Revisiting the Long and Winding (Less Travelled) Road: The Road to Chaos in Marketing

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Abstract In this chapter I revisit the fruitful but also very time consuming paper Pascale Quester and I published in 2010. We consider here a group of consumers that are all the same and adopt a given product with the same probability p. This simplest case leads to nothing of interest. However we add a sociological model based on imitation and reactance. This law of social imitation was validated on both theoretical and empirical levels. It consists of a very simple equation that is non-linear (Eq. 4). This dramatically changes the richness of the consumers' behaviour. Because of their social interactions, the group can be stable, oscillating or even chaotic. More precisely, we have shown six different dynamic regimes depending on the individuals' probability of adopting the product p_0. This shows very clearly that a group is not the sum of the individuals. More than this, very elementary individual behaviour can aggregate within an interacting social group, leading to complexity and chaos.

Keywords Social imitation · Social chaos · Choice · Probability · Consumer behaviour

Introduction

In 2010 Pascale Quester and I published a very fruitful but also very time consuming paper (Quester and Steyer 2010). Pascale went to the Sorbonne for a sabbatical year and we were looking for something that would conjugate her remarkable ability to manage experimental science with my interest in social interactions which I developed in both my physics and marketing PhD theses.

In the literature, we found a great current base on imitation as a source of diffusion in the process of innovation. But in social psychology, we also found the concept of reactance that prevents people from imitating each other. I developed in my PhD thesis (Steyer 1992) a model called *avalanche theory* in which both

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imitation and reactance were taken into account. The result is an equation with three parameters as in the classical Bass model, but with much better prevision ability on the same data. Thus, I validate the coexistence of both imitation and reactance, but only in an indirect way.

Pascale and I decided to show this in a direct experimental way and developed two experiments. The first concerns Sorbonne students after a fictional lottery. We asked them, one after the other, to choose the chocolate bar that they would like to win. We were able to control exactly what they knew about their friends' choices, and they were unconscious of the real aim of the experiment. A second study was the statistical analysis of real data in a restaurant similar to the Ariely and Levav (2000) one.

A mathematical model was built and estimations made. It showed that both imitation and reactance took place, depending of the level of unanimity within the group. As a result, the relationship between the proportion of choices in the group and the probability of choice for an individual in the group is strongly non-linear. In this paper I use this relationship to show the behavioural consequences within the group, which are highly counterintuitive.

My derivation is mathematical, but it is important to realise what is at the beginning and at the end of it. The beginning is an equation validated by Pascale and I in two totally different situations. As it is the same equation, we hope to have established some very general law of imitation that could be validated in many others fields. At the end of the demonstration we demonstrated chaos in marketing, not by either conceptual or purely empirical evidence. We demonstrated chaos by the precise mathematical and sociological mechanism, which is a very innovative approach in our field.

Toward a Law of Imitation

The two studies (Quester and Steyer 2010) are different and complementary. In the chocolate bar experiment, the control of the other's choices is total on both synchronicity and diachronicity. The second one is less controlled, but totally realistic. The first one took place in a classroom of the Sorbonne. There was no discussion between the students. They only saw the choices made by their friends before they wrote on the paper. The possible consummation of the bar was a future and individual one. On the contrary, in the restaurant there was lot of discussion. The choice of the beverage was individual, but the consummation was collective. The choice was exposed to others, indicating something of the personality and the role played in the group. In particular, they had to choose between an alcoholic beverage or not. The chocolate mark is not a social marker; on the contrary, there is no context effect.

Because of these differences, one could have expected to obtain different results in each experiment. Even if the global equation could be the same, the parameters could be very different in each case. In reality, this was not the case. Both experiments led to the same equations with the same parameters, except one. In the 2010 paper, we show the curves of the probability of choice with respect to the proportion of group choice, and it is the same curve in both experiments except for a translation. The parameter that varies and the translations of the curves are due to differences of intrinsic choice of the different products regardless of imitation.

