and the reiforcing loops, respectively.

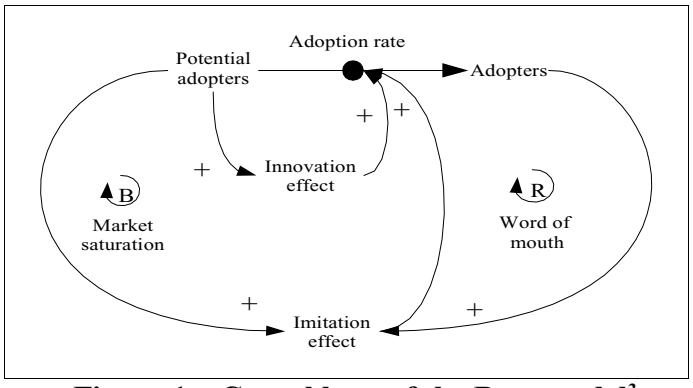

Figure 1 – Causal loop of the Bass model[3]

Some studies, measurements and analyses on product diffusion process based on the Bass model are found, for example, in (Swami and Khairnar 2003), (Talukdar *et al*. 2002), (Zabkar and Zuzel 2002) and (Gupta *et al*. 1999). Despite the fact that Bass model has been largely and successfully utilized in estimating and predicting analyses, several extensions or adaptations on its approach have been performed. Zabkar and Zuzel (2002) comment some contributions on this matter, and other authors point out analyses considering unusual changes during the diffusion process period (Bass *et al*. 1994) and the effects of marketing variables on this process (Mahajan *et al*. 1990). Another extension of the Bass model is presented in (Wright *et al*. 1997) for high technology innovations.

In a broad sense, this approach overcomes the startup problem. However it considers the market of potential adopters as a uniform social structure. While the market is homogenous and there is perceived value in a new product, the adoption will occur inexorably for all users. The adoption time of the last individual will be determined only by the diffusion speed, which depends on the diffusion Bass model parameters.

For developed countries, this presupposition is sufficiently plausible. As remembered by Talukdar *et al*. (2002), most studies about diffusion of innovation process analyze the market from developed countries. However, such hypothesis of homogenous individuals may pose some problems on the Bass model, especially when the value perceived by each user, the uncertain economic scenario and complex social networks of a developing country are considered.

In the case of developing economies, such as Brazil, the socioeconomic factors may represent powerful inhibitors not only to the acceleration of diffusion, but also to the product penetration level. In this sense, the Bass model ignores the existence of more rigid barriers to adoption of new products by population, such as low level of income per capita.

[3]Based on Sterman (2000).

In the Brazilian context, socioeconomic conditions are a fundamental issue of the market behavior, since most Brazilians belong to the most underprivileged classes.

Madden *et al.* (2004), on their studies about the growth of global mobile telephony and the economic factors affecting this growth, adopted deflated GDP series divided by population to provide per capita income series. It seems that GDP series are the most common entry data for modeling purposes of *ex post* economic phenomena. However, in Brazil, simply taking into account the GDP per capita (R$ 6,400 in 2000) would allow a large diffusion of durable goods with high prices, as DTT receivers. Such approach does not consider that, because of the high income concentration[4], the number of households which really have socioeconomic conditions of acquiring a high price good becomes relatively small. Thus, it was decided to adopt a broader factor called disposable income.

The households' average disposable income is defined as the difference between total household earned income and fixed expenses, that is, those expenditures which cannot be compressed (e.g.: food, health, education, and transport). This factor reveals not only the effects of income distribution and the consumers' purchase power but also the effects of their expenses variations.

2.2 An expanded model: theoretical and empirical issues

In order to obtain a diffusion model closer to particularities of a developing country like Brazil, this study adopts a diffusion Bass model added to the two socioeconomic factors: disposable income and interest curves.

