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The cusp catastrophe model in describing a bank's attractiveness as measured by its image

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Abstract

Banking has always been an extremely competitive industry and competition has become tougher over the last years. Every bank has two sides to consider, customers and investors. Customers, however, are clearly the most important part of a bank as they provide the basic raw materials of deposits and the demand for loans, which are the revenue streams of net interest income but also provide the fee income. The bank offers an intermediation service between customers with excess funds and those with a funds deficit. It borrows and lends wholesale funds to keep the two piles in some kind of balance. The drivers of customer behaviour are complex. Understanding the needs of their customers and reacting to the changes of their behaviour, aid banks and financial institutions to face the hard competition. Clearly then, the success of a bank is subject to its ability to attract and retain its customers, and a large part of their business. This ability depends on what is called the image of a bank. In highly competitive sectors, like the banking sector, the image represents an asset which allows firms to differentiate and increase their success chances. However, although its impact on consumer behavior is of primary importance, a bank's image is a difficult asset to value and quantify. The concept of image has been given considerable attention in the literature over the past years. Image has been defined as the total impression that an entity makes on the minds of people and as the net result of the interaction of beliefs, ideas, feelings and previous experiences with an institution, which are stored in memory and transformed in concepts. Especially a bank's image can be seen as the perception that customers or potential customers have for a specific bank, based on the messages they received by the examined financial institution. Image is a strategic tool since it helps banks to achieve long-term objectives and it can be shown as a source of competitive advantage. The present paper builds on the previous work on the subject and focuses on the definition and measurement of a bank's image. It introduces image as a variable which expresses a bank's current state of development and future prospects. It identifies the factors affecting this variable, suggests ways of

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measuring them and uses image as the basis for the building of a non-linear model expressing a bank's development. The image of a bank, as defined in this paper, may prove a very useful tool for planning purposes, since it doesn't only give an early diagnosis of possible changes, sometimes discontinuous, in the bank's pattern of progress, but also indicates the reasons for them. Hence, it may be used as the basis for designing appropriate measures to assist a bank's evolution. The theoretical findings are applied to a group of banks operating in Greece and the results are presented and discussed.

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1. Introduction

Banking is an extremely competitive industry. Competing in the financial services industry has become tougher over the last years with the entrance of such players as insurance companies, credit unions, check cashing services and credit card companies. As a response, banks have developed financial instruments, through financial market operations such as brokerage and trading.

Every bank has two sides to consider, the customers and the investors. Customers, however, are clearly the most important part of a bank. Customers provide the basic raw materials of deposits and the demand for loans, which are the revenue streams of net interest income and they provide the fee income. The bank provides an intermediation service between customers with excess funds and those with a funds deficit. It borrows and lends wholesale funds to keep the two piles in some kind of balance. The drivers of customer behaviour are complex. Understanding the needs of their customers and reacting to the changes of their behaviour, aid banks and financial institutions to face the hard competition. Clearly then, the success of a retail bank is subject to its ability to attract and retain its customers, and how much of the customers' business it attracts. This ability depends on what is called the image of a bank. In highly competitive sectors, like the banking (financial) sector, the image represents an asset which allows firms to differentiate and increase their success chances. However, although its impact on consumer behavior is of primary importance, a bank's image is a difficult asset to value and quantify.

The concept of image has been given considerable attention in the literature over the past years. The present paper builds on the previous work on the subject and focuses on the definition and measurement of a bank's image. It introduces a bank's image as a variable which expresses a bank's current state of development and future prospects. Furthermore, the factors affecting this variable are defined and ways of measuring them are suggested. Finally, this variable is used as the basis for the building of a non-linear model expressing a bank's growth pattern.

Following this brief introduction, the remainder of the paper is organized as follows: Section 2 gives an overview of the literature on the concept of the bank's image. Section 3 presents the proposed approach for defining and quantifying a bank's image. Section 4 presents the basic properties characterising a bank's image, while section 5 develops a non-linear mathematical model for its estimation. Finally, section 6 applies this model to the case of nine banks operating in Greece, whereas section 7 summarizes the conclusions and makes suggestions for further research.

2. The concept of a bank's image: Literature review

The concept of image has been addressed in a number of academic papers. Dichter (1985) describes an image as the total impression that an entity makes on the minds of people. He argues that images are a powerful influence in the way people perceive and react to things. Aaker (1982) defines that an image is the set of meanings by which an object is known and through which people describe, remember and relate to it. MacInnis (1987) and Worcester (1997) support that image is the net result of the interaction of beliefs, ideas, feelings and previous experiences with an institution, which are stored in memory and transformed in concepts. Dowling (1986) states that the measurement of corporate image implies the incorporation of beliefs, and the transformation of them into mental images. The image profile of a business or an organization, as perceived by its external public, is best understood within the

general framework of the beliefs and attitudes held by various corporate publics towards business in general and the relationship between the company, its competitors, and the industry in which it operates in particular. According to Leuthesser and Kolhi (1997) and van Riel and Balmer (1997), corporate image is the result of a communication process in which the firm creates and transmits the identity that reflects the values and essence of brand.

Focusing on a bank's image, Hatch et al. (2003) state that image is the perception that customers or potential customers have for a specific bank, based on the messages that they received by the examined financial institution. Yavas et al. (1995) argue that when changes take place in banking industry, it is important for banks to understand the image that consumers hold for them. Morello (1988) states that images are subjective rather than objective entities of customers' cognitive processes, and in services industries such as banking, are crucial for designing development strategies. Finally, Abratt and Mofokeng (2001) state that image is a strategic tool since it helps banks to achieve long-term objectives and it can be shown as a source of competitive advantage.

The factors affecting an organisation's image, as identified through literature, include product quality, institution's financial performance, technological innovation, institution's social responsibility, firm's reputation and credibility (Grönroos, 1988; Kim, 2006). According to Howcroft (1991) image is a multidimensional construct formed by all the impressions and expectations that individuals develop throughout a certain period of time. Factors such as personal beliefs, feelings, product quality are related to the determination of image. Pina et al. (2006) in their study found that the corporate image is positively related to consumers' perceptions on service quality. Abratt (1989) notes that the corporate personality determines the corporate identity, which constitutes the corporate image. Behavioral and intellectual characteristics determine the personality of each corporation and distinguish it from the others, the corporate identity is defined as a set of beliefs, experiences, feeling, knowledge, attitudes and perceptions while the image consisted by elements such as employee behavior, customer service, need-satisfying products or services, and the corporate name, logo and slogan.