Being more quantitative, the chocolate bar experiment gave for a logit transformation of the probability choice, the equation:

$$\begin{array}{l} \text{Logit of probability} = -\underset{(6.3)}{37.3}\,\pi + \underset{(14.4)}{70.9}\,\pi^2 - \underset{(9.4)}{40.2}\,\pi^3 + \text{constant} \end{array} \tag{1}$$

where π is the proportion of consumer's choice on paper, and the numbers in brackets are the standard deviations of the estimates.

For the restaurant experiment, the equation is:

$$\text{Logit of probability} = -\underset{(3.4)}{35.0}\,\pi + \underset{(8.6)}{82.2}\,\pi^2 - \underset{(5.6)}{48.3}\,\pi^3 + \text{constant} \tag{2}$$

It is remarkable that the two equations are almost the same. The coefficients are very close to one another, and the differences are lower than two times the standard deviations, so they are not statistically significant different. The constants that reflect the attractions of the brands are different, but the other coefficients that reflect the social behaviour are the same. Of course, more studies need to confirm this result, but at this time two studies confirm equality of the three social coefficients. For students making choices in a classroom and for consumers in a restaurant, the three coefficients are the same.

Waiting for additional research, I suggest the following equation as the non-linear social law of imitation:

$$\text{Logit of probability} = -35.5\,\pi + 79.2\,\pi^2 - 46.1\,\pi^3 + \text{constant} \tag{3}$$

This equation is an average of Eqs. 1 and 2. I will now show all of the consequences of this apparently very simple equation in the following sections of this paper.

Social Chaos

Equation 3 gives the probability p of a consumer choosing a product, taking into account the fact that a proportion π of the group has made the same choice. We have to make the equation dynamic, because when one consumer has made a choice, the proportion π within the group changes automatically. According to Eq. 3, this change of π will change the probability p, and so on from time to time.

Intuitively, one could expect the process to stabilize at some level of probability but we will demonstrate that this is almost never the case…

For simplicity, we will concentrate on the simplest case, in which each consumer can only choose one product or nothing. Thus, p is the probability of choosing the product. We can think of a basic restaurant which proposes only one starter on the menu that the consumer could choose or not. We note p(0) the probability of choosing this product at the beginning before any interaction within the group, and p(t) the probability at time t during the interactions. The probability of choosing the product one time depends on the precedent proportion of consumers π in the group that would adopt the product. The expectancy of π is simply the mean of p(t − 1), so we can write the recursive law of imitation according to Eq. 3 with the logit transformation:

$$1/\mathrm{p}(\mathrm{t}+1) = 1 + (1/\mathrm{p}_0 - 1)\exp\left(-35.5\ \mathrm{p}(\mathrm{t}) + 79.2\ \mathrm{p}(\mathrm{t})^2 - 46.1\ \mathrm{p}(\mathrm{t})^3\right) \tag{4}$$

where exp is the exponential function. P_0 is the probability of choosing the product when nobody has already done it, so without social interactions.

Intuitively, one could expect that p(t) will evolve within the group according to Eq. 4, until it reaches a stable value. Even if social interactions are complex, the group will stabilise in a mixture of two types of consumers: some will adopt and others not, and Eq. 4 would give identical values for p(t) and p(t + 1). This could effectively happen for only a few values of p_0. In most cases the dynamic behaviour of the group will be much richer than this, as we will see.

When p_0 is greater than 0.93, the group converges to a stable situation with about 8 consumers adopting the product and 2 out of 10 not adopting. Figure 1 shows such a group. Of course in the real world it is infrequent to observe groups in which such unanimity exists a priori. Let us examine cases with p_0 lower than 0.93 whose behaviour is totally new in the literature of social interactions.

Figure 1 shows the dynamics of the group beginning with $p_0 = 0.94$. Figure 2 shows the group beginning with $p_0 = 0.932$ which is very near 0.94.

