# When Should Nintendo Launch its Wii?
## Insights From a Bivariate Successive Generation Model

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# When should Nintendo launch its Wii?
## Insights from a bivariate successive generation model

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June 16, 2006

*Address of correspondence: Econometric Institute, Erasmus University Rotterdam, P.O.Box 1738, NL-3000 DR Rotterdam, The Netherlands, franses@few.eur.nl. The Matlab program to solve the optimization problem is reported in Table 6. We thank Jeroen Binken and Stefan Stremersch for helpful suggestions.

**Abstract**

November 2006 most likely marks the launch of Sony's PS3, the successor to PS2. Later, Nintendo is expected to launch the Wii, the successor to the GameCube. We answer the question in the title by analyzing the diffusion of the earlier generations of these consoles, and by using a new model that extends the successive-generations model of Norton and Bass (1987) by introducing two market players. Based on interviews with consumers and with retailers, we calibrate part of this model. The main outcome is that an optimal launch time is around June 2007, as then total sales of Nintendo's GameCube and Wii would get maximized.

# 1 Introduction

This paper concerns the optimal moment to launch the next generation of a product, given that the current generation still yields sales, and given that there is a competitor who also has a current generation and who has announced the date of the introduction of its own next generation. Although this issue is quite generic from a marketing strategy point of view, we illustrate our findings for the case of game consoles. We are aware of the fact that there are more than two players in this market (think of Microsoft Xbox 360), but in this paper we only focus on the game consoles of Sony and Nintendo.[1]

November 2006 marks the launch of Sony's PlayStation 3 (PS3), the successor to the PlayStation 2 (PS2). Nintendo is expected to launch the Wii (Revolution), the successor to GameCube, but at the time of writing, June 2006, it is unknown when it would do so. For sure, the launch of Wii will not occur before November 2006, and it will most likely occur in 2007 or even later. Both current generation products have been and still are very successful, and it is expected that both next generation products will be too. The consoles rely on their own games, although there is overlap in titles and in type of games. Hence, both current and future products can be viewed as serious competitors.

[1]Microsoft just recently launched Xbox 360, and in this study we assume that adopters of this recent product do not already switch to new generations of Sony and Nintendo and that adopters of current generations of Sony and Nintendo products do not switch to Xbox 360 after the newest generations of these two appear in the market. Both assumptions seem very plausible.

At first one may think that as the question in the title is a very simple one, the answer should be simple too. In this paper we will show that the literature on the optimal moment to launch a new generation product is scattered and shows various restrictions. For example, many studies consider the case of a monopoly, hence the absence of competition. In Section 2 of our paper, where we look at the various strands of literature, we argue that the results of these monopoly studies cannot immediately be extended to the case of two market players. One reason is that it leads to the suggestion to introduce the second generation at the same time as the first one, which, of course, in a product category like game consoles is impossible. A second strand of literature, on optimal introduction timing, concerns the case where the product has never been on the market before, and hence, the product is completely new. Again, for game consoles, and we believe for many product categories, this situation does not hold. For game consoles, all individuals involved in gaming know what one can do with these products, and numerous web sites give ample information on all aspects of these products. A third strand of literature proposes mathematical models that can be solved in order to get a prediction of the optimal timing. The key problems with these models are that one needs to know many parameter values in advance, and that the models are extremely complicated to analyze.

In this paper we try to meet these problems by proposing a simple model, with a small number of parameters, which can be used to cases where the evolution of products is already in its second or third (or more) generation, and where there are two players. Our model can simply be extended to three or more players, but for the sake of convenience (and also as our illustration does not seem to depend on it) we stick to the two-player case. Our model extends the familiar successive-generation model of Norton and Bass (1987) to the case of two competitors. The extension is kept at a basic level, and further extensions can of course be proposed but are not considered here. We discuss the details of this model in Section 3. The model is plugged into an optimization problem, where, given a certain planning horizon, total sales of the two generations or new sales of the second generation can be maximized. Our multi-player diffusion model allows the generation buyers from player A to switch to the next generation of player B, and vice versa. These parameters cannot be estimated using actual sales data, whereas the basic diffusion parameters can, so we have to rely on interviews with experts. We show that in case of two players there are only 4 parameters that one needs to retrieve this way, and that this retrieval can be based on a simple questionnaire. In the first part of Section 3 we write down the mathematical expressions of our new diffusion model, whereas in the second part we illustrate the model for synthetic data. This illustration demonstrates the merits of our simple model.

In Section 4 we consider our two-player diffusion model for the case of Wii versus PS3. First, we review a few facts for the game-console industry. At the time of writing, world-wide sales data on the GameCube and PS2 data are available, and we display these in *Table 1.* We show that the underlying shape of the diffusion can simply be estimated using a basic Bass (1969) model. Next, we report on our interviews with 16 experts, 4 of which are retailers and 12 are consumers who are self-stated hardcore gamers and hence we treat them as experts. Interestingly, the opinions of the consumers are much more coherent. So, even though we show what the various survey results imply for the optimal timing, we take those of the consumers as most important. Also, we show that the planning horizon is crucial in the computations. When we rely on the Bass-based estimation results, on the consumers' opinions and on a planning horizon of 2020, we derive that the optimal timing to launch Wii is June 2007.

Section 5 concludes this paper with a discussion of the potential limitations of our model and of our optimization approach. Next, it outlines various areas for further research.

## 2 Literature Review

The academic literature about optimal timing is scattered and it shows some restrictions and puzzling views. For example, planned obsolescence research and industrial organization literature have dealt with monopolies and cartels behavior and both research streams suggest that firms have strong incentives to sell products with shorter than socially desirable lives. This entails that it seems beneficial not to launch the next version of a product simultaneously with the previous one, and not to launch the next version after the market has cleared. However, rivalry might force firms to increase products' lives and to delay the introduction of new products. Hence, in economics, many studies have centered around the question whether firms have incentives to sell products with shorter than socially desirable lives and around the question when it is optimal for a firm to adopt a new technology of production in a competitive environment[2], see Waldman (1993), Bulow (1986), Lee and Lee (1998), Fishman et al. (1993) and Swan (1972).

The question regarding the timing of innovations, nonetheless, has been addressed directly by economists. Scholars in economics have examined whether it is optimal for firms to adopt an innovation at the same time or at a different date than competitors, and whether it is optimal for a firm to launch as soon as possible or delay the launching of a new product. Scherer (1967) and Barzel (1968) were among the first to pay attention to innovations' introduction time. Scherer (1967) suggested that, under rivalry, a firm's strategic equilibrium is to introduce new products at the same time as its competitors. Meanwhile, Barzel (1968) argued that firms' managers will have strong incentives to adopt or launch an innovation as soon as possible due to competition. Not in line with them, Reinganum (1981) found that firms under rivalry should adopt an innovation at different dates in order to maximize profits. Only for the case that Reinganum (1981) calls "degenerate", in which the costs of delaying adoption are much greater than the benefits of delaying, firms should launch or adopt as soon as possible regardless of their competitors' strategies. Similar to Reinganum (1981), Fudenberg and Tirole (1985) concluded that oligopoly firms' strategic equilibrium is to

[2]The second question is particularly interesting given that it is analogous to our research problem. Most studies in economics have examined the following context: A firm has a current production technology and it should decide when to adopt a new technology given its current and future profits stream, the cost of adopting and the threat of competitors' earlier adoption of a better technology. Similarly, we are interested in the context in which a firm is selling a product in the market and it should decide when to launch a new product given its current and future profits' stream and the threat of earlier products' launch of competitors.

adopt or launch an innovation at different dates. However, if an innovation is advantageous only when competitors have not adopted, Fudenberg and Tirole (1985) argued that firms' incentives will lead them to adopt at the same time and as soon as possible. Finally, Kamien and Schwartz (1972) argued that increased competition might lead to either earlier or delayed innovation adoption depending on product similarity between competitors, the probability of competitors' entrance and the costs structure of firms. All these findings are important but might not hold in the context in which we are interested. One of the reasons is that most scholars assumed linear demand functions and consequently they left aside the typical S-shaped diffusion that match the well known product life cycle encountered almost everywhere.