Focusing on the factors affecting the bank's image, the literature review shows that they include: bank's financial data and forecasts of performance, information concerning marketing strategy, bank's developing strategy, and attributes that measure dissimilarities with other banks. Dowling (1986) and Bravo et al. (2009) determined the corporate image of the financial institutions and found that in commercial banks the image includes dimensions related to the services offered, accessibility, corporate social responsibility, global impression, location and personnel. They developed two alternative models, one for customers and one for non-customers in order to examine how corporate image influences intention to use the bank's services. Satisfaction was defined as the crucial factor for current customers. Finally, a number of research studies classify the factors affecting a bank's image into two groups related to the offered services and the accessibility of these services (van Heerden and Puth, 1995; LeBlanc and Nguyen, 1996; O'Loughlin and Szmigin, 2005).

The image of a bank is received by all different groups of individuals, associated with bank, which are stakeholders, consumers, and employees. Each time that an individual from one of these groups comes in contact with a bank, an impression about this company is automatically formed (Dowling, 1986). However, as financial institutions serve multiple and different customers, who understand by their own way, the image of the bank, an institution has many and different images. Each group develops a different image which is affected by its demographic, economic and social characteristics (Fombrun, 1996; Hatch et al., 2003; Dowling, 1988; Kazoleas et al., 2001). Since we expect different groups of people to hold different images of a bank, the first step in measuring its image(s) is to identify these groups. According to Dowling (1986), companies often try to project an "ideal" image, for all their customers. However, as different groups of people perceive an organization differently, it is necessary to customize the set of factors (and attributes) used to describe a company.

Having defined the image of a bank, we proceed to the study of its relationship with bank's performance, customer satisfaction and customer behaviour. Many studies examine the relation between customer satisfaction, customer loyalty and customer switching behavior (Parasuraman, 1988; Barich and Kotler, 1991; Bolton and Drew, 1991). The results according to Nguyen and Le Blanc (1998) show that satisfaction and quality are positively related to value and that value leads to corporate image. A variety of studies have made it clear that image and consumer trust can significantly affect individual behavior (Ratnasingham, 1998). Nguyen and Le Blanc (1998) argue that understanding the role of corporate image in customer retention decision is a key issue. Furthermore, they state that as services industry delivers intangible goods, a better understanding of the components of the image means improvement of an institution's performance. Granbois (1981) states that a favorable image could be understood as

a critical aspect of an institution's ability to maintain its market position. Image is highly related to organizational success aspects. Fombrun and Shanley (1990) state that firms with strong corporate image in the market succeed in attracting stakeholders, neutralizing the competitors' actions and increasing their profits. Furthermore, it has been found that customer satisfaction is highly correlated to the perceptions and emotions that consumers have in their mind about a bank. Finally, customer loyalty in banking industry is the end result of both image and satisfaction (Nguyen and Le Blanc, 1998).

Concluding this section, we shall refer to ways of measuring a bank's image. A variety of measurement techniques have been used to quantify images. According to Dowling (1986) the used methods can be grouped into two categories: (a) Non attribute-based Scaling Procedures where the attributes of a company are described and are used for future research and (b) Attribute-based Scaling Procedures where managerial experience, theory, and exploratory research can be used to select a relevant set of attributes. Techniques like Multiple Discriminant Analysis (Hauser and Koppelman, 1979), factor analysis (Wind 1973; Anderson 1979), classification matrix are used for measuring image. Positive values of image are signs of the position of a bank in the financial market and imply that a bank has the ability to attract customers and exercise a positive influence on the trust of different groups. Otherwise, Flavian et al. (2009) note that negative values of image could be a warning for the reorientation of the direction of the company's interests.

3. Defining a bank's image: The proposed approach

The growth and decline of a bank depends on its power to pull and retain its customers; this pulling power depends on what we call the image of a bank. At each point in time the bank sends out its image and depending on its impact on the customers and potential customers the bank may be considered as attractive or repulsive. One may argue that since customers "receiving" the image of the bank belong to various distinct groups (i.e. corporate customers of various types, retail customers of various types) and are sensitive to different factors, the impact of the image of the bank on the members of each particular group will be different. This is a plausible argument supported by the evidence presented in the previous section. On the other hand however, the same evidence shows that all groups of potential customers react similarly to a basic set of factors; more precisely, a set of minimum standards largely common to all groups must be satisfied if the bank is to be considered as a potential choice by any of them. To reconcile these two views we refine the concept of a bank's image by introducing the following two concepts: the Basic Image and the Specific Image.

The Basic Image of a given bank measures the degree to which the bank satisfies a set of basic criteria common for all customers. A bank satisfying those criteria is considered by all potential customers as worth a closer examination and as a potential final choice.

The Specific Image of a given bank, as perceived by a particular group of potential customers, measures the degree to which customers belonging to that particular group consider the bank as their best final choice. This Specific Image however, although a function of specific factors, appealing mainly to members of that group, is primarily a function of the Basic Image.

The remainder of this paper will focus on the definition and study of a bank's Basic Image. This is a rather abstract concept which expresses the actual state of the bank; a physically realizable measure for the Basic image is difficult to find. What may be measured more easily is the net change of a bank's customers during each time period. Such a change however is of very little importance as a measure of the real state of the bank. The perception and reaction times to any change are different for the various groups of potential customers. Hence, the measurable changes of the bank's customers may be generally considered as the delayed and considerably smoothed consequence of changes in the Basic Image.

The study of the mechanisms governing the shaping and the changes of a bank's Basic Image is a task of imperative importance. Many bank analysts have assumed that the path towards bankruptcy or insolvency is smooth and continuous. As a consequence a number of early-warning systems have been suggested in the banking and financial literature to aid regulators in the identification of potential problem banks. However, the analysts' assumptions are not always valid, as the banking history is full of cases of sudden and explosive bank failures. Hence, these systems may be of little use when the path towards failure is explosive, involving a sudden crash or catastrophe (Ho and Saunders, 1980). It would therefore be interesting to develop an early warning system that

could cater for both continuous and discontinuous paths towards bank insolvency. Such a system may prove valuable, especially as the unexpected failure of even a single bank could adversely affect the depositors and investors confidence as to the soundness of the banking system and ultimately of the payments mechanism itself. The development of such a system is the objective of this paper.