One could expect the same behaviour in a group that is convergent to some stability. It is the case at the beginning. Until time 23, the group converges, but after that there is a collapse and the group becomes totally unstable. The probability of adopting the product is fluctuating every time, making it impossible to predict what proportion of people will choose the product. This is social chaos. But behind this chaos there is a non-random and simple equation which is the fourth in this paper, and for this reason, physicists call these kinds of situation *deterministic chaos*. We have shown that because of the coexistence of both imitation and reactance in the groups, they can exhibit chaotic, unpredictable, and unstable behaviour. Chaos is a well known phenomenon and has already been evocated in marketing literature, but without empirical evidence and without psycho-sociological mechanisms that would make it emerge (Diamond 1993; Doherty and Delener 2001; Gault and Jaccaci 1996; Glass 1996; Herbig 1990).

We can remark that, in this example, individual consumers have a great tendency to adopt about 90 %, but at the group level it oscillates around 25 % because of the

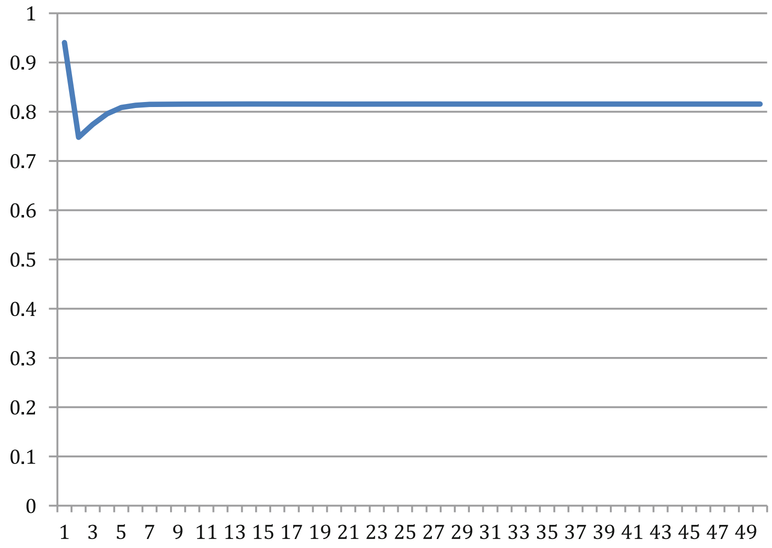

Fig. 1 Temporal evolution of the probability of choosing the product with $p_0 = 0.94$

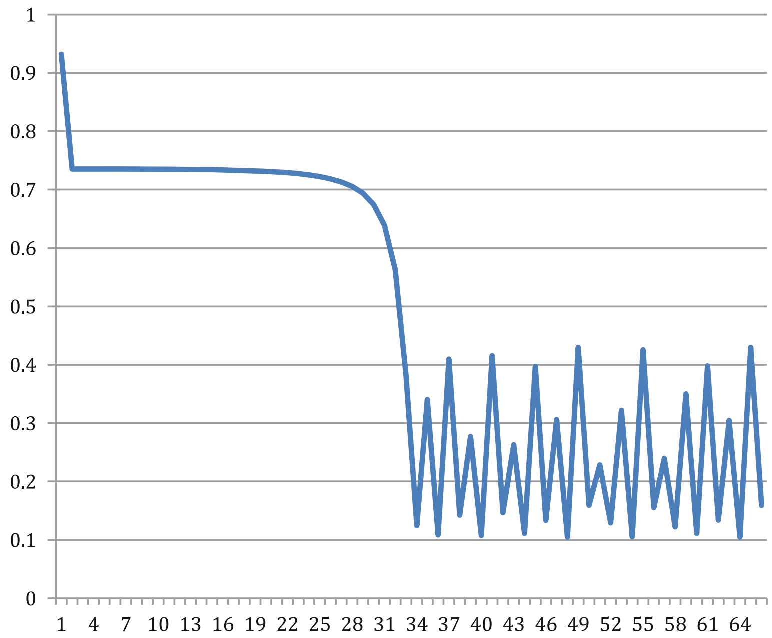

Fig. 2 Temporal evolution of the probability of choosing the product with $p_0 = 0.932$