In Brazil, one of the assumptions concerning DTT discussions is the need to reduce transition costs incurred by final users. Due to the fact that initial prices of Digital TV sets may be too high, it is supposed that the transition to DTT will occur by spreading out set-top boxes in the short and medium run. A set-top box is a device which converts digital TV and is used with an analogue TV set.

For the modeling purposes of this article, the differentiation between set-top box and digital TV sets has no significance. Only price level differentiates each other: in such a case, the set-top box price is much lower than the digital TV set. Therefore, both are referred as digital receivers.

In Figure 2, the depicted variables constitute the DTT diffusion process in Brazil. The Bass diffusion process is implicitly presented in the figure within the element called "DTT adopters (diffusion model)"[5].

[4]Brazil has one of the highest levels of income inequality in the world. Its Gini coefficient (which measures the inequality of income distribution within a country) is 0.59 (in 1999), which means that "the expected difference in income per capita between any two Brazilians chosen at random is nearly 1.2 times the average income per capita" (Ferreira *et al*. 2004, XVIII). For comparing purposes, the North American Gini coefficient is 0.45 (in 2000), which is considered a high income concentration if compared to other rich countries (Ferreira *et al*. 2004).

[5]The parameter values of the Bass model (the coefficient of innovation p and the coefficient of imitation q) used to obtain the simulation results were obtained from case studies of national durable consumer goods (like color TV sets, DVD players and cellular phones) as well as cases from other countries. For a more detailed Bass model description, see (Holanda *et al*. 2003). It is important to note that the focus of

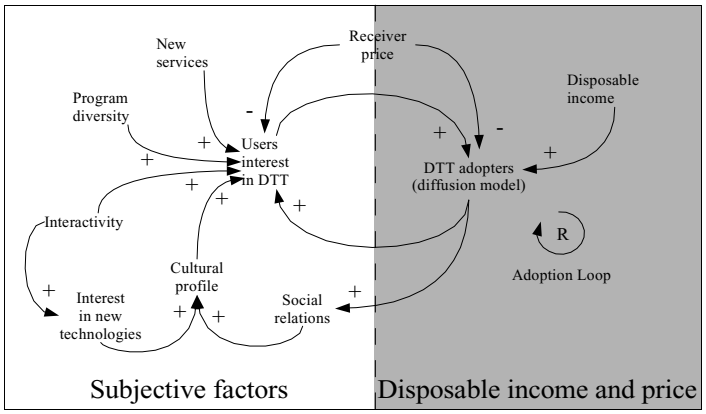

Figure 2 – Causal loop diagram of DTT diffusion in Brazil

The disposable income can be visualized in Figure 2 inside the block at right (shaded effect). While such a factor acts positively on the number of DTT potential adopters, the receiver price effect is the opposite: the higher the price, the smaller the potential consumer market is, because it reduces the number of users able to acquire the DTT receiver. Given a constant receiver price, the disposable income delimits the potential market extension, since the purchase power associated to an individual of a household is strongly dependent on this variable. It is supposed that, if the disposable income is bigger than the price or installment of a digital receiver (it can be sold in up to twelve monthly installments), the individual will be able to acquire the device. Then, this household is added to the group of potential buyers, which will be submitted to the Bass diffusion process. In case the disposable income is lower than the installment, individuals from such household have less chance of being able to acquire the digital receiver and, therefore, could not be included in the potential market.

Although the disposable income distribution is indeed assimetric, for simplicity purpose, some aleatory values of income were generated based on a normal distribution to smooth such a rigidicity. In this sense, even if the difference between the disposable income and the value of installment is negative for a group of households, part of this group would have the possibility to be considered able to buy the receiver.

The main subjective factors which may influence the DTT diffusion are also represented in Figure 2, inside the block on the left. The variable "interest in new technologies" directly measured through primary market survey[6] is used in the making of interest curves. To estimate the interest for the new functionalities offered by the digital broadcasting technology, two types of digital receivers were considered: the first one offers only basic functions, whereas the second type has interactive ones. With a return

this paper is not such parameters, but the penetration level related to the parameter m from the Bass model, which corresponds to the total number of potential buyers of a new product.