## 2.1 Monopoly

To our knowledge, only Wilson and Norton (1989) and Mahajan and Muller (1996) have studied when it is optimal to launch multi-generation products. They are the only scholars who have developed a theoretical model, which in both cases is based on Norton and Bass (1987). Both Wilson and Norton (1989) and Mahajan and Muller (1996) examine the case of a monopoly producing a sequence of new products. According to Wilson and Norton (1989), there are three critical issues which affect the optimal introduction time of a new generation. These are the interrelationship of sales of the two products, their profit margins and the planning horizon. Surprisingly, their model provides two optimal solutions regardless of the relevance of these factors. They conclude that different versions of a product should be introduced either all at the same time or sequentially (not overlapping). Moreover, the behavioral premises proposed by Wilson and Norton (1989) do not exactly resemble the premises proposed by Bass (1969) as their model includes a non-linear information function to describe consumer behavior.

In a similar vein, Mahajan and Muller (1996) conclude that a new product's generation should be introduced as soon as it is available or it should be delayed to a much later stage, that is, to the maturity of the previous generation. They further argue that a new generation should be introduced simultaneously with the preceding one only if the market potential of the latter is large. Otherwise, a new generation should be introduced when the maximum profits of the previous generation are almost reached, a stage that they call maturity. The model of Mahajan and Muller (1996) is composed of four equations and 30 parameters and to simplify it they assume that innovation and imitation become slightly better from one generation to the next one.

Important facts to notice both in Wilson and Norton (1989) and Mahajan and Muller (1996) are that they propose to introduce the next generation of a product either at $T = 0$, delay it permanently to $T = \infty$, or to launch only when the first product version cumulative sales $S_1(t)$ almost reach a maximum. Second, their findings are only special cases of the timing strategies studied by Fudenberg and Tirole (1985), Reinganum (1981) and Kamien and Schwartz (1972). For example, Kamien and Schwartz (1972) found that $T = 0$ is optimal only if firms need to take advantage of a profit stream that would be smaller once competitors come in and $T = \infty$ is optimal only under extreme rivalry between firms. More recently, Cohen et al. (1996), Radas and Shugan (1998) and Savin and Terwiesch (2005) proposed different views and incorporated competition in their studies. Nevertheless, these later authors' theoretical models are extremely difficult to analyze, depend on many parameters or do not describe S-shaped sales paths that are typically observed in practice.

## 2.2 When you are first to launch

The optimal introduction time depends mostly on the degree of substitution and the relation between different generations. Peterson and Mahajan (1978) proposed four possible interactions between innovations, that is, they can be independent, complementary, contingent or be substitutes. They provided the following examples; that is, housing and electric trash compactors as independent products, washers and dryers as complements, computer software and hardware as contingent, and finally color television and black and white television as substitutes. Furthermore, products' introduction times might as well depend on firms' objectives like to replace a product, to sell a line extension or to offer upgrades, see Purohit (1994).

We have little knowledge about how products' interactions and firm objectives affect products' launch time and the outcomes of products' entry timing, but for the single generation case they have been documented extensively in marketing literature. However, there is still no consensus if early timing leads to higher profits and firms' survival or not, see Shankar et al. (1998), Shankar et al. (1999), Krishnan et al. (2000), Lehmann and Pae (2003) ,Bridges et al. (1993), Morgan et al. (2001), Golder and Tellis (1993), Golder and Tellis (1997) and Mitra and Golder (2002). And again, for game consoles, and we believe for many product categories, the context studied by this literature strand does not hold.

## 2.3 Mathematical Models

The basic model of diffusion of new products was proposed by Bass (1969) and it has been extensively studied in a wide variety of applications and contexts, see Boswijk and Franses (2005), Danaher et al. (2001) for some examples and properties of this model, or Mahajan et al. (1990) and Mahajan and Peterson (1985) for reviews of diffusion models. Later on, Norton and Bass (1987) extended the Bass model to allow for diffusion and substitution between a sequence of new products. In addition, Norton and Bass (1992) forecasted quite accurately the sales path of several sequences of new products and called *the Law of Capture* to the substitution dynamics between generations of products described by their model.

Scholars have applied the Norton and Bass model, or similar extensions of the Bass model, to study several characteristics of multi-generation products. Padmanabhan and Bass (1993) and Bayus (1992) proposed models to price successive generations of products, Danaher et al. (2001) analyzed the relation between marketing mix and diffusion of multi-generation products, Bucklin and Sengupta (1993) examined the diffusion of complementary innovations, Kim et al. (2001), Chatterjee and Eliashberg (1990), Kim and Srinivasan (2001), Jun and Park (1999), Vakratsas and Bass (2002) and Bayus (1991) studied how and when consumers decide to upgrade to improved products' versions, Islam and Meade (2000), Islam and Meade (1997) and Olson and Joi (1985) proposed models for diffusion and replacement of products, Purohit (1994), Robertson et al. (1995) and Prasad et al. (2004)

analyzed the introduction strategies of multi-generations products or the release of single products in multiple channels. Finally, Kim et al. (2000), Kim and Lee (2005), Peterson and Mahajan (1978) and Islam and Meade (1997) presented alternative diffusion models for successive generations of products.

Hence, the Norton and Bass (1987) model is still in use today to describe and forecast the sales patterns of newer versions of products. This model includes the moment of the introduction of a new generation as a parameter.

One would think that solving the Norton and Bass (1987) model with respect to this parameter could lead to insights into the optimal timing of introduction. Surprisingly, the results are twofold. The first is that generation N+1 must be introduced at the same time as generation N. The second insight is that N+1 must be introduced by the time all potential adopters have purchased a product of generation N. We will demonstrate this result as follows.

In the model of Norton and Bass (1987), sales are proportional to the cumulative distribution function of the adoption rate $F(t)$ and the market potential $m$. When a second generation is introduced, substitution and adoption effects should be added to the previous equation. For the case of two generations, they posit that the fist generation follows

$$S_1(t) = m_1 F_1(t)[1 - F_2(t_2 - \tau_2)], \text{ for } t > 0, \tag{1}$$

and that the second generation follows

$$S_2(t) = F_2(t - \tau_2)[m_2 + F_1(t)m_1], \text{ for t>}\tau_2 \tag{2}$$

That is, after the second generation has been introduced at time $\tau_2$, the first generation's sales $S_1(t)$ become proportional to its cumulative adoption function $F_1(t)$, its market potential $m_1$, and the sales not captured by the second generation [1 - $F_2(t_2$-$\tau_2)$] after $\tau_2$. The sales of the second generation $S_2(t)$ are proportional to their own market potential $m_2$ and to the cumulative sales of the first generation $F_1(t)m_1$ after $\tau_2$. $F_i$ is the cumulative sales function of generation $i$ as proposed by Bass (1969). Therefore, $F_i = [1 - e^{-b_i t}/1 + a_i e^{-b_i(t)}]$ and $a_i$=$q_i/p_i$ and $b_i = p_i + q_i$. It is not difficult to derive that $\partial(S_1(t) + S_2(t))/\partial\tau_2 = 0$ is obtained when $\tau_2 = 0$ or $\tau_2 = \infty$. Hence, the basic Norton and Bass (1987) model is not helpful to find the optimal time to introduce the next generation.