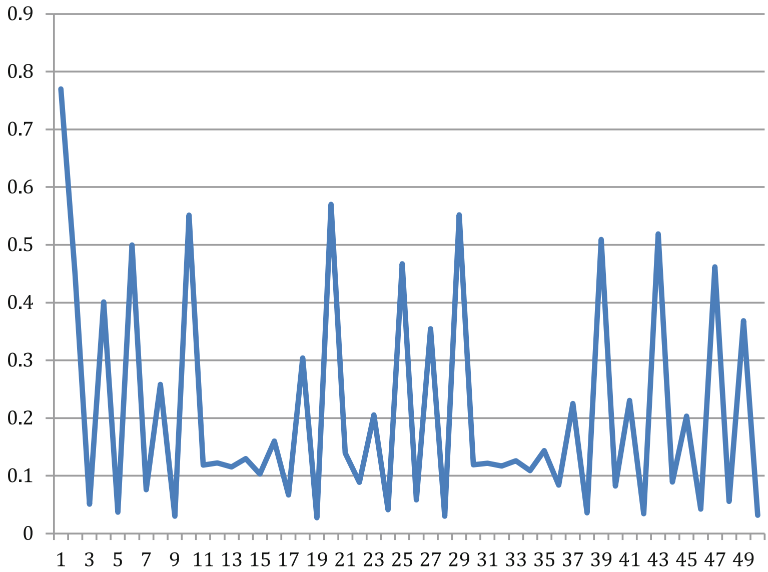

Fig. 3 Temporal evolution of the probability of choosing the product with $p_0 = 0.77$

reactance effect or variety seeking. When we lower p_0, the apparently initial stable state disappears and we observe pure chaos. Figure 3 shows such an example.

Probability of choice evolved in a totally random and apparently a totally non predictable way, even if in fact it is perfectly deterministic as in Eq. 4. In this state of chaos, what the group will ultimately choose depends mainly at the time at which the waiter asks for the choice. All the time dedicated to discussion and social interactions just enhance the randomness within the group.

When p_0 lowers, the randomness changes naturally. In chaos, all values of p can be observed. When p is lower than 0.7, the group oscillates randomly between some more or less definite values. Figure 4 shows such a case with about 3 values of attraction. The smaller p_0 is, the less chaotic the dynamic of the group is. Under $p_0 = 0.5$ there is no more chaos.

Chaos takes place in a pure oscillation between two very precise values of probability p. One is near the value of p_0 that reflects the individual tendency to adopt the product and the other is near 0, which reflects the effect of reactance. The two states are incompatible, but nevertheless they exist, and so as a consequence is that the group does a bivalent oscillation between the two indefinitely. Figures 5 and 6 show such oscillations for two different values of p_0.

When p_0 is still lower, oscillation of bivalence becomes attenuated. The amplitude becomes lower and lower, until it disappears. After that, the group is again stable, but this time with nobody adopting the product as shown in Fig. 7.