[6]The quantitative market survey was conducted in May-June 2004, based on face-to-face interview. The random sample was constituted of 3.127 respondents from all Brazilian regions and segmented into five economic classes according to Brazilian Criteria of Economic Classification of IBGE (acronym for Brazilian Institute for Geography and Statistics). The price sensitivity data were gathered by using the trade-off method. In addition, some qualitative surveys, based on focus group, were carried out in order to shed light on subjective aspects related to users' preferences and interests in new services offering.

channel, which provides a bi-directional interactivity, it is possible to offer a wider range of services and the interactive receiver will be probably commercialized with a higher price due to its greater technological complexity.

It is important to note that the interest factor consists of several subjective variables such as cultural profile and new services offering acting positively on DTT interest, as indicated by the diagram in Figure 1. Subjective variables such as cultural profile or social relations are predominantly qualitative and can be employed as determinants of the simulation output ranges.

Other hypotheses were also adopted to elaborate the dynamic simulation model, namely: total geographical coverage of digital signals, constant price during the whole period of time and nominal values of disposable income.

3. Price and income effects on diffusion[7]

The disposable income factor was integrated to the diffusion model in order to verify population income effects over digital receivers adoption. It is based on the supposition that the households' disposable income will be used for acquiring durable consumer goods.

The average disposable income data per household presented in Table 1 were estimated for each decile from the total Brazilian households. This means the households' average disposable income from the richest decile is R$ 3,402, while the value for the poorest decile is R$ -147, which means that the poorest households have no disposable income or that they receive donations in order to cover non-compressible expenses.

In fact, the disposable income data in Brazil illustrate the socioeconomic disparity among population as observed in Figure 3. When one estimates the disposable income in a given macroeconomic scenario, it is noted that the households group from the first to the fourth decile – corresponding to 40% of total households – has negative disposable income. The positive values are observed between the fifth and tenth deciles, although the fifth one is extremely low.

[7]The simulation model developed for supporting this section was implemented with the help of *I-think*® tool. For a description of such tool, see Richmond (2001).

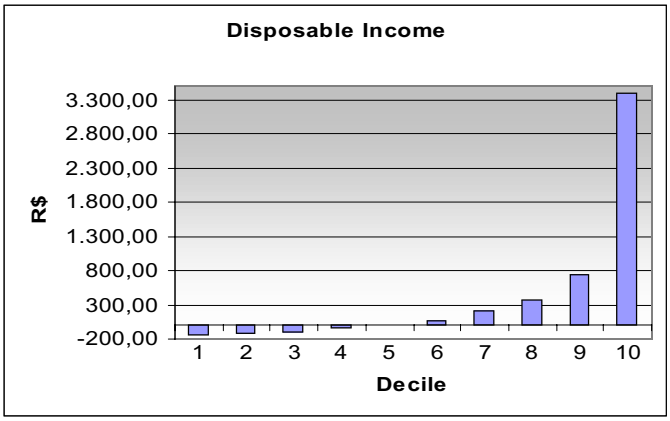

Figure 3 – Average disposable income per household (values from 2002)[8]

As the market surveys were done by classifying the population into five socioeconomic classes[9], the convertion of the households per deciles into households per socioeconomic class was needed in order to use these data as input of the dynamic simulation model. For such purpose, it is reasonable to suppose that household distribution into deciles is quite close to individual distribution per class. Moreover, the classes are also ordered according to income. Each class is made of households which may belong to different deciles, and more than one decile may constitute only one class. Therefore, the average disposable income per household for a specific class is obtained by weighing the disposable incomes according to the fraction of each decile which compose such a class. Figure 4 shows how the deciles are distributed between each socioeconomic class.

[8]Source: Tendências, 2004.