Our literature review indicates that there are various studies in optimal timing of a new generation. However, these studies all take perspective or adopt assumptions that are not relevant for our situation. Hence, to describe the process of two competitors launching next generations of roughly the same product, and to understand what could be the best moment to launch a new generation, we are in need of a new model. This model will be proposed in the next section.

## 3 A new successive-generations model for two market players

As the Norton and Bass (1987) provides a natural starting point, our first task is to expand it to a multi-player context, where here the market is composed by two firms. Each firm is assumed to launch over time two generations of a new technological product. Our second task is to show, with this new model, how each firm attempts to maximize its market share and sales, or any other similar objective, given the observed behavior of its competitor.

Before introducing our multi-player model, it is important to look more closely at the two generations case proposed by Norton and Bass (1987). If equation (1) would contain only the term $m_1 F_1(t)$, then the sales $S_1(t)$ will be equivalent to the model of Bass (1969). However, Norton and Bass multiply the term $m_1 F_1(t)$ with $[1 - F_2(t - \tau_2)]$, so that a fraction $F_2(t - \tau_2)$ of $m_1 F_1(t)$ could be captured by the second generation. Consequently, there could be a moment in time when $F_2(t - \tau_2)$ will become 1 and all of the first generation sales will be captured by the second generation and $S_1(t) = 0$.

Additionally, Norton and Bass (1987) design their model such that the sales lost by the first generation are all transferred to the second generation by adding $F_2(t)F_1(t)m_1$ to the sales of the second version, that is $m_2 F_2(t)$, and therefore $S_2(t) = m_2 F_2(t) + F_2(t)F_1(t)m_1$, that is equation (2). Hence, the Norton and Bass (1987) model is a very simple and elegant model that allows diffusion and substitution between two generations of the same product. Nevertheless, they restrict their model to the case of a single firm or single product case, whereas we have two players.

## 3.1 Our model

In order to expand the Norton and Bass (1987) model and add a second firm or a second competing product, we should make assumptions about the relationship between different firms' products. If we believe that the relation between two generations of the same product as in the model proposed by Norton and Bass also holds between competing products, then a product not only loses sales that go to its newer version but it also loses sales that go to the current and future versions of competitors' products. Therefore, we stick to the relationship between two generations of the same product as in the Norton and Bass model, but additionally, we will assume that the sales that go from one product to its competitors' versions are proportional to the cumulative sales function of its competitor's products.

Formally, if the market is composed by *two* firms $a$ and $b$, the sales of firm $a$ are

$$S_1^a(t) = \tilde{S}_1^a(t)[1 - \alpha_a F_1^b(t)][1 - \phi_a F_2^b(t)] \tag{3}$$

and

$$S_2^a(t) = \tilde{S}_2^a(t)[1 - \beta_a F_1^b(t)][1 - \gamma_a F_2^b(t)] \tag{4}$$

The sales of firm $b$ are

$$S_1^b(t) = \tilde{S}_1^b(t)[1 - \alpha_b F_1^a(t)][1 - \phi_b F_2^a(t)] \tag{5}$$

and

$$S_2^b(t) = \tilde{S}_2^b(t)[1 - \beta_b F_1^a(t)][1 - \gamma_b F_2^a(t)] \tag{6}$$

where $\tilde{S}_1^j$ and $\tilde{S}_2^j$ are defined as

$$\tilde{S}_1^j = m_1^j F_1^j(t)[1 - F_2^j(t - \tau_2)] \text{ for } j = a \text{ or } b \tag{7}$$

and

$$\tilde{S}_2^j = F_2^j(t-\tau_2)[m_2^j + F_1^j(t)m_1^j] \text{ for } j = a \text{ or } b \tag{8}$$

As in the basic Bass model, we have that

$$F_i^j(t) = [1 - e^{-b_i(t-\tau_i^j)}/1 + a_i e^{-b_i(t-\tau_i^j)}] \times I(\tau_i^j > t) \text{ for } t > 0 \tag{9}$$

where $a_i = q_i/p_i$ and $b_i = p_i + q_i$ and $I(\tau_i^j > t)$ is an indicator function that equals one when the introduction time of generation $i$ of firm $j$, $\tau_i^j$, is larger than $t$ and zero otherwise. The parameters $p_i$ and $q_i$ are the innovation and imitation parameters of generation $i$, respectively.

Equations (3) to (9) allow for a wide variety of relationships given the sign and size of the parameters $\alpha_j$, $\beta_j$, $\phi_j$ and $\gamma_j$ for $j = a, b$. For example, if all parameters are negative, it means that competition deters sales instead of increasing them. Another case is that all parameters are positive and that would mean that competing products complement each other, and that total sales increase when a new product is introduced in the market. Another interesting case is given when a firm's product is superior to the competitor's products. In this case, one firm would have the equations with positive parameters and the competing firm faces negative parameters. More complex relationships might arise depending on the sign and size of $\alpha_j$, $\beta_j$, $\phi_j$ and $\gamma_j$. Finally, our formulation could allow for the case of a radical innovation in the market as it could allow one of the products to absorb all the existing products' sales. More detailed illustrative examples follow next.

## 3.2 An illustration of the use of our model for synthetic data

The model in (3) to (9) can be plugged into an optimization routine that can maximize some objective function for values of introduction time. In our case we have information on the introduction time of one of the players and we aim to derive the optimal introduction time of the second player.

Given that $\alpha_j$, $\beta_j$, $\phi_j$ and $\gamma_j$ define the relationship between competing generations of products, it is possible to find the optimal time when a firm should launch the next generation product. For example, if a firm produces inferior products and the launch of a competitor's product will reduce its sales, then there should be a timing strategy that maximizes its market share. Or, in the opposite case, if a competitor's product might enhance a firm's sales then there should be a timing strategy that could maximize its sales. The timing strategy depends heavily on the relationship between competing generations of products, their launch time and on firms' planning horizon.

An objective function for the case of PS3 and Wii could be defined as follows. The optimal launch times for firm $b$ given firm $a$ launch times $\tau_1^a$ and $\tau_2^a$ are the times $\tau_1^b$ and $\tau_2^b$ that maximize $S_1^b(t)$ and $S_2^b(t)$.[3] Formally we can state that given a planning horizon $T^p$, these dates are found from

$$\tau_1^b = \arg\max_{\tau_1^b}\{S_1^b(T^p)\} \tag{10}$$

[3]In our model, as in the Norton and Bass model, the first generation is completely replaced by the second generation, that is $S_1^b(t) \to 0$ if $t \to \infty$. Therefore, we maximize the peak of $S_1^b(t)$ and not $S_1^b(t)$ directly in any objective function.

and

$$\tau_2^b = \arg\max_{\tau_2^b}\{S_2^b(T^p)\} \tag{11}$$

A second function might be to find the optimal introduction times $\tau_1^b$ and $\tau_2^b$ that maximize the market share of firm's $b$ products, that is

$$\tau_1^b = \arg\max_{\tau_1^b}\{S_1^b(T^p)/(S_1^b(T^p) + S_1^a(T^p))\} \tag{12}$$

and

$$\tau_2^b = \arg\max_{\tau_2^b}\{S_2^b(T^p)/(S_2^b(T^p) + S_2^a(T^p))\} \tag{13}$$