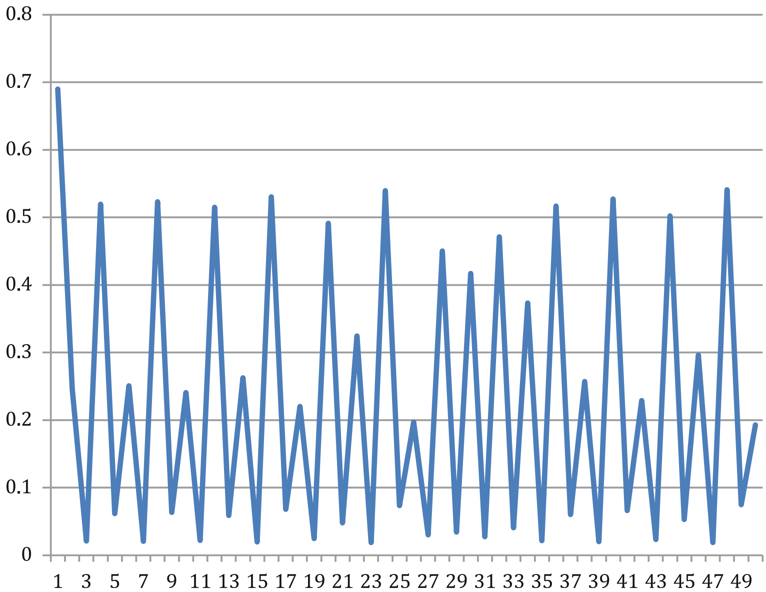

Fig. 4 Temporal evolution of the probability of choosing the product with $p_0 = 0.69$

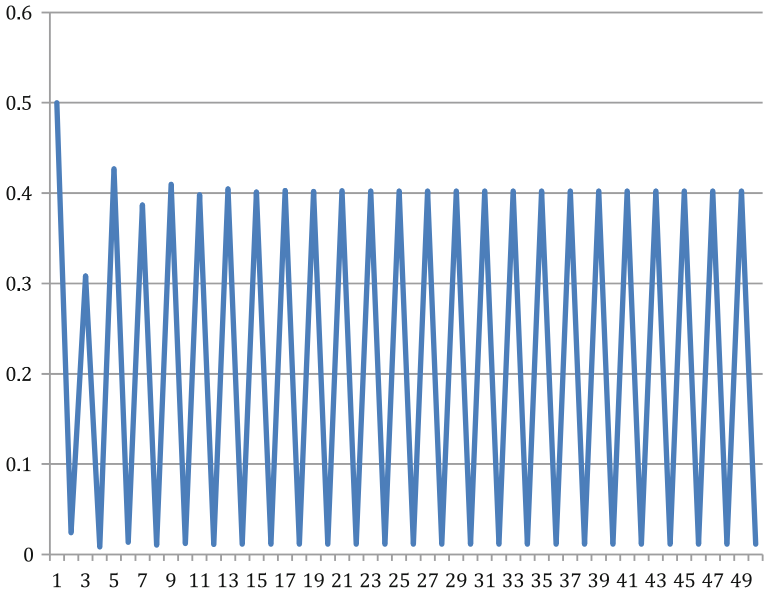

Fig. 5 Temporal evolution of the probability of choosing the product with $p_0 = 0.5$

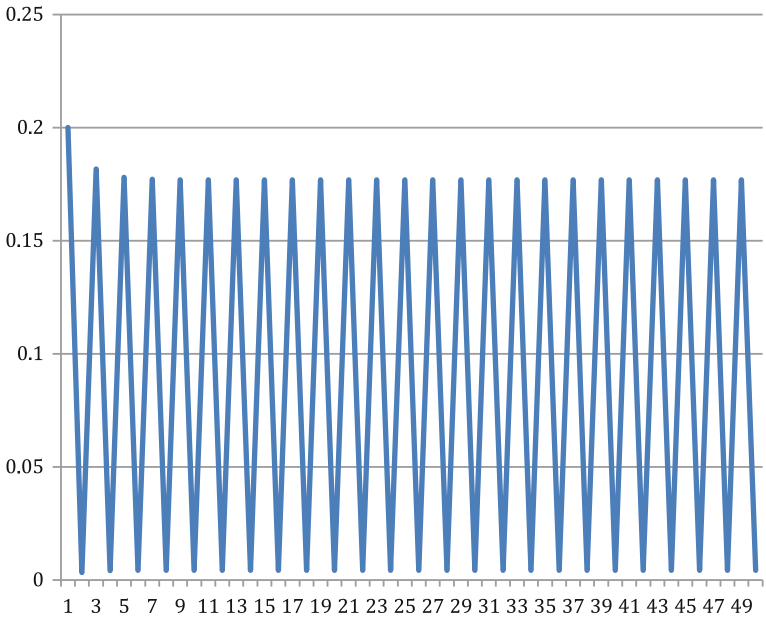

Fig. 6 Temporal evolution of the probability of choosing the product with p_0 = 0.2