The Basic Image as an overall measure of its attractiveness and performance, apart from simplifying the analysis of a bank's development, has the following two advantages: it gives an early warning of any potential danger of decline; it gives the "true" picture of the bank and helps us to detect the causes and not only the symptoms of any existing problems. An early and correct diagnosis of a problem is perhaps the biggest step towards its solution. In the case of a bank's development however, the seeds of decay are usually planted during a period of prosperity and no action is taken against them until it is too late. There are several reasons for this, one of which is the lax attitude some banks have adopted because of the years of "good times." The potential for this is exacerbated by the reduction in the regulatory oversight of banks and in some cases depth of management. Problems are more likely to go undetected, resulting in a significant impact on the bank when they are recognized. Therefore a monitoring device which will alert us at the first sight of danger is a device of great importance.

We have so far introduced the Basic Image of a bank as a function of a number of factors which influence the behaviour of customers and potential customers. The choice of a bank is essentially a voluntary process and hence, any attempt to improve or sustain the attractiveness of a bank must be directed towards providing the framework within which this voluntary process can flourish. The Basic Image as defined may be the basis for such a framework and the factors affecting will be the prime targets for improvement. The factors affecting Basic Image have been defined and presented in the previous section. Furthermore, these factors may be divided into two groups depending on whether they refer to the variety and quality of the bank's products/services or to their accessibility. The factors of the first set (i.e. Variety of Products and Services, Quality of Products and Services) properly quantified and scaled, give a measure of the range and quality of the products and the services offered. This measure is referred to as the Products and Services Indicator of bank i (IND_i^1). Similarly, the factors of the second set (i.e. Interest Rates of Deposit accounts, Interest Rates of Loan accounts and cards, Points of Sales), give a measure of the accessibility and the cost of a bank's products and services. This measure is referred to as the Reachability Indicator of bank i (IND_i^2). Hence, a bank's Basic Image is a function of those two Indicators, i.e.

$$\text{Basic Image} = \varphi(\text{Products \& Services Indicator, Reachability Indicator}) = \varphi(IND_i^1, IND_i^2) \quad (1)$$

Ways for quantifying those Indicators will be given in section 5. The expression of the Basic Image as a function of those two Indicators is not accidental; on the contrary, it is consistent with:

- The concept of a bank as a complex service unit whose growth depends on achieving a balance between potentially conflicting objectives.
- The latest CRM (Customer Relationship Management) findings indicating that service quality and delivery channels are two key points affecting a bank's development.

A bank's Basic Image, as defined in our study, is a CRM based tool, which gives a "snapshot" of a bank's current state ("good" or "bad") and may act as an early warning device for any future problems. We believe that by defining a bank's Basic Image as a function of its attributes related to customer satisfaction on one hand and reachability of products and services on the other, we have an overall reliable estimate for the bank's prospects of development.

Concluding, it should be mentioned that the growth of a bank may be expressed both in absolute or relative terms. In the latter and most interesting case the development pattern of a given bank is compared to that of a hypothetical bank, which is referred to as the "typical" bank and expresses, as far as possible, an average of the main banks of a similar type to that of the study. In this paper we shall be looking at the relative development patterns of a bank. Hence, all the factors affecting its images (Basic and Specific) should be expressed in relative terms as compared to the corresponding values of the "typical" bank.

4. Properties of the Basic Image

Let us now move a step further and concentrate on the problem of the theoretical shape of the graph of the Basic Image. It is reminded that the Basic Image has been defined as a function of two conflicting indicators and hence its graph must be a three-dimensional one. In order to get a first feeling of the shape of that graph we start by stating the following simple observations describing the way in which the two indicators operate.

- The higher the Products and Services Indicator of a bank the more attractive its Basic Image.
- The lower the Reachability Indicator of a bank the less attractive its Basic Image,
- If the Products and Services Indicator of a bank is continuously increasing but at the same time its Reachability Indicator is continuously decreasing, the Basic Image of the bank may be either attractive or non attractive and sudden changes in its state may be expected.

Observations (i) and (ii) describe the effects of the two Indicators when they act separately and independently of each other; observation (iii) on the other hand, describes certain effects which may be expected when both indicators are acting together. Observation (iii) is the most interesting because it implies that the graph we want to draw is discontinuous.

The general mathematical theory of discontinuous and divergent behaviour from continuous underlying forces is called Catastrophe Theory (Thom, 1975; Zeeman, 1973). The theory is derived from Topology and is based upon some new theorems in the geometry of many dimensions, which classify the ways in which discontinuities may occur, in terms of a few archetypal forms called elementary catastrophes (Poston and Stewart, 1996). Although the underlying mathematics are difficult and the proofs of the theorems involved complicated, the elementary catastrophes themselves are relatively easy to understand and can be used effectively, even by non-experts in the subject (Angelis and Dimaki, 2011). Catastrophe theory was developed and popularized in the early 1970's. After a period of criticism, it is now well established and widely applied (Rosser, 2007). Today, the theory is very much alive and numerous nonlinear phenomena that exhibit discontinuous jumps in behavior have been modeled by using the theory, for instance in chemistry (Wales, 2001), in physics (Aerts, 2003), in psychology (Van der Mass et al., 2003) in clinical studies (Smerz and Guastello, 2008) and in the social sciences (e.g. Smith et al., 2005; Dou and Ghose, 2006; Huang, 2008).

Table 1 summarizes the elementary catastrophes in the case where a process is expressed through one behaviour variable depending on one up to four control variables.

In the case of a process, for example, whose behaviour depends on two control variables it is sufficient to know that a theorem exists giving the qualitative shape of a 3-dimensional surface, which shows all possible ways in which a discontinuity in the behaviour may occur. The two control variables are usually referred to as normal and splitting factor respectively.