A third alternative could be to find the optimal introduction time for either the first or second generation such that we will maximize the sales of both generations. That is,

$$\tau_1^b = \arg\max_{\tau_1^b}\{S_1^b(T^p) + S_2^b(T^p)\} \tag{14}$$

and

$$\tau_2^b = \arg\max_{\tau_2^b}\{S_1^b(T^p) + S_2^b(T^p)\} \tag{15}$$

To illustrate the use of our model and the consequences of choosing an objective function, in this case function (13), we will assume $T^p = 7$ years (84 months), $m_1^a = m_1^b = 400$, $m_2^a = m_2^b = 500$, $p_i = 0.025$ and $q_i = 0.15$ for all $i$, $\alpha_a = 0.2$, $\beta_a = 0.2$, $\phi_a = 0.1$ and $\gamma_a = 0.1$, while $\alpha_b$, $\beta_b$, $\phi_b$, $\gamma_b$ are the same size as for firm $a$ but negative. This makes the generations of firm $b$ superior to the ones of firm $a$. If both firms launch their products at the same time, say their first generation at time 0 and their second generation at time 12, then the market share of the first and second generations of firm $b$ would be

59% and 62%, respectively. *Figure 1* depicts the adoption trajectories of all four products for these two launch times.

As a second case, if it is known that firm $a$ products will be launched at time 0 and 12, then firm $b$ could maximize its market share, equation (13), by setting the second generation launch time equal to 20. This strategy would yield a market share of 67% and 65% for firm's $b$ first and second generations. *Figure 2* illustrates the adoption trajectories of all four products for this second case. We can see that in *Figure 2* the sales of the second generation of firm $b$ almost reaches 1300 units, while in *Figure 1* they are shown to reach a level lower than 1100 units. It is also important to notice that the launching time of the second generation of $b$ occurs later than the second generation of $a$. That is, launching a superior product after the introduction of a competitor's product does not necessarily give a lower market share.

As a third illustration, in *Figure 3* we depict the sales patterns of the four generations given that the second generation of firm $b$ is a radical innovation. In this case, $\gamma_b = -1$ and $\gamma_a = 1$. Therefore, the second generation of firm $b$ absorbs all sales of the second generation of $a$ and eventually of all products in the market, approximately 1900 units. This number closely corresponds to the sum of the market potential for each product.

These calculations for synthetic data show that a wide variety of sales patterns possible and that the key parameters are $\alpha_j$, $\beta_j$, $\phi_j$ and $\gamma_j$. Also, as we will show in our empirical section below, the planning horizon is important.

# 4 Optimal Launch Time for Wii

In this section we will analyze the video game industry and we will suggest the optimal launch time for a video game console not yet launched, Nintendo's Wii. First we review a few industry facts and next we calibrate our model for a few parameters configurations, where some parameters are obtained through interviews. With these, and an objective function, we derive the optimal time for launching Wii.

## 4.1 Facts

Three important players in the video game console industry are Sony, Nintendo and Microsoft. Console refers to non-pc hardware used to play video games. All three companies launched several video game consoles in the last decade and in 2006, a new product is being introduced. Microsoft is relatively new in the industry because its first console was launched in 2000. However, Sony and Nintendo have been in the business for longer. Nintendo launched its first console in 1983, while Sony's most popular console, the PlayStation, was launched in the mid nineties. The new console of Sony, PlayStation 3, is announced to be launched in November 2006, that is one year after Microsoft launched its latest console, the Xbox 360.

Nintendo is one of the earliest founded companies in the console industry and at the time of writing we do not have information about the launch date of its newest console, the Nintendo Wii. The planning context for Nintendo's management is very interesting given that the main player in the industry, Sony, has announced to launch its latest console in November 2006 and although this data may shift we stick to it in the present version of this paper. In case the date would change, we can easily adapt our computations. In the meantime Microsoft Xbox 360 could reach its peak sales this or next year.

## 4.2 Illustration of our model

Sony launched PlayStation 2 in October 2000 and the company's management is planning to launch PlayStation 3 six years later, in November 2006. Nintendo's GameCube was launched in November 2001 and there have been no announcements about the launch date for its latest console Nintendo Wii. Up to 2005, Sony has sold 52.1 million PS2 consoles in the United States and Japan and this product is in the later stages of diffusion, see *Table 1.* The sales of PS2 have been decreasing since 2002. Meanwhile, Nintendo GameCube sales in the United States and Japan are about 23.7 million consoles and its sales have been decreasing since 2003.

We estimate a Bass model for the current generation of Xbox, GameCube and PS2. Our findings, given in *Table 5*, suggest that the innovation ($p$) and imitation ($q$) parameters in this industry are on average 0.18 and 0.60, respectively.

In our multi-player model we will set the innovation and imitation parameters equal to 0.18 and 0.60. The market potential for PS2 and GameCube will be set at 33 and 13 million, respectively.[4]. For the sake of convenience we assume that these parameters stay constant across generations. While the

[4]We experimented with other parameters

market potential for the next generation of the Sony and Nintendo consoles will be assumed to be 35 and 15 million, respectively.[5] The known launch dates are October 2000 for PS2, November 2001 for Nintendo's GameCube and November 2006 for PS3.

The next important step is to obtain estimates of the competitive parameters $\alpha_j$, $\beta_j$, $\phi_j$ and $\gamma_j$ or loyalty. Hence, we asked a group of twelve self-stated hardcore gamers to answer a short survey about video game consoles in which they had to suggest or predict the size of $\alpha$, $\phi$ $\beta$, and $\gamma$. The survey questions are given in *Figure 4*. We also visited four shops in Rotterdam's City Center and we asked sales people to answer the same survey based on their knowledge. The competitive parameters $\alpha_j$, $\beta_j$, $\phi_j$ and $\gamma_j$ should be interpreted as the maximum percentage of sales that are transferred from one product to its competitors.

### 4.3 Launching Wii

We will discuss three scenarios. In the first we will assume that the loyalty parameters are the average of consumers' predictions. In the second and third scenarios we will consider the answers of sales people. To begin with the consumers' scenario we will assume that $\alpha_N = -0.05$, $\phi_N = -0.21$, $\beta_N = -0.06$ and $\gamma_N = 0.29$ as these are the average values, see *Table 2* for all answers and *Table 4* for a summary.

[5] We choose these market potentials only for illustration purposes and they will remain the same across all scenarios. Choosing different market potentials will change only our scenarios' total sales while the optimal introduction time, for most scenarios, will remain roughly the same.

If the parameters in *Table 4* are positive it means that Nintendo is losing sales to Sony or that the loyalty to Nintendo is low. If the parameters are negative, it means that Nintendo loyalty is high and that it is receiving sales from Sony. For example, the average reported for $\gamma$ in *Table 4* is 0.29 and this is the average of consumers' answers to question $b$ of our survey, see *Figure 4*. Question $b$ asks what would be the percentage of sales that GameCube would gain or lose to Sony PS3, if PS3 is introduced in November 2006. All consumers answered that the sales of Gamecube will remain the same or decrease, so the parameter should be positive, and they think that this decrease will be, on average, of 0.29 percent. As we can see, consumers believe that the loyalty parameters should favor Nintendo in most of the parameters except for $\gamma_N = 0.29$. This positive $\gamma_N$ implies that Nintendo needs to launch Wii or Sony PS3 will get some proportion of the customers of GameCube as there is no newer model for Nintendo's customers to upgrade. Finally, we will assume that Sony's loyalty's parameters are of the same size as Nintendo's but with opposite sign.