[9]In accordance with IBGE´s Criteria of Economic Classification, the Brazilian socioeconomic classes are divided according to the minimum wages quantities earned per household. A minimum wage (MW) is established by Brazilian legislation as warranty of the minimum amount earned by a worker. So the socioeconomic classes average income can be estimated as 3-5 MW for classes D and E; 5-10 MW for class C; 10-20 MW for class B; and more than 20 MW for class A.

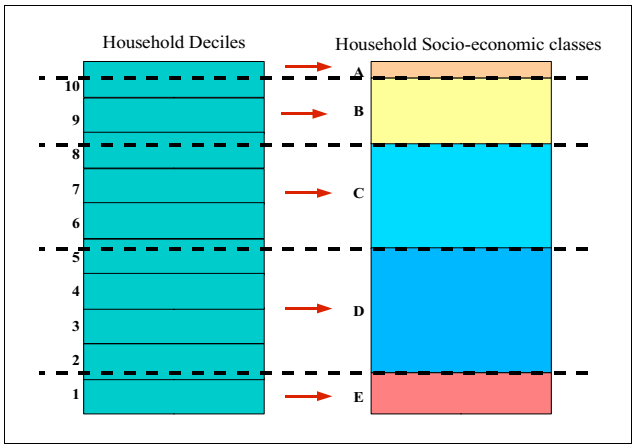

Figure 4 – Conversion of household deciles into households per socioeconomic class

Figure 5 illustrates the results of the dynamic model simulation described in Section 1. The results reveal the price variation effect over digital receiver diffusion given the average disposable income per household of each class. It is important to recall that the purchase can be on credit (pay in up to twelve monthly installments), and it is possible to have variations over the average disposable income, which make the rule of compatibility between disposable income and the value of receiver installments more flexible.

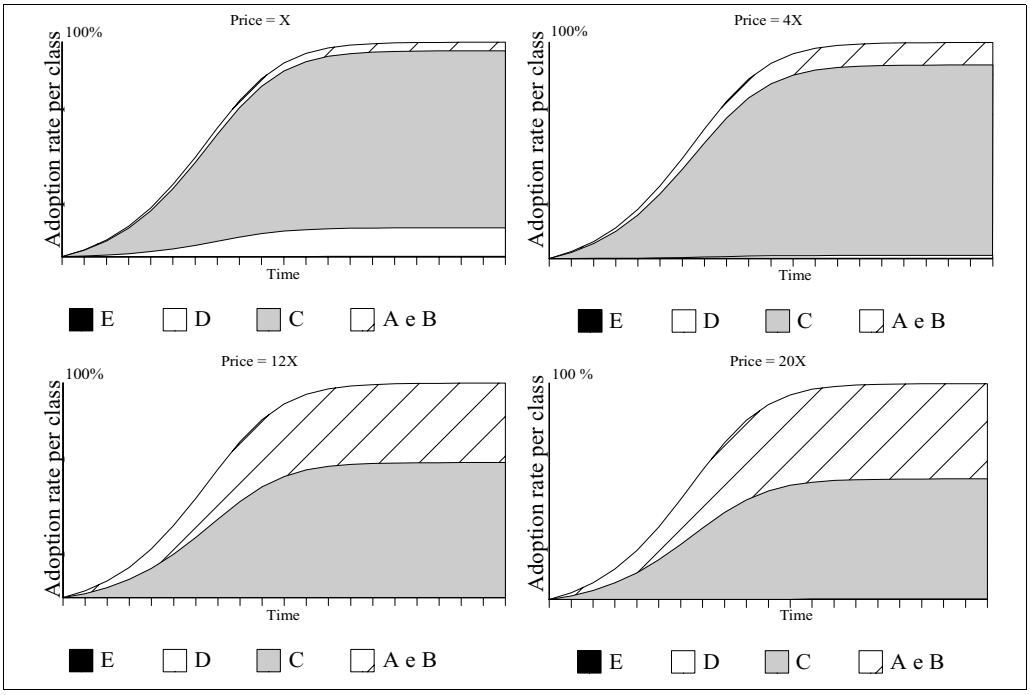

Figure 5 – DTT diffusion sensitivity for receiver price

For carrying out the sensitivity analysis four prices for the digital receiver were considered, which hypothetically vary between X and 20X. As classes A and B practically displayed the same penetration rates for any price level within this range, they were joined for simplification reasons.