Table 1. Some elementary catastrophes

Number of Behavior Variables	Number of Control Variables	Type of Catastrophe
1	1	Fold
1	2	Cusp
1	3	Swallowtail
1	4	Butterfly

Elementary Catastrophes have characteristic invariant properties and, often, even wave flags (Gilmore, 1993) to gain our attention. Figure 1 illustrates graphically those five properties for the case of cusp catastrophe. Further details about them are given below:

- Modality arises when, for some combinations of values of the control parameters, there are two or more possible stable values for the state variable.

- Sudden Jumps take place when a small change in the values of the control parameters may result in a large change in the value of the state variable, as the system jumps from one local minimum to another.
- Hysteresis occurs whenever a physical process is not strictly reversible. That is, when the jump from one local minimum to another does not occur over the same point in the control parameter space as the reciprocal jump.
- Divergence arises when small changes in initial values of the control parameters lead to large changes in the final value of the state variable.
- Inaccessibility means that the physical system has an equilibrium state which is unstable.

Returning to the present case, our intention is to show that the process of shaping a bank's Basic Image may be modeled in terms of a cusp catastrophe. The first step towards this direction will be to show that at least some of the five invariant properties characterizing phenomena that may be described by the cusp catastrophe (i.e. bimodality, sudden transitions, hysteresis, divergence and inaccessibility) are present in our particular case.

The idea of bimodality and sudden transitions is not novel in banking literature. Banking crises and bank failures have developed many times throughout history, for the banking sector as a whole or for individual banks. The 18th century saw 11 banking and financial crashes and the 19th another 18, including American banking crises in 1819, 1837, 1847, 1857, 1873, 1884, 1890 and 1896. Finally, there were a healthy 33 such storms in the 20th century. Prominent examples of generalized crises include the bank run that occurred during the Great Depression, the U.S. Savings and Loan crisis in the 1980s and early 1990s, the Japanese banking crisis during the 1990s, and the subprime mortgage crisis in the 2000s. Typical examples of severe crises in individual banks include a number of banks all over the world (Henley, 2007). In all cases, banking crises, to varying degrees, have resulted, at a minimum, in large losses of wealth and disruptions in the supply of credit for investment and commerce and have caused considerable distress to investors and savers, large and small. Furthermore, resolving the crises has in most cases involved large outlays of public funds (Hardy, 1998). Some bank failures will continue to come as a surprise and appear as sudden crashes. On the other hand there are also cases of crises exhibiting an hysteresis i.e. a long gestation period. Those are the cases when banking crises appear to be imminent for a long period but do not occur, because of either backing by the government, risky activities undertaken by the management to overcome the problem or sheer luck. Those "measures" may work for some time but sooner or later the crisis will come. Banking history is full of such examples, the most recent of which is the case of two of Iceland's main banks (Magnusson et al, 2009).

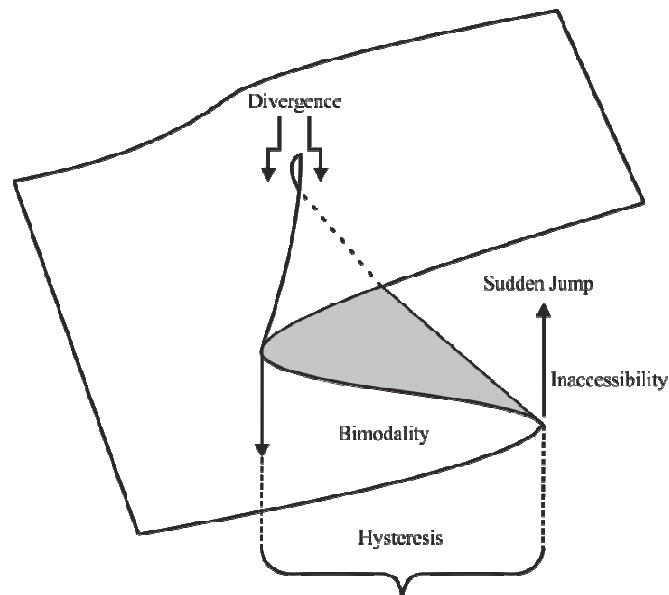


Fig. 1. The five characteristic properties of the Cusp Catastrophe graph

Divergence may appear in the case of two banks trying to penetrate a new market but their strategies concerning risk taking are different. Their development hence will be different and if the risk exposure of the risk - prone bank exceeds certain limits this may lead to problems and eventual failure. The idea of inaccessibility although never expressed explicitly, is not novel in banking literature. When a bank is facing possible bankruptcy, its owners and managers may take greater risks if they expect to avoid being held accountable. As a result, problems that can ordinarily be contained may be magnified, sooner or later the banking system will run into difficulties and the delayed failure will then be sudden and explosive (Hardy, 1998). The potential of high acceleration in the loss or gain of a bank's attraction power, once it has entered a cycle of deprivation or prosperity, suggests that in such cases a range of values of its Basic Image representing neutrality may be generally considered an unstable and therefore practically unattainable situation. In many cases banking crises start when a bank is overexposed to risk in an effort to increase its market share by offering more competitive products than its competitors. In most of these cases this exposition to risk is related to development and offer of specialty products aiming to satisfy specific needs of the market.

5. Modeling a bank's Basic Image

5.1. The general form of the model

We have so far shown that the process of shaping a bank's Basic Image has all the properties characterizing phenomena which may be modeled in terms of Catastrophe Theory. Hence, we may now use Catastrophe Theory to estimate a bank's Basic Image. It is reminded that the Basic Image of a bank has been defined as a function of two conflicting indicators. Therefore, the appropriate elementary catastrophe is the cusp. Consequently, the value x_i , $i = 1, 2, \dots, n$, of the i^{th} bank's Basic Image, at each point in time, is given as a solution of the equation:

$$x_i^3 - bx_i - a = 0 \quad (2)$$

with

$$\begin{cases} a = m(IND_i^1 - IND_0^1) + (IND_i^2 - IND_0^2) \\ b = (IND_i^1 - IND_0^1) - m(IND_i^2 - IND_0^2) \end{cases} \text{ if } m \leq 1$$

and

$$\begin{cases} a = (IND_i^1 - IND_0^1) + (1/m)(IND_i^2 - IND_0^2) \\ b = (1/m)(IND_i^1 - IND_0^1) - (IND_i^2 - IND_0^2) \end{cases} \text{ if } m > 1$$

- Equation (2) is referred to as the Basic Image Equation and its graph is qualitatively equivalent to the Cusp Catastrophe Graph (Figure 2).
- IND_i^1 and IND_i^2 express the values of the two Indicators for the i^{th} bank, while IND_0^1 and IND_0^2 express the values of those two Indicators for the "typical" bank. The point (IND_0^1, IND_0^2) corresponds to the vertex of the cusp, while $m = \tan \theta$ represents the slope of the cusp axis and expresses the relative weights attached to each one of the two indicators in defining the Basic Image. For the purposes of this work, the values of all Indicators lie in the interval $[0,1]$, whereas the value of its Basic Image lies in the interval $[-1,1]$. The value of the "typical" bank's Basic Image is 0. Hence, positive Basic Image indicates an attractive bank that may be considered as a potential final choice by the various groups of prospective customers.