To find the optimal launch time for Wii, we assume that Nintendo maximizes the sales of both GameCube and Wii, that is we assume Nintendo maximizes the objective function (15). Given a long-term planning horizon $T^p =$ Dec 2020, we consider:

$$\tau_2^b = \arg\max_{\tau_2^b} \{S_1^b(T^p) + S_2^b(T^p)\} \tag{16}$$

Given the consumers based estimates, our model indicates that the optimal launch time for Nintendo Wii is June 2007. This launch time yields total sales of 48 million consoles, that is 12.3 million for GameCube and 35.9 million for Wii. In *Figure 5*, we depict the total sales that Nintendo could achieve given different introduction times for Wii. As we can notice, the function is an inverted $U$ shape and it reaches a maximum in June 2007.

### 4.4 Other scenarios

We also interviewed retailers at specialized video game stores. The data is given in *Table 3*. The sales person of MediaMarkt predicts that $\alpha_N = 0.0, \phi_N = -0.40, \beta_N = 0.0$ and $\gamma_N = 0.70$. With this scenario Wii optimal launch time is November 2006. By launching in November this year, Nintendo's total sales will be 50.8 million consoles, that is 11.6 million for GameCube and 39.2 million for Wii. And, if we were to use the answers of Dynabyte's salesman we will get October 2007 as the optimal introduction time for Wii. This latter scenario's assumptions are that $\alpha_N = 0.0, \phi_N = 0.0, \beta_N = 0.0$ and $\gamma_N = 0.20$ and its optimal time is close to the June 2007 introduction time implied by consumers' loyalty parameters.

It is clear that scenarios' outcomes depend on the relation between different generations of products. They also depend on the planning horizon. For all computations so far we assumed that the planning horizon is rather distant in the future. However, the shape of the profit function will change if the planning horizon would be shorter and if firm $b$ would aim to maximize diffusion in the shorter run. In *Figure 6* we graph the profit function for the long and short term planning horizons $T^p$ = Dec 2020 and $T^p$ = Dec 2012 using consumers' parameters again. We chose 2012 with the purpose of resembling what could be the planning horizon of video game producers. For example, Sony is planning to introduce its newer console six years after the previous generation, and therefore, 2012 is a quite reasonable choice for $T_p$. As we can see, the profit function convexity for 2012 is greater and it decays faster than for the long term planning horizon scenario. Given this shorter planning horizon the optimal time to launch Wii is July 2006, which at the time of writing seems unlikely. In *Figure 7* we depict this latter scenario and in *Figure 8* we depict the original scenario with $T_p = 2020$ and June 2007 as optimal introduction time.

# 5 Discussion

In this paper we introduced a model for two competitors who sequentially launch new generations of their products, which amounts to an extension of the well-known Norton and Bass (1987) model. The model contains parameters that can be estimated from actual sales data, but it also contains parameters that need to be calibrated based on interviews with experts. We show that the model can be embedded into an optimization routine, which delivers the optimal timing of introducing new generations. We apply the model and this routine of the real-life case of the optimal moment to launch Nintendo's Wii, and show that the empirical results suggest that around June 2007 should be optimal.

A limitation of our study is that we did not take the networks effects literature into account. This literature predicts that one would only launch a hardware technology later if this would only give superior intrinsic hardware capabilities. (assuming upgrades/add-on's are not an option). Indirect network effects (software/complements/role of independent software providers) are however considered as the main element regarding consumer utility/adoption in hardware-software markets. Indeed, why would a consumer adopt the hardware, if he/she does not also adopt the software? Consumers are supposed to maximize their utility of the system and not just the hardware. Further work should be directed to include such effects in our bivariate successive-generations model.

Our model can be extended in various ways, where we mention the inclusion of more than two market players and more than two next generations. Also, our model abstains from including software sales, and given that hardware and software diffusion interact, a further extension of our model can include software. Finally, the estimate of the optimal launch date of a next generation does not yet come with standard errors, and it would be interesting to derive these as well. Moreover, the model parameters are now based on just a small amount of interviews, and more information could increase precision of the estimates. Further applications of our model and methodology would yield further insights into their merits.

## 6 Epilogue (June 15, 2006)

Nintendo is expected to launch the Wii at the same time, or even earlier, as the PS3 (see http://wii.vggen.com/news/news.php?id=1276). An informed colleague told us that at the latest E3 trade fair (held three weeks ago) the Wii looked more finished compared to the PS3, and had more playable demos available compared to the PS3. The PS3 also has to 'wait' for the Blue-Ray standard (next generation DVD) to be set, before it can launch.

# 7 Tables and Figures

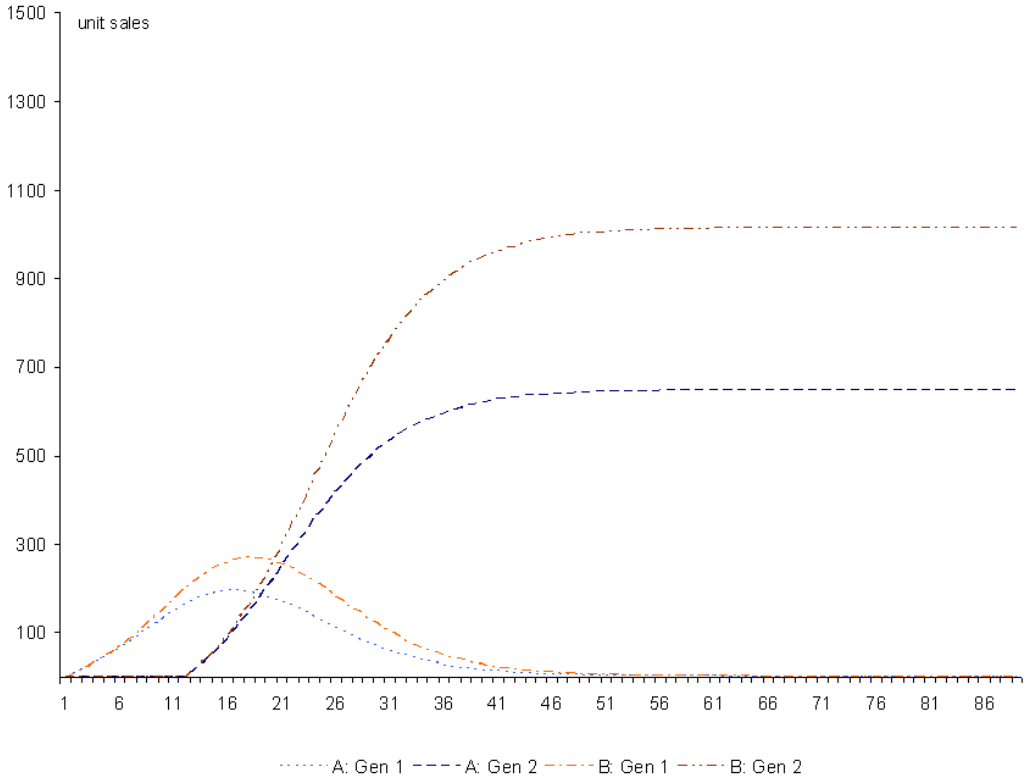



Figure 1: Diffusion and Substitution of Firms A and B Products.

