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**ANALYSIS OF SURVIVAL AS A TOOL FOR DETECTION
OF SYSTEMIC RISKS IN DECISION-MAKING:
A PROPOSED THEORETICAL MODEL FOR SPANISH
CREDIT COOPERATIVE SECTOR**

In the literature on cooperative financial system it is needed to undertake empirical studies to provide evidence on systemic risk and the factors that cause it. This paper discusses how the important process of restructuring the financial system, following the tough economic and financial crisis in late 2007, has triggered ongoing regulatory changes which have led to the adaptation of the entire financial system. In the case of credit cooperatives, the new economic and regulatory environment has resulted in numerous mergers and cooperative group membership as a way to ensure their survival. That is why the aim of this paper is to provide a preventive tool that allows the analysis of the survival of these entities. In practice, after analysing sector balance sheets from 2007 to the first quarter of 2012, the theoretical application of the work of Kaplan-Meier and Cox regression model allowed us identify the variables that explain the processes of sector concentration in Spain.

Keywords: survival analysis model, restructuring of Spanish financial system, credit unions, systemic risk.

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**АНАЛІЗ ВИХОДУ З КРИЗИ ЯК ІНСТРУМЕНТ ВИЯВЛЕННЯ
СИСТЕМНИХ РИЗИКІВ У ПРОЦЕСІ ПРИЙНЯТТЯ РІШЕНЬ:
ТЕОРЕТИЧНА МОДЕЛЬ ЗА ДАНИМИ ІСПАНСЬКИХ
КРЕДИТНИХ КООПЕРАТИВІВ**

У статті описано процеси реструктуризації фінансової системи після жорсткої фінансово-економічної кризи 2007 р., нормативні зміни у всій фінансовій системі. Для кредитних кооперативів нове економічне і нормативно-правове середовище призвело до численних злиттів і кооперативного членства як способу виходу з кризи. Описано профілактичний інструментарій, який дозволить провести аналіз виживання кооперативів на ринку. Аналіз даних галузі з 2007 р. по перший квартал 2012 р., теоретичне застосування роботи Каплана-Мейєра і модель регресії Кокса дозволили визначити змінні, які пояснюють процеси концентрації в кооперативному секторі Іспанії. Ключові слова: моделі аналізу виживання, реструктуризація іспанської фінансової системи, кредитні спілки, системні ризики.

Табл. 2. Рис. 3. Форм. 10. Літ. 31.

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**АНАЛИЗ ВЫХОДА ИЗ КРИЗИСА КАК ИНСТРУМЕНТ
ВЫЯВЛЕНИЯ СИСТЕМНЫХ РИСКОВ В ПРОЦЕССЕ ПРИНЯТИЯ
РЕШЕНИЙ: ТЕОРЕТИЧЕСКАЯ МОДЕЛЬ ПО ДАННЫМ
ИСПАНСКИХ КРЕДИТНЫХ КООПЕРАТИВОВ**

В статье описаны процессы реструктуризации финансовой системы после жесткого финансово-экономического кризиса 2007 г., нормативные изменения во всей финансовой

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системе. Для кредитных кооперативов новая экономическая и нормативно-правовая среда привела к многочисленным слияниям и кооперативному членству как способу выхода из кризиса. Описан профилактический инструмент, который позволит провести анализ выживания кооперативов на рынке. Анализ данных отрасли с 2007 г. по первый квартал 2012 г., теоретическое применение работы Каплана-Мейера и модель регрессии Кокса позволили определить переменные, которые объясняют процессы концентрации в кооперативном секторе Испании.

Ключевые слова: модели анализа выживания, реструктуризация испанской финансовой системы, кредитные союзы, системные риски.

1. Introduction.

The current international financial crisis that began in August 2007, was triggered after an expansionary cycle which has meant the disintegration and instability in various sectors of Spanish economy. Specifically, in the financial sector the implemented expansionary policies and irresponsible credit risk efforts have led to the aggravation of the situation (Martin, 2010). Furthermore, in countless cases, financial transactions have been conducted, only moving risks and not producing any value (Ocana and Carbo, 2011). Also, the oversizing of Spanish financial sector is another source of structural imbalance, resulting in weaknesses in its future viability.

Thus, the continued economic instability and changes taking place in the real economy, and more specifically in the financial sector, has encouraged industry players to rethink its corporate strategy to promote long-term survival (Cardwell, 2009). In this sense the most important strategic change that has occurred in the field is determined by continuous mergers between institutions, with the aim of strengthening their position (Belmonte, 2012). This phenomenon was strongly encouraged and supported by the international standards set by the Basel Committee (Basel III) and subsequent regulatory change processes, both at community and national level, led by financial reform and development of Royal Decree Act 9/2009 of June 26, on bank restructuring and strengthening equity of financial institutions.

Within the banking system, the business model of credit cooperatives is based more on sustainability and the application to productive sectors, due to the very practice that causes the birth of the same. The less speculative nature of these entities, makes it attractive to study the systemic risk that can occur in this sector. In addition, the study will allow the detection of systemic risk microeconomic factors that have occurred in recent mergers. In this regard, it should be noted that the area of Spanish credit cooperatives has been one of the most active in banking concentration processes (Belmonte, 2011), while it has been one of the least studied, due little relevance to their market share. To the best of our knowledge, this is the first attempt of application of the survival analysis to the credit cooperative sector. There are only certain referents to the commercial banking sector, such as the work of Ayala et al. (2006) in which the survival analysis on Venezuelan banks is applied. These arguments have led to the development of a model for detecting systemic risk factors applied to the process of restructuring and concentration in Spanish credit union sector.