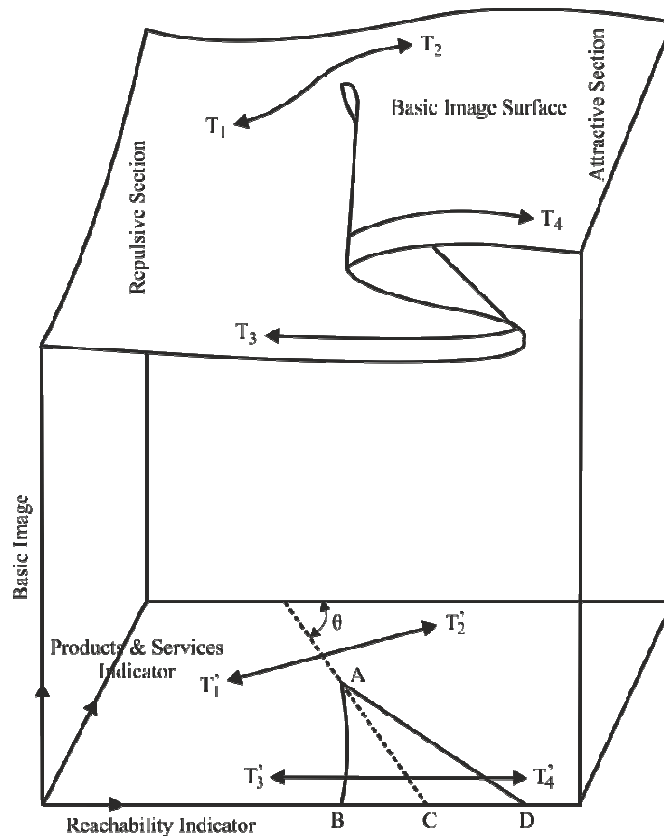


Fig. 2. The Cusp Catastrophe graph in the case of Basic Image

The position of the cusp in Figure 2 is indicative. The trajectory of a bank's Basic Image lies on the Basic Image surface. As long as the trajectory remains on the upper section of this surface, the bank is attractive, while if the trajectory moves on the lower part, the bank becomes repulsive. T_1T_2 and T_3T_4 are typical trajectories of a bank's Basic Image and $T_1'T_2'$, $T_3'T_4'$ are their projections on the two dimensional Control Space C .

We have so far defined a bank's i Basic Image as a function of a multitude of factors, grouped into two potentially conflicting indicators. A large variety of indicators, either simple or composite, quantifying the variety and quality of products and services on one hand and the physical and economic reachability on the other, may be found in the relevant literature. For the purposes of our model, those indicators are expressed as the geometric mean of several Sub indicators, each of which depends on a number of factors among those affecting the bank's Basic Image. The use of this geometric mean is justified by the fact that each one of the Sub indicators affecting the respective indicator is considered to be critically important for this indicator's value. Consequently,

$$IND_i^h = \sqrt[m]{\prod_{j=1}^m SBI_{ij}^h}, \quad h = 1, 2; i = 1, 2, \dots, n \quad (3)$$

where IND_i^h denotes the h^{th} Indicator of bank i and SBI_{ij}^h denotes the j^{th} Sub indicator of bank i , which is related to Indicator h . Each Sub indicator SBI_{ij}^h is defined as a non-linear function of a respective Relative Index RI_{ij}^h . This index is, in turn, a function of all variables, measured or estimated, affecting the Sub indicator and may be defined in the following two ways:

- The values of all variables, expressed in relative terms with respect to the typical bank, are used to obtain directly the Relative Index RI_{ij}^h , $h = 1, 2$, $i = 1, 2, \dots, n$, $j = 1, 2, \dots, m$.
- The variables are classified into various sets, depending on the specific component of the Sub indicator they affect. The values of all variables belonging to every set, expressed in relative terms with respect to the typical bank, are used to obtain directly the respective Relative Sub indices RSI_{ijk}^h , $h = 1, 2$, $i = 1, 2, \dots, n$, $j = 1, 2, \dots, m$, $k = 1, 2, \dots, r$. Finally, those Sub Indices are combined so as to give Relative Index:

$$RI_{ij}^h = \frac{\sum_{k=1}^r w_k RSI_{ijk}^h}{\sum_{k=1}^r w_k}, \quad h = 1, 2, \quad i = 1, 2, \dots, n, \quad j = 1, 2, \dots, m \quad (4)$$

where w_k , $k = 1, 2, \dots, r$ are weights indicating the relative importance attached to each Sub index in defining the respective Relative Index.

For the purposes of the present paper, the second way will be used. Once the Relative Index has been defined, its values are transformed so as to obtain the corresponding values of Sub indicator SbI_{ij}^h . For the purposes of the model, this transformation has been based on available data but, also, on assumptions consistent with generally accepted views expressed in literature. In the case of a given sub indicator SbI_{ij}^h , depending on a Relative Index RI_{ij}^h , a simple relationship has been used. As long as the value of the Relative Index RI_{ij}^h is close to 1, the value of the corresponding sub indicator remains also close to 1, i.e. close to the typical bank's value, thus indicating a limited variation of the sub indicator's influence on the bank's Image. However, as the value of the Relative Index RI_{ij}^h becomes substantially greater or lower than 1, in other words substantially better or worse than the typical bank's value, SbI_{ij}^h also increases rapidly, indicating its strong influence on the bank's development. An indicative transformation is shown in Figure 3. The prospective user of the model, however, may easily modify this transformation if his underlying set of assumptions is different.