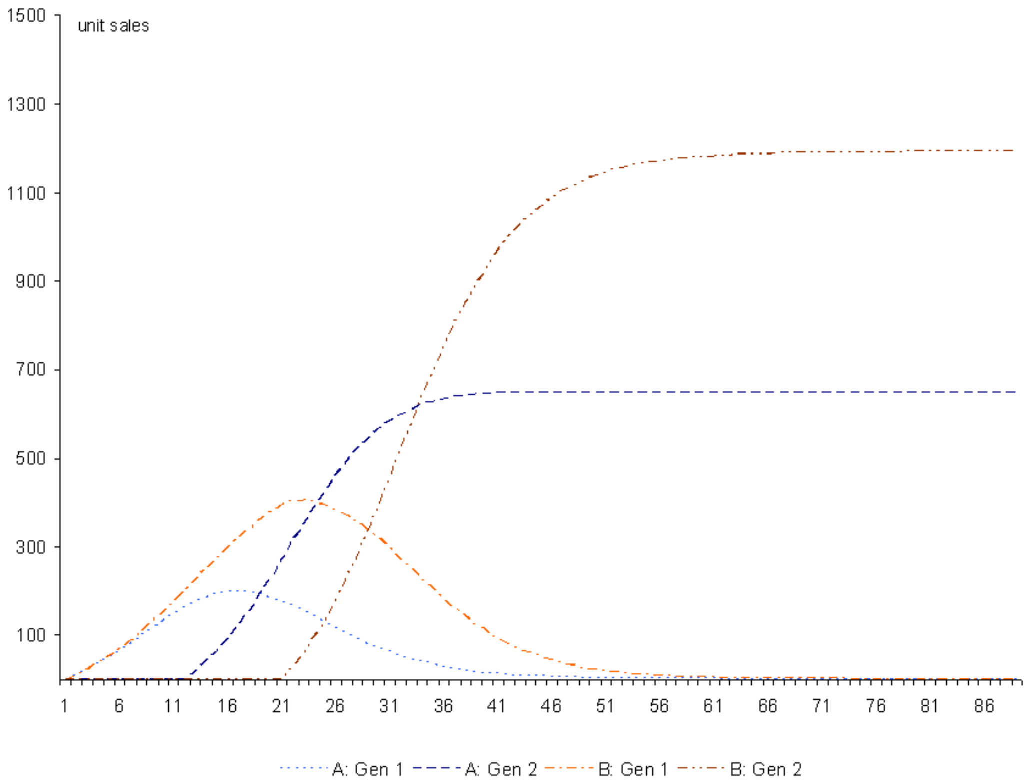



Figure 2: Diffusion and Substitution of Firms A and B Products.

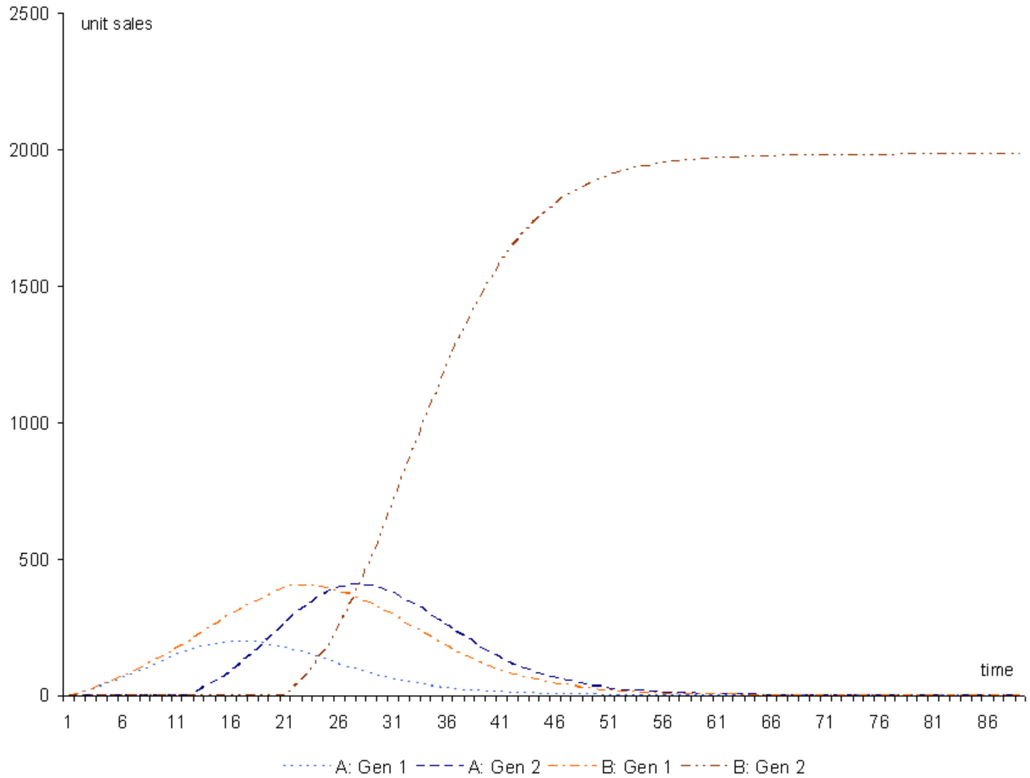
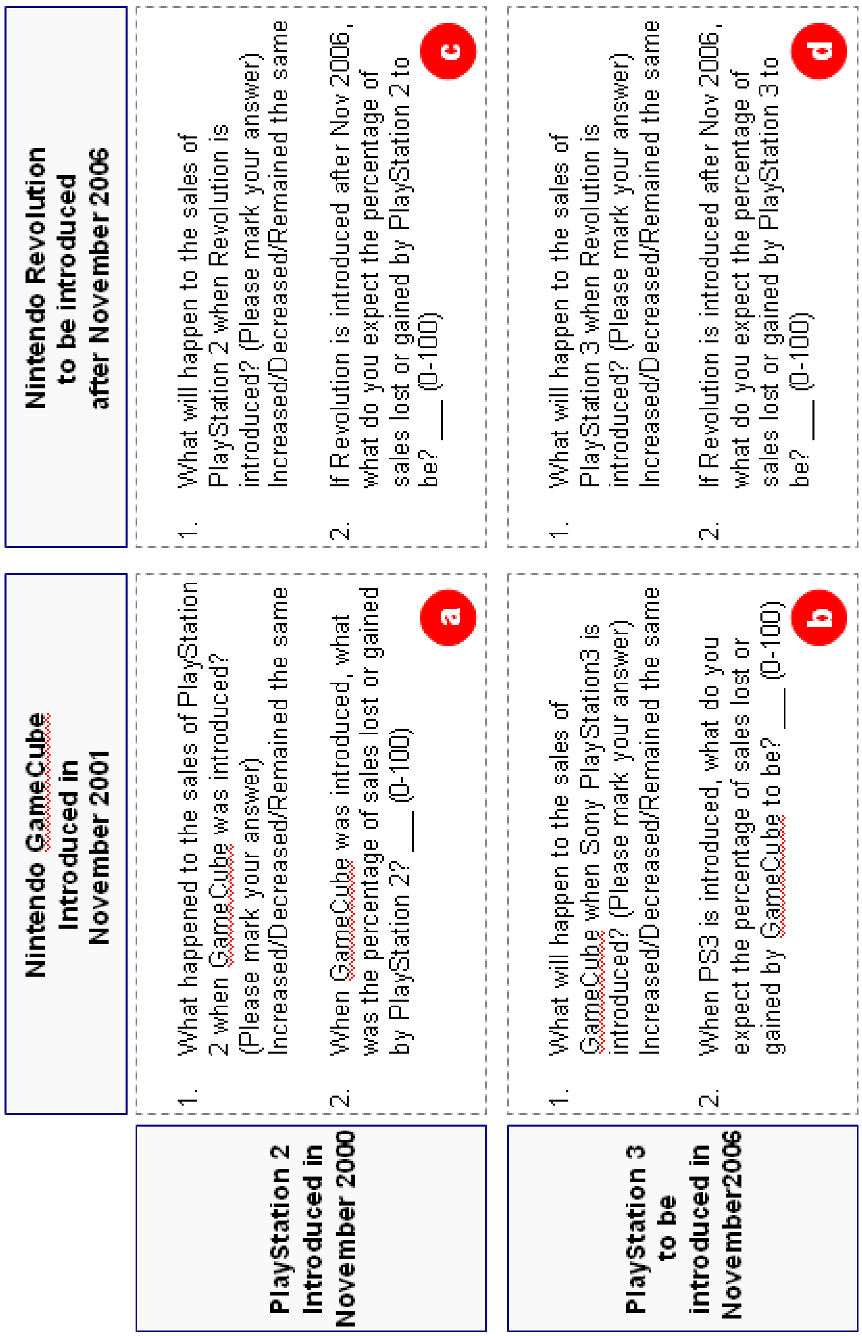