Observing the curves in Figure 5, it is possible to notice that there are two groups which are not affected by price. The first group is composed by classes A and B. Up to the superior limit-price tested (20X), the digital receivers penetration rate remained unchanged. On the other extreme, there is no adoption in class E, even with a hypothetical minimum price (X).

Higher sensitivity can be noted for the diffusion process of the poorer classes. When price is X, the DTT penetration into class C households is quite close to the totality of households, whereas this parameter is less than one fifth of all households pertaining to class D.

In Figure 6, the results of the entire population are shown, with the objective of indicating the saturation levels of the digital receiver market. For this simulation inputs, the higher penetration is around fifty percent, corresponding to a price level of X.

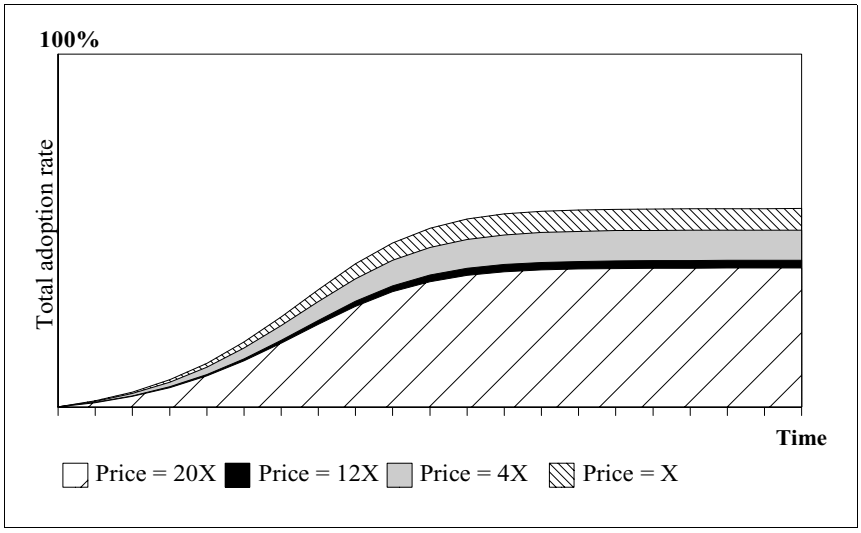

Figure 6 – Total adoption rate X price

These results illustrate how the DTT diffusion may occur in Brazil in face of socioeconomic conditions of the large majority of the population. Therefore, it is extremely important to deal with less expensive alternatives in order to foster penetration in all society segments and to bridge the digital divide. This fact emphasizes the relevance of low cost technological solutions and reveals aspects to be considered by formulating policies able to successfully promote the DTT deployment.

Another aspect that can enhance the penetration level is the users' interest in the new media, which is directly related to the platform capability of providing new services and applications as discussed in the following section.

4. Subjective effects on diffusion sensitivity: interest curve

The assumption that the interest has influence on the market behavior is the consequence of subjective factors and biases which determine the users' preferences (*cf.* Tversky and Kahneman, 1982). Such factors are identified when quantitative and qualitative primary data gathered from market surveys are analyzed. For simulation purposes, the tendencies that come from these factors are expressed in the form of interest curves, whose impacts over DTT diffusion are analyzed and discussed by taking into account the functionalities and potential services of the new digital television platform.

In order to show how interest in innovations may arise, two digital receiver options were considered: a basic receiver and an interactive receiver. The latter allows a broader array of services and will likely be produced at a higher cost due to a greater technology complexity.