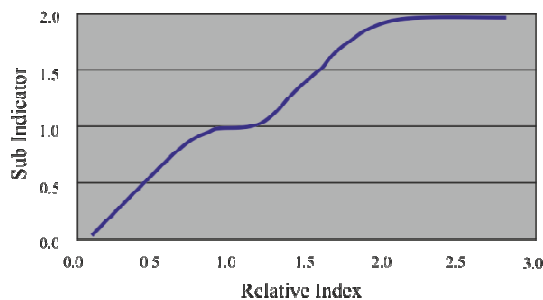


Fig. 3. An indicative transformation of a Relative Index into the corresponding Sub indicator

Note that each Sub indicator and the respective Relative Index summarize the same aspect of a bank's development. The transformation used works as a standardization process and it is needed to ensure that:

- All sub indicators have the same range. For the purposes of the model, all sub indicators have the same range values, usually $[0, 2]$; hence, the range of their product is $[0, 2^n]$ and, consequently, the range of IND_i^h , $h = 1, 2$; $i = 1, 2, \dots, n$ is also $[0, 2]$. In certain cases, however, the dominance of a particular sub indicator needs to be emphasized. This may be done by increasing its range. In such a case, the range of the remaining sub indicators must be modified, so that the range of their product remains the same i.e. $[0, 2^n]$.
- The effect of changes in the values of variables on the values of the respective sub indicators follows the same pattern for all sub indicators.

5.2. Estimation of the model parameters for the case under study

Returning to the present case it is reminded that the factors affecting a bank's Basic Image may be divided into two groups according to whether they concern the variety and the quality of the services offered or their physical accessibility and financial affordability.

Table 2. Indicators and Sub indicators

$IND_i^1 = \sqrt[2]{\prod_{j=1}^2 Sbl_{ij}^1}, i = 1, 2, \dots, n$		$IND_i^2 = \sqrt[3]{\prod_{j=1}^3 Sbl_{ij}^2}, i = 1, 2, \dots, n$	
where			
IND_i^1	The Products & Services Indicator of bank i	IND_i^2	The Reachability Indicator of bank i
Sbl_{i1}^1	The Variety of Products & Services Sub indicator of bank i	Sbl_{i1}^2	The Cost of Borrowing Sub indicator of bank i
Sbl_{i2}^1	The Quality of Products & Services Sub indicator of bank i	Sbl_{i2}^2	The Earnings from Deposits Sub indicator of bank i
		Sbl_{i3}^2	The Point of Sales Sub indicator of bank i

The factors of the first group properly quantified and scaled, give a measure of the variety and quality of the products and services offered. This measure is referred to as the Products & Services Indicator. Similarly, the factors of the second group give a measure of the accessibility and the cost of a bank's products and services. This measure is referred to as the Reachability Indicator. Furthermore, each of those Indicators is expressed as the geometric mean of several Sub indicators as shown in Table 2.

A clear overview of the variables affecting a bank's Basic Image and their conversion through Sub Indices, Relative Sub indices, Relative Indices and Sub-indicators into Indicators and finally into the bank's Basic Image is given in Table 3. The selection of the factors included in Table 3, is based on the available literature.

At this stage two points should be made: The first refers to the structure of a bank's Basic Image. The way in which Basic Image has been structured allows the researcher to determine not only any changes in the Basic Image value but also the causes of those changes. Going backwards from the Basic Image through indicators, sub indicators and relative indices to the variables, one can identify the causes of the Basic Image changes and hence propose the necessary measures. The second point refers to the variables which have been used to define a bank's Basic Image. One may argue that a number of significant variables expressing a bank's performance and the satisfaction of its customers are not present in Table 3. Such variables include: profits, share values, reliability, accuracy, speed, responsibility, convenience related considerations. This is true but, on the other hand, it should be reminded that of a bank's image is not a measure of the bank's performance and the satisfaction of its customers at a given point in time but a true picture of its current state of development and its future prospects. As it has already been mentioned, the measurable changes in the bank's performance and the satisfaction of its customers may be generally considered as the delayed and considerably smoothed consequence of changes in the Basic Image. Hence, a bank's Basic Image as defined, is a CRM based tool, which gives a reliable, overall estimate for the bank's prospects of development and an early warning for any potential danger. Finally, it must be underlined that the choice of variables used for the estimation of a bank's image depends, among other things, on the availability of data. In any way, however, our intention in this paper is to provide a generic framework for the estimation of a bank's Basic Image. Within this framework every researcher may make the appropriate modifications according to both his research requirements and the data availability. All the sub indicators presented in Table 3, are defined below.

The Variety of Products & Services Sub indicator of the i^{th} bank (Sbl_{i1}^1) is a non linear transformation of the Relative Variety of Products and Services Index (RI_{i1}^1), which quantifies the range of products and services offered by the bank. This relative index is expressed as the weighted average of four ratios, giving respectively, the number of deposit accounts, loan accounts, types of cards and customized products over the respective numbers for the typical bank. The weights attached to each ratio indicate the relative frequency of the respective product in the typical bank's range of products.