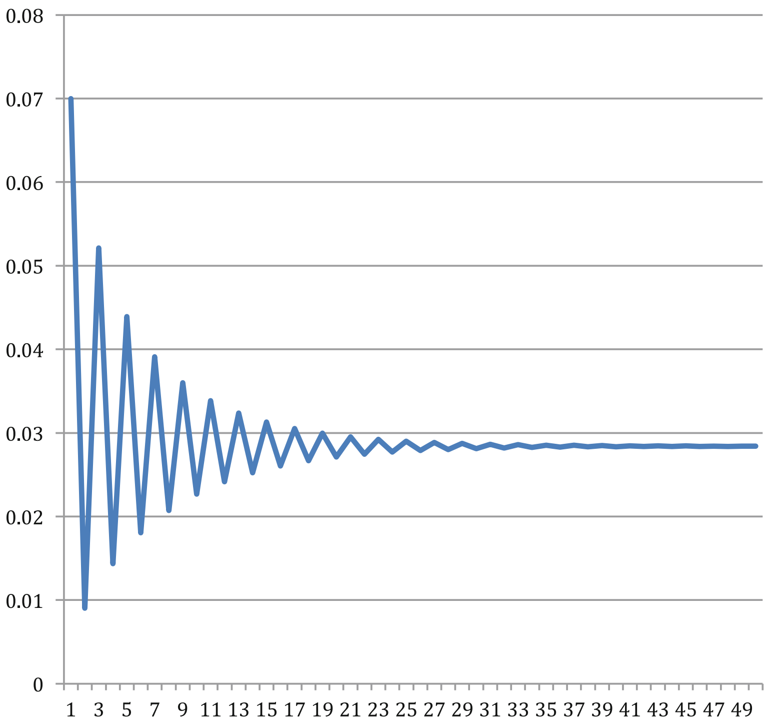

Fig. 7 Temporal evolution of the probability of choosing the product with p_0 = 0.07

Conclusion

In this paper we consider a group of very simple consumers. They are all the same and adopt a given product with the same probability p. This simplest case leads to nothing of interest. However we add a sociological model based on imitation and reactance. This law of social imitation was validated on both theoretical and empirical levels. It consists of a very simple equation that is non-linear (Eq. 4). This dramatically changes the richness of the consumers' behaviour. Because of their social interactions, the group can be stable, oscillating or even chaotic. More precisely, we have shown six different dynamic regimes depending on the individuals' probability of adopting the product p_0.

1. When p_0 is near 1, the group is stable. Almost everyone adopts the product
2. When p_0 is near 0.93, the group begins to adopt the product in a great majority. But after some time, the majority breaks and the probability becomes totally chaotic with respect to time
3. When $0.91 > p_0 > 0.7$ there is nothing but pure chaos
4. When $0.7 > p_0 > 0.5$ chaos become to structure around some less instable positions
5. When $0.5 > p_0 > 0.1$ the group oscillate between two opposite states. One of non-adoption and another of adoption.
6. When $p_0 < 0.1$ initial bivalence diminish until total non adoption of the product

This shows very clearly that a group is not the sum of the individuals. More than this, very elementary individual behaviour can aggregate within an interacting social group, leading to complexity and chaos.

The applications of these findings are straightforward. Whyte (1954) has shown, a long time ago, that social interactions are ubiquitous in marketing. Internet and social networks have made them increasingly accurate. So the law of imitation we found with Pascale Quester must always be in the manager's mind.

When faced with these three empirical facts:

1. A low market share, together with high purchase intention in market research
2. A very complex market share with chaotic evolution in all directions
3. Sudden change from stability to instability in the market share

the manager should ask himself if the cause is in the psychology of the consumers, or in the social interactions between them. Traditionally, more emphasis has been placed on the first reason. These simulations show that the second is as important as the first.

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