Figure 7 illustrates the price sensitivity curves whose projections were based on market survey data. Price sensitivity curves were depicted for basic and interactive receivers, including payment methods as cash and on credit. Such curves express the population percentage that demonstrates interest for a services array given a receiver price.

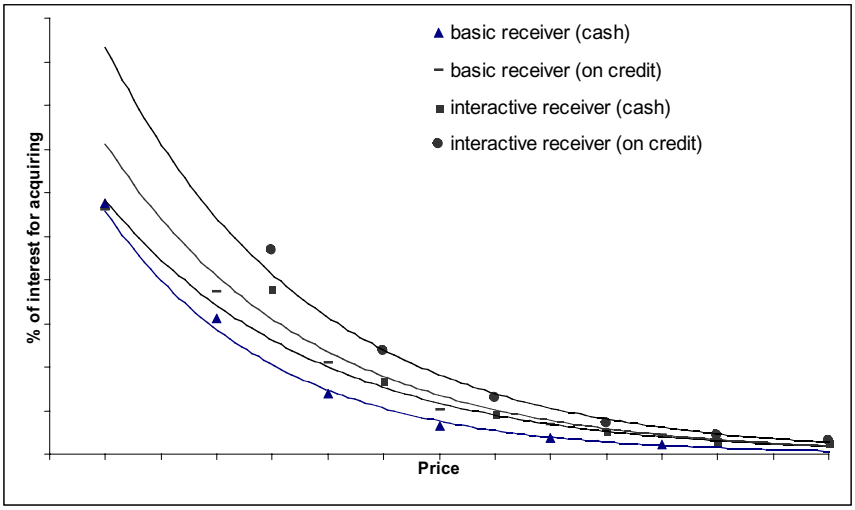

Figure 7 – Price sensitivity curves for basic and interactive receivers

Based on such curves, one may observe two conditions which enhance the interest in acquiring the digital receiver: payment on credit and interactive together. Special attention should be paid on the second condition that stimulates substantially technology acceptance. On the other hand, the difference among all curves is minimum when receivers have higher prices. Concerning the payment on credit, the positive effect is already expected (from disposable income analysis itself); nevertheless, it is a practice largely adopted in the Brazilian consumer goods market, motivated by cultural and socioeconomic reasons.

More detailed curves by socioeconomic class are shown in Figure 8, differentiating the basic receiver from the interactive one.