Figure 3: Diffusion and Substitution of Firms A and B Products.



| | Nintendo GameCube Introduced in November 2001 | Nintendo Revolution to be introduced after November 2006 |
|---|---|---|
| PlayStation 2 Introduced in November 2000 | 1. What happened to the sales of PlayStation 2 when GameCube was introduced? (Please mark your answer) Increased/Decreased/Remained the same<br>2. When GameCube was introduced, what was the percentage of sales lost or gained by PlayStation 2? ___ (0-100)<br>a | 1. What will happen to the sales of PlayStation 2 when Revolution is introduced? (Please mark your answer) Increased/Decreased/Remained the same<br>2. If Revolution is introduced after Nov 2006, what do you expect the percentage of sales lost or gained by PlayStation 2 to be? ___ (0-100)<br>c |
| PlayStation 3 to be introduced in November2006 | 1. What will happen to the sales of GameCube when Sony PlayStation3 is introduced? (Please mark your answer) Increased/Decreased/Remained the same<br>2. When PS3 is introduced, what do you expect the percentage of sales lost or gained by GameCube to be? ___ (0-100)<br>b | 1. What will happen to the sales of PlayStation 3 when Revolution is introduced? (Please mark your answer) Increased/Decreased/Remained the same<br>2. If Revolution is introduced after Nov 2006, what do you expect the percentage of sales lost or gained by PlayStation 3 to be? ___ (0-100)<br>d |

Figure 4: Survey applied to get consumers and retailers parameter estimates.

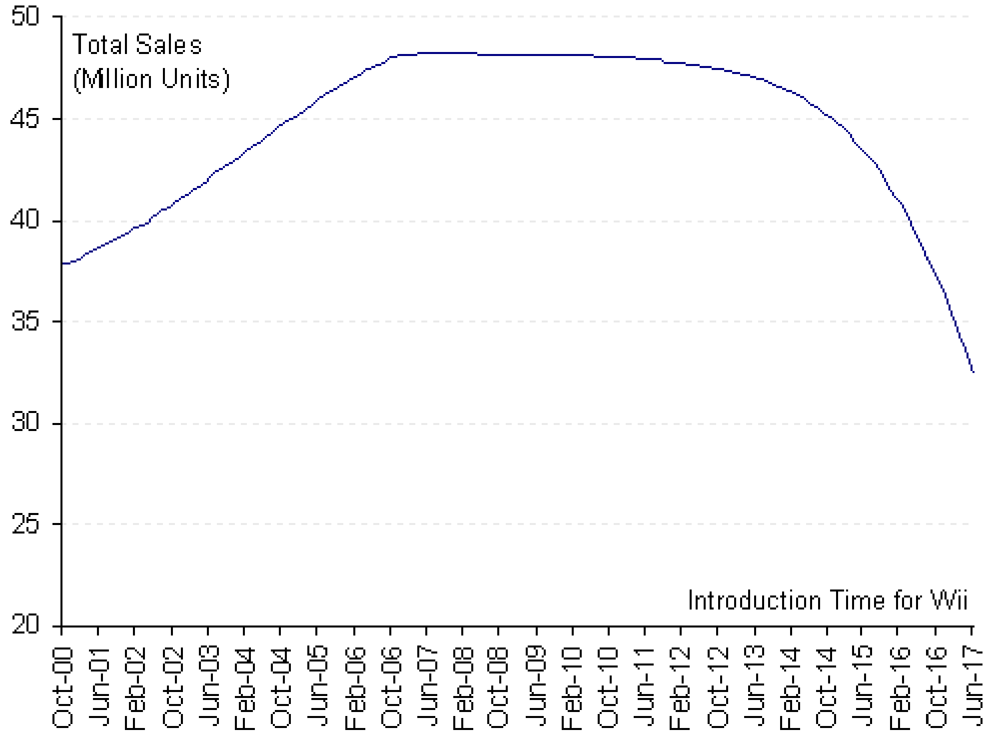



Figure 5: Nintendo's Profit Function given Wii launch date. (Consumers' Scenario)


Figure 6: Profit functions shapes for different planning horizons.

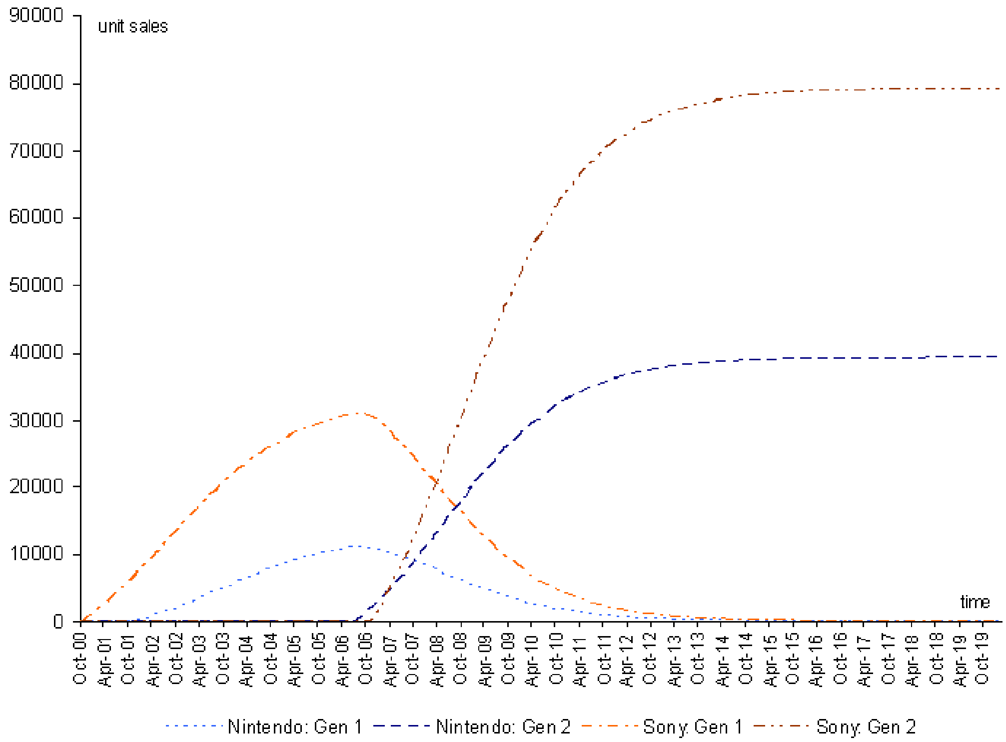



Figure 7: Wii launched in July 2006. Planning horizon December 2012.