Table 3. Conversion of the variables affecting the Basic Image of bank i

Indicators of bank i	Sub indicators of bank i	Relative Indices of bank i	Variables of bank i	Variables of the typical bank
Products & Services Indicator (IND_i^1)	Variety of Products & Services Sub indicator (SbI_{i1}^1)	Relative Variety of Products & Services Index (RI_{i1}^1)	k : the number of different groups of products offered by the banks ($k=4$) p_{ik} : the number of different products and services within group k , offered by the i -th bank	p_{ik} : the number of different products and services within group k , offered by the typical bank
	Quality of Products & Services Sub indicator (SbI_{i2}^1)	Relative Quality of Products & Services Index (RI_{i2}^1)	e_i : the number of employees of the i -th bank b_i : the number of branches of the i -th bank	e_t : the number of employees of the typical bank b_t : the number of branches of the typical bank
	Cost of Borrowing Sub indicator (SbI_{i1}^2)	Relative Cost of Borrowing Index (RI_{i1}^2)	s : the number of the different groups of lending products offered by the banks ($s=2$) lp_{is} : the number of selected products within group s , offered by the i -th bank. IRL_{is} : the interest rates of selected products within group s , offered by the i -th bank	lp_{is} : the number of selected products within group s , offered by the typical bank IRL_{is} : the interest rates of selected products within group s , offered by the typical bank.
Reachability Indicator (IND_i^2)	Earnings from Deposits Sub indicator (SbI_{i2}^2)	Relative Earnings from Deposits Index (RI_{i2}^2)	dp_i : the number of selected deposit accounts offered by the i -th bank. IRD_{iq} : the interest rates of selected deposit accounts, offered by the i -th bank	dp_t : the number of selected deposit accounts offered by the typical bank IRD_{iq} : the interest rates of selected deposit accounts, offered by the typical bank
	Point of Sales Sub indicator (SbI_{i3}^2)	Relative Point of Sales Index (RI_{i3}^2)	l : the number of the different types of points of sales offered by the banks ($l=3$) p_{il} : the number of the different points of sales of type l , offered by the i -th bank.	p_{il} : the number of the different points of sales of type l , offered by the typical bank

Hence,

$$RI_{i1}^1 = \sum_{r=1}^k w_r \frac{p_{ir}}{p_{tr}} \quad \text{with} \quad w_r = p_r / \sum_{r=1}^k p_r \quad (5)$$

where k is the number of the different groups of products offered by the banks (for the purpose of our model $k=3$), p_{ir} the number of the different products within group r offered by the i^{th} bank and p_{tr} the number of the different products within group r offered by the typical bank.

The Quality of Products & Services Sub indicator of the i^{th} bank (SbI_{i2}^1) is a non linear transformation of the Relative and Services Quality of Products and Services Index (RI_{i2}^1), which quantifies the emphasis placed by the bank on the factors affecting the quality of its products and services. Such factors include personnel availability and level of education and training. For the purposes of this paper this index is expressed as the ratio of the number of employees per branch for the i^{th} bank over the same quantity for the typical bank. Hence,

$$RI_{i2}^1 = \frac{e_i}{b_i} / \frac{e_t}{b_t} \quad (6)$$

where e_i the number of employees of the i^{th} bank, b_i the number of branches of the i^{th} bank, e_t the number of employees of the typical bank and b_t the number of branches of the typical bank.

The Cost of Borrowing Sub indicator of the i^{th} bank (SbI_{i1}^2) is a non linear transformation of the Relative Cost of Borrowing Index (RI_{i1}^2), which quantifies the cost induced to the customers by the interest rates charged on all loan accounts. This relative index is expressed as the weighted average of two ratios. The first ratio is the average of interest rates of all lending products offered by the given bank, over the same figure of the typical bank. The second ratio is the average of interest rates of all cards offered by the given bank, over the same figure of the typical bank. The weights attached to the two ratios indicate the relative frequency of loan accounts and cards offered by the typical bank. Hence,

$$RI_{i1}^2 = \sum_{r=1}^s w_r \left(\frac{\sum_{q=1}^{lp_{ir}} IRL_{iq}}{lp_{ir}} \right) \bigg/ \left(\frac{\sum_{q=1}^{lp_{tr}} IRL_{iq}}{lp_{tr}} \right) \quad \text{with} \quad w_r = \frac{p_r}{\sum_{r=1}^s p_r} \quad (7)$$

where s is the number of the different groups of lending products offered by the banks (for the purpose of our model $s=2$), lp_{ir} the number of selected products within group r offered by the i^{th} bank, lp_{tr} the number of selected products within group r offered by the typical bank, IRL_{ir} the interest rates of selected products within group r offered by the i^{th} bank IRL_{tr} the interest rates of selected products within group r offered by the typical bank.

The Earnings from Deposits Sub indicator of the i^{th} bank (SbI_{i2}^2) is a non linear transformation of the relative Interest Rates of Lending Index (RI_{i2}^2), which measures the profits gained by the customers from the interest rates offered by the bank for the various deposit accounts. This index is expressed as the average of the interest rates of all deposit products for the given bank over the same figure for the typical bank. Hence,

$$RI_{i2}^2 = \frac{\sum_{q=1}^{dp_i} IRD_{iq}}{dp_i} \bigg/ \frac{\sum_{q=1}^{dp_t} IRD_{iq}}{dp_t} \quad (8)$$

where dp_i the number of selected deposit accounts offered by the i^{th} bank, dp_t the number of selected deposit accounts offered by the typical bank, IRD_{iq} the interest rates of selected deposit accounts offered by the i^{th} bank and IRD_{tq} the interest rates of selected deposit accounts offered by the typical bank.

The Points of Sales Sub indicator of the i^{th} bank (SbI_{i3}^2) is a non linear transformation of the relative Points of Sales Index (RI_{i3}^2), which quantifies the density and spread of the bank's points of sales network including both traditional branches and ATMs and online services. This index expresses the weighted average of three ratios expressing the number of branches, ATMs and alternative distribution channels of the given bank over the respective number of the typical bank. The weights attached to each ratio indicate the relative frequency of those two types of the points of sales in the typical bank's overall point of sales network. Hence,

$$RI_{i3}^2 = \sum_{r=1}^l w_r \frac{ps_{ir}}{ps_{tr}} \quad \text{with} \quad w_r = ps_{tr} \bigg/ \sum_{r=1}^l ps_{tr} \quad (9)$$

where l the number of the different types of points of sales offered by the banks (for the purpose of our model $l=2$), ps_{ir} the number of the different points of sales of type r offered by the i^{th} bank, and ps_{tr} the number of the different points of sales of type r offered by the typical bank.

6. Application of the Proposed Model

The methodology presented in the previous section is now used for the estimation of the Basic Image of a sample of nine banks (B1-B9) operating in Greece. The required data have been drawn from the official site of the Hellenic Bank Association. The results are shown in Table 4 which gives the values of Products & Services Indicator,

Reachability Indicator and Basic Image of all nine Greek banks for the year 2013. The values of Products & Services and Reachability Indicator for the typical bank have also been calculated and found to be 0.495 and 0.474 respectively.