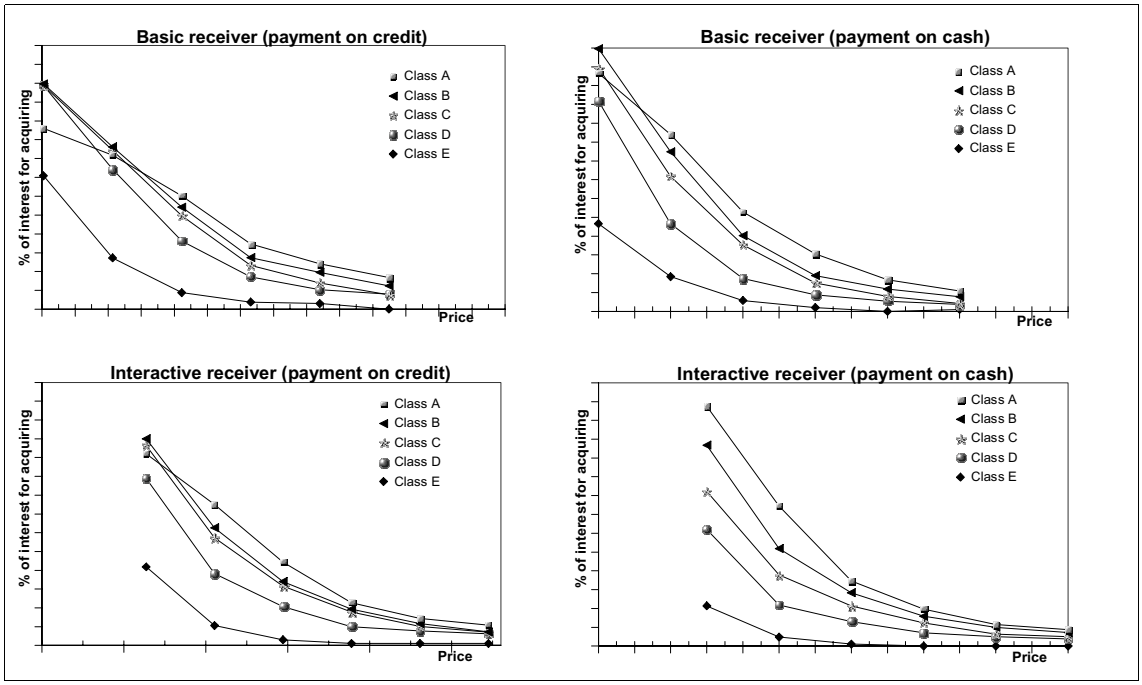

Figure 8 – Receiver price sensitivity per socioeconomic class[10]

It is possible to note in Figure 8 the relevance of the purchase on credit to D and E classes, as well as the differences regarding interest estimates among socioeconomic classes.

According to demand mapping studies[11], some of the new services and applications, such as the future possibility of choosing alternative endings of films and programs, voting via interactive applications, getting additional information and choosing different angles from the same scene, did not receive a high classification from part of the interviewees of the survey. Nonetheless, a new offer of programs and the possibility to access internet from the TV set revealed a relative high importance, as well as e-gov and services oriented towards the citizen.

Moreover, the interactivity achieves high acceptance by population. However, this evaluation is conditioned to the newness and to the program diversity, and the local interactivity does not have the same impact than the bi-directional interactivity which allows internet access. Such aspects are reflected in the interest curves (see Figure 4), highlighting that users add more value to the interactive receiver.

Beyond the interest curves, the results from market surveys also allow an evaluation on additional qualitative information and their effects over the DTT diffusion. In spite of

[10] Source: CPqD, 2004.

[11]Concluded in 2004, the demand mapping was based on market surveys to indicate the DTT interest in Brazil. Its results were internally reported in (Gerolamo *et al*., 2004).

the difficulties of working with subjective data, such information can complement the dynamic simulation model.

In short, the conclusion of the demand mapping analysis is that the greatest interest will occur when services bouquet encompasses the majority of items desired by interviewees, such as (i) the lowest receiver price possible; (ii) the provision of services towards the citizenship, which were suggested on user expectations; (iii) greater programming diversity, not only in terms of quantity of programs, but also a broader variety and a more individualized offering; and (iv) the provision of services and applications based on bi-directional interactivity, including return channel and internet navigation. However, even with such as exhaustive service bouquet, factors related to individuals, expressed by cultural profiles, affect the consumer interest.

In order to make a first approach to define the superior limit of DTT interest, it was considered the best case in terms of DTT attractiveness, that is, the interest curve of class A related to the offerings of the full service bouquet. Class A presents the best curve due to its highest interest in acquiring, with its cultural profile (as revealed by the market survey). Therefore, its interest curve is displayed in Figure 9 as being the possible global upper limit of DTT attractiveness. The supposed lower limit, in turn, is considered as the opposite side, that is, the worst case, represented by the class E interest curve to basic receiver, without more complex interactivity attributes. In such a way, these two limits establish a mold for sensitivity analysis of all others influence variables.