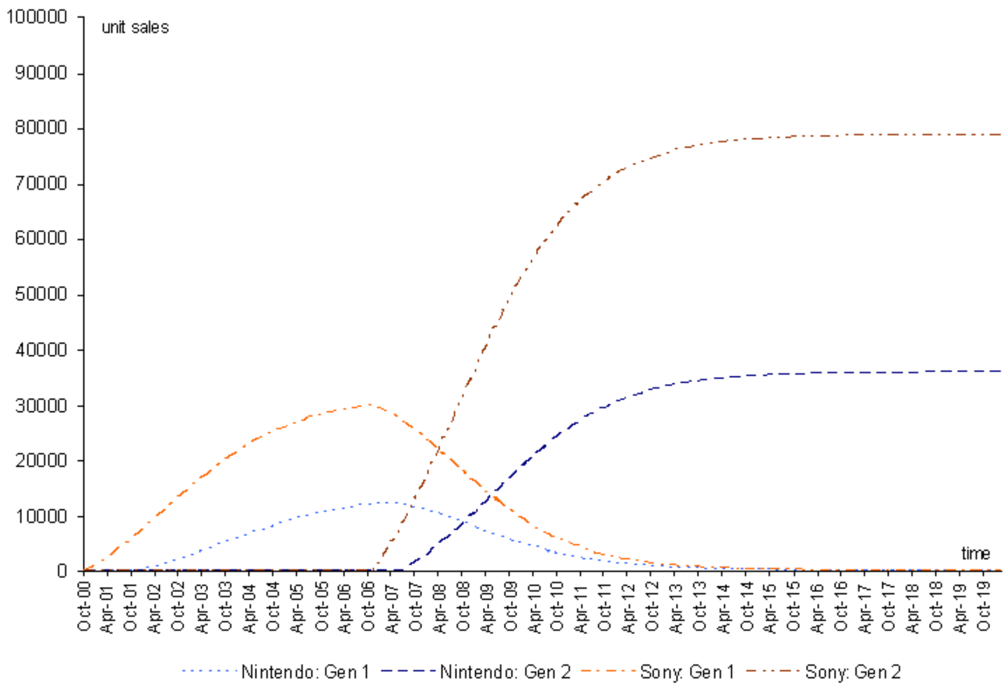



Figure 8: Wii launched in June 2007. Planning horizon December 2020.

| Console / Year | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|
| **Microsoft Xbox** | 0 | 1421 | 3509 | 3287 | 4096 | 2285 |
| **Sony PS2** | 5565 | 9879 | 12303 | 9381 | 7379 | 7663 |
| **Nintendo Gamecube** | 0 | 4162 | 5385 | 6325 | 3887 | 4009 |

**Source: FirstCall Web Analyst Reports**

Table 1: Game Consoles Hardware Sales in US and Japan (Thousand Units)

| Fraction of sales from / Questionnaire No | q1 | q2 | q3 | q4 | q5 | q6 | q7 | q8 | q9 | q10 | q11 | q12 | **Ave.** | **Sig** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PlayStation 2 to Gamecume ($\alpha$) | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | **0.05** | **0.11** |
| PlayStation 2 to Wii ($\phi$) | 0.2 | 0.8 | 0.1 | 0.6 | 0.1 | 0.3 | 0.2 | 0.1 | 0.1 | 0.2 | 0.0 | 0.0 | **0.21** | **0.24** |
| Gamecube to PlayStation3 ($\gamma$) | 0.2 | 0.4 | 0.2 | 0.7 | 0.2 | 0.5 | 0.3 | 0.0 | 0.3 | 0.4 | 0.4 | 0.0 | **0.29** | **0.20** |
| PlayStation 3 to Wii ($\beta$) | 0.0 | 0.0 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | **0.06** | **0.08** |

Table 2: Results of questionnaires applied to 12 hardcore gamers

| Fraction of sales from / Store | **Dynabyte** | **Dixons** | **E-plaza** | **Mediamarkt** | **Average** |
|---|---|---|---|---|---|
| PlayStation 2 to Gamecume ($\alpha$) | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |
| PlayStation 2 to Wii ($\phi$) | 0.0 | 0.5 | 0.0 | 0.4 | 0.23 |
| Gamecube to PlayStation 3 ($\gamma$) | 0.2 | 0.0 | 0.0 | 0.7 | 0.23 |
| PlayStation 3 to Wii ($\beta$) | 0.0 | 0.0 | 0.0 | 0.0 | 0.00 |

Table 3: Retailers' Survey Answers

| Sales from | to Sony PS2 | to Sony PS3 |
| --- | --- | --- |
| Nintendo GameCube | $\alpha_N = -0.05$ | $\gamma_N = 0.29$ |
| Nintendo Wii | $\phi_N = -0.21$ | $\beta_N = -0.06$ |

Table 4: Average of Consumers' Estimates

| **Video Game Console** | **p** | **q** | **m** | **Sample** |
|---|---|---|---|---|
| **GameCube** | **0.19** | **0.71** | **21303** | **2001-2004** |
| | (0.01) | (0.12) | (1090.00) | |
| **Xbox** | **0.16** | **0.54** | **16001** | **2002-2005** |
| | (0.05) | (0.35) | (2574.88) | |
| **PlayStation2** | **0.18** | **0.59** | **30885** | **2001-2004** |
| | (0.04) | (0.24) | (3031.54) | |
| **Average** | **0.18** | **0.61** | **22729** | |

**Note: standard error in parenthesis**

Table 5: Bass model estimates (WLS Method, Weight=1/Sales). The model allows for heteroscedasticity as proposed by Boswijk and Franses (2005)

```
p=0.15;
q=0.60;
a=q/p;
b=p+q;
ma1=30000;
ma2=35000;
mb1=13000;
mb2=15000;
t=0:(1/12):24;
tau1a=0;
tau2a=(73/12);
tau1b=(12/12);
tau2b=(81/12);
tau2b=0;
i=1; Tp=220;
for tau2b = 0:(1/12):24
 af2=(1-exp(-b*(t-tau2a)))./(1+a.*exp(-b*(t-tau2a))).*(t-tau2a>=0);
 af1=((1-exp(-b.*t))./(1+a*exp(-b.*t))).*(1-af2);
 af1o=((1-exp(-b.*t))./(1+a*exp(-b.*t))); as1=ma1.*af1;
 as2=af2.*ma2+(af1o.*ma1.*af2);
 bf2=(1-exp(-b*(t-tau2b)))./(1+a.*exp(-b*(t-tau2a))).*(t-tau2b>=0);
 bf1=((1-exp(-b.*(t-tau1b)))./(1+a*exp(-b.*(t-tau1b)))).*(t-tau1b>=0).*(1-bf2);
 bf1o=((1-exp(-b.*t))./(1+a*exp(-b.*t))).*(t-tau1b>=0); bs1=mb1.*bf1;
 bs2=bf2.*mb2+(bf1o.*mb1.*bf2);
 alpha=0.6;
 beta=0.0;
 phi=-0.2;
 rho=0.0;
 as11=as1.*(1+alpha*bf2).*(1+beta*bf1);
 as22=as2.*(1+phi*bf2).*(1+rho*bf1);
 bs11=bs1.*(1-rho*af2).*(1-beta*af1);
 bs22=bs2.*(1-phi*af2).*(1-alpha*af1);
 tau2b=tau2b+(1/12); sales(i)=max(bs11(1,1:Tp))+max(bs22(1,1:Tp)); i=i+1;
end
total=max(sales); optime=find(max(sales));
plot (sales(1,1:150), 'DisplayName',
'sales(1,1:150)', 'YDataSource', 'sales(1,1:150)'); figure(gcf)
```

Table 6: Matlab basic program

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