Table 4. Basic Image and Indicator values for the nine banks operating in Greece ($\alpha_0 = 0.495$, $\beta_0 = 0.474$)

9 Banks Operating in Greece	Products & Services Indicator IND_i^1	Reachability Indicator IND_i^2	Basic Image of the i-th Bank
B1	0.627	0.527	0.616
B2	0.563	0.641	0.563
B4	0.561	0.557	0.519
B3	0.552	0.509	0.467
B8	0.575	0.403	0.414
B7	0.328	0.475	-0.449
B6	0.392	0.445	-0.463
B5	0.372	0.392	-0.568
B9	0.489	0.321	-0.632

The banking sector in Greece has changed dramatically over the last few years. Big and traditional banks but also a number of smaller banks, have been bought out by some newer banks, which have now become the key players in a game with much fewer participants. Banks B1-B4 are the big four banks in Greece after the reshuffling described above. Two of them are among the older and larger banks with long tradition and extended network of physical branches and ATMs. The remaining two are banks which grew rapidly, mainly through merges and buying outs in the last few years. Banks B5-B7 are smaller Greek banks with much fewer number of branches and ATMs (although spread throughout the country) and limited variety of products, although in some cases more attractive (i.e. high returns and low cost of borrowing). Finally, Banks B8-B9 are subsidiaries of foreign banks, focusing on selected market segments. Their network is confined to large urban centers but their products are in some cases very attractive (i.e. high returns and low cost of borrowing).

Looking at the results the following conclusions may be drawn:

- The nine banks may be classified into two groups. Group 1 contains five banks with positive Basic Image, whereas Group 2 contains four banks with negative Basic Image.
- Group 1 may be split into two sub groups:
 1. Sub group 1.1 contains four banks (B1-B4) with the higher Basic Image values. All four of them have higher than average Products & Services Indicator and Reachability Indicator.
 2. Sub group 1.2 contains one bank (B8) with Basic Image value somehow lower than the respective values of Sub group 1 banks. It has higher than average Products & Services Indicator and lower than average Reachability Indicator.
- Group 2 may be split into two sub groups:
 1. Sub group 2.1 contains three banks (B5-B7) with very low Products & Services Indicator and slightly below average up to average Reachability Indicator.
 2. Sub group 2.2 contains one bank (B9) with very low Reachability Indicator and slightly below average Products & Services Indicator.

It should be noted that the limited reachability of certain banks may be explained by the fact that they focus on selected groups of customers which are located to specific geographical areas (i.e. big urban centres) and/or use alternative distribution channels. On the other hand, it must also be said that banks with low reachability may increase it indirectly through agreements allowing their customers to use other bank's points of sales network without extra charge, an option which has not been built into our model.

The estimation of a bank's Basic Image for a given year gives a "snapshot" view of a bank's development. A more interesting exercise however, would be to estimate the bank's Basic Image for a number of years, to identify its respective trend and to study its changes. It must be noted that the way in which the Basic Image has been

structured, allows the researcher to determine not only the changes in the bank's Basic Image value, but also the causes of those changes. Going backwards from the Basic Image, through indicators, sub indicators, indices and sub indices to the variables, one can identify the real causes of the Basic Image changes. Hence, the Basic Image may prove a very useful managerial tool for both bank management and investors. The bank management may use the Basic Image in order to monitor its development, get an early warning of any potential problems it may face and take the necessary measures to prevent them. The investors on the other hand, may use the Basic Image in order to follow the development of various banks, assess their potential for future growth and take the proper investment decisions.

7. Conclusions and suggestions for further research

A bank's growth depends on its ability to retain existing customers and attract new ones. This ability depends on what we call the image of a Bank and it is a measure expressing the bank's current state of development and its future prospects. The paper introduced the concept of a Bank's Image, developed a mathematical model for its estimation, applied the model to the case of nine banks operating in Greece and presented the results. The Basic Image gives a "true" picture of a bank's current state of development and an early warning of any future problems. Furthermore, its structure allows a researcher to identify not only the changes in the Basic Image value, but also the causes of those changes and hence to propose the necessary measures. Consequently, the Basic Image may prove a very useful managerial tool which can help a bank's management to improve its operations and development. The application results seem logical and expected. They show that the proposed model expresses a bank's attractiveness in a realistic way, in the sense that it quantifies the bank's appeal to the full range of its existing and potential customers. Banks with numerous, high quality, competitive products and large distribution networks show positive Basic Image. On the other hand banks with fewer, less competitive products and smaller distribution networks show negative Basic Image. One may argue however, that the customers of certain banks with negative Basic Image may be satisfied by the services provided. This may be true but on the other hand the negative Basic Image of those banks indicates that the satisfaction of their niche markets may be the limit of their capacity. Furthermore, their negative Basic Image implies an unstable equilibrium which may be easily overthrown. Nevertheless a number of improvements may be made.

The definition of the Basic Image has been based on the assumption that all groups of potential bank customers react similarly to a basic set of criteria. A different approach would be to consider that the basic set of criteria is different for the two main groups of bank customers, business and individuals, both in terms of the variables included in them but also in the relative weight attached to each of those variables. Hence, a first area of further research would be to identify the main variables affecting the members of each group, as well as their relative weights, and define the corresponding Basic Images.

The Basic Image as defined so far has left out a number of important variables, endogenous or exogenous. Hence, another area of further research would be to redefine a bank's Basic Image, or Basic Images in case we have differentiated between corporate and retail banks, so as to include some of those variables. A first set of such variables may be those referring to the general economic environment where the bank operates and could define a third indicator, which may be referred to as the Economic Environment Indicator. A second set of variables may be those related to the bank's brand name, history and tradition and could define a fourth indicator which may be referred to as the bank's Status Indicator. As we have seen in section 5, in the case of three or four Indicators the most appropriate elementary catastrophes are the Swallowtail and the Butterfly Catastrophes respectively. Hence a second area of further research will be enrich the Basic Image or Basic Images and examine how those elementary catastrophes may be used to model them.

The Basic Image, as already mentioned, expresses a bank's appeal to all potential customers. However, it cannot take into account the differences in the needs and preferences of the various groups of customers and this, in certain cases like the case of subgroup 2.2 banks, may lead to wrong conclusions. To overcome this problem we must identify the specific factors for all groups of customers and define the bank's Specific Images as perceived by each of those groups. The definition of those Specific Images may be a third area of further research.

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