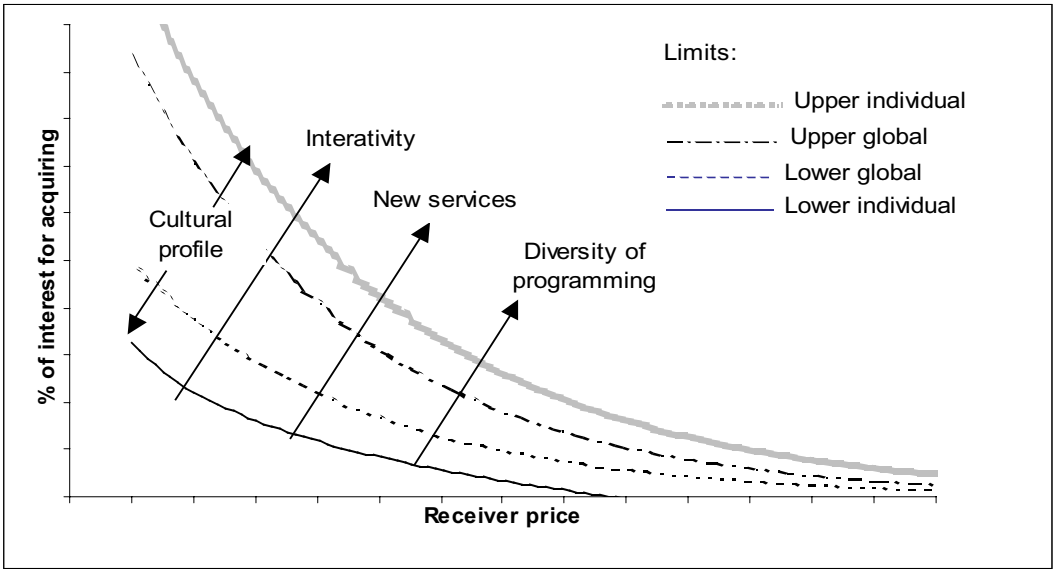

Figure 9 – Upper and lower limits for DTT penetration estimates

In cognitive terms, the reception provides different senses and values to the people who are different in terms of socioeconomic class, age, educational level and geographic distribution. By influencing attitudes and individual actions, the cultural profile leads to different interest curves given an established scenario. When the focus is on the

individual behavior, it implies a broader variety of curves if compared to the behavior of the whole population. This is the reason for the differences between limits showed in Figure 9. In spite of analytic and prospective interest concentrated on global effects, that is, the behavior of all population, individual perspective is useful to reveal counterintuitive tendencies and biases.

5. Conclusion

This paper has shown how the *ex ante* analysis of the socioeconomic factors is being considered on the definition of DTT reference model in Brazil. Such an analysis is supported by a Bass diffusion model added of two socioeconomic factors being the predictive exercise closer to Brazilian reality. The modeling process made use of systems dynamics approach and simulations were performed with real data, encompassing income projections and trend analysis from market surveys on users' demand.

Although considering the analysis is in progress, some aspects may be highlighted based on the preliminary results herein discussed. The first one refers to the receiver price in the face of high percentage of Brazilian population with low disposable income: the most underprivileged classes (classes C to E) have higher receiver price sensitivity. In this sense, the Brazilian policies may include special actions as subsidies and pricing strategies.

The second point refers to the subjective factors of DTT attractiveness. Based on market surveys, it is shown that interest curves reveal a higher attractiveness for interactive receivers in spite of their higher prices. Therefore, factors such as program diversity and new services may be important to new technology attractiveness. It is remarkable that there is a certain willingness to pay more for such services, mainly if they present interactive features. In short, it was observed that a comprehensive service offering oriented to the preferences and interests of all users' segments may be one of the best strategies to foster DTT diffusion in Brazil.

This analysis also highlights that socioeconomic factors are crucial for individuals' decision to acquire a digital receiver. Despite the difficulties of dealing with subjective data, this information can help the interpretation of the dynamic simulation results and delimit the universe of possible outputs for simplification purpose. Nevertheless, some issues related to subjective factors still demand deeper studies. Being conscientious of such a need the authors are carrying out further investigations in which the subjective factors and users' behavior modeling are taking into account by means of interdisciplinary analyses supported by agent-based simulations.

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