The main objective of the research is to provide a preventive tool to detect difficulties and risks incurred by institutions as a way to support decision-making processes. Our interest is to study the risk of failure that can be generated from the merger or membership in a cooperative financial group. To do this, we propose a model for

detection systemic risk, which has been drawn from the experiences of concentration carried out in the area of Spanish credit cooperatives.

When defining variables of the model the provisions of Basel III have been taken into account, on minimum capital requirements, liquidity, leverage, efficiency and profitability, which will give us an idea of the risks that incurred by the entities that have proposed their merger. These factors, and the likelihood of risk of merger, are determined by a set of hypotheses to be tested through the survival analysis techniques, such as the Kaplan-Meier and Cox regression models.

From now on, the work is divided into 3 different blocks. The first is the review of the literature on the credit union sectors, of which main features, structure and recent concentration processes that have occurred are listed. Secondly we present the methodology of the survival analysis model. Finally, we present the results of the analysis and we conclude with the section with the main thoughts of work.

2. The sector of credit cooperatives in Spain. Features and analysis of concentration.

Consistent with works like Fama and Jensen (1983) and Ory (2004), about those distinctive features that characterize credit cooperatives, we can identify the following distinctive features of the sector internationally:

- Singularity in the configuration of capital. The equity is not related to the decision-making power, the latter being divided evenly between partners. Soler (2002) calls it the principle of "one member, one vote", in which the political right is not related to greater participation in capital, but by the mere fact of membership, regardless the volume as capital.

- Its capital is variable and subject to the voluntariness of partners. In this sense there is a "freedom" that can be called as the willing of the partner to increase, maintain or decrease their contribution to capital. This feature leads to not specifying complex and lasting mechanisms of enlargement or reduction of capital.

- Importance of the common interest underlying their origin (Belmonte, 2007). The birth of the entity and its original mission will determine the future of the same. Belmonte (2007) states that "normally the clarity and identification of the common interest drives homogeneous and low turnover "customer" to join together to achieve a larger entity."

- They are private entities, which merge characteristics of a cooperative society and a credit institution. They provide preferential service to its members. As stated in Law, the service must prevail financial service to its members, although non-members customers may be served on request. In this sense, there is a restriction on the total investment operations that can be performed with non-members customers. In particular, they must not exceed 50% of the volume of total capital of a cooperative.

- Social commitment. In accordance with fulfilling its social function, every year benefits should be spread which were obtained in the previous year to a reserve constitution of the following:

- o Transfer to or less than 20% of the profit to the Reserve Fund Obligation (FRO).

- o Transfer to or less than 10% of income to the Education and Development Fund (EFF) for welfare activities, culture etc.

I. The concentration of the credit cooperative sector.

The concentration process of Spanish credit cooperatives is gaining importance in recent months as a result of the significant changes taking place throughout Spanish financial system. Specifically, the sector of savings has finally disappeared, becoming commercial banks, so it is interesting to know what would be the outcome of the credit cooperative sector.

The integration process and industry cluster of credit cooperatives is not new; from the beginning of the century and mainly in European countries like France, Germany, Netherlands, Italy and Belgium has taken the place gradual process of cooperative banking grouping, forming strong business structures or comparable to other financial groups. In this respect, the accession and integration processes have been made in view of the similarity of corporate culture, organizational and operational levels (Palomo, 2000).

In recent years, the degree of concentration of Spanish cooperative sector has increased, mainly due to mergers between rural banks. In this sense, the impact on customers has been decreasing their negotiating power by reducing the number of financial bidders (Melian, Campos and Sanchis, 2011). This is because while small banks maintain their policy of supporting their customers-partners, larger banks are increasingly distant from its founding principles, charging higher fees to their customers, partners and finance sectors remote from the primary sector (Belmonte and Cortes; 2010; Chaves and Soler; 2004).



Source: Own, elaborated from UNACC (several years).

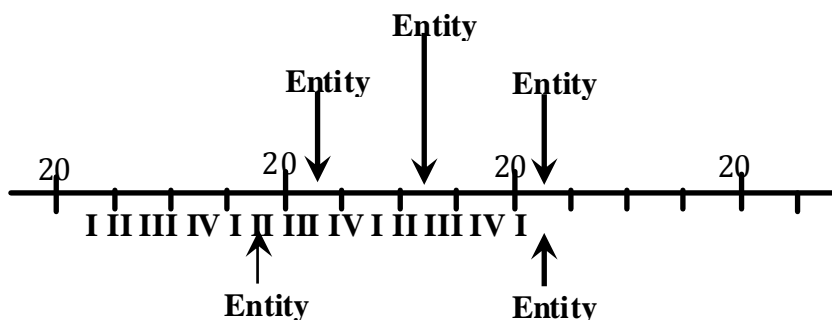
Graph 1. Proposed consolidation of Spanish cooperative sector

Concentration processes that have taken place pursued the goal of achieving greater strength and profitability of groups. However, there has been a curious fact, as small entities, the absorbed, technically were presented with better results. In this sense, one can say that the size is not always synonymous to profitability and efficiency. In most cases, the motivation of large institutions for growth is to capture more customers.

II. Process of forming a cooperative group.

As a prelude to the exhibition of the theoretical model of systemic risk, it is necessary to know how to develop and consolidate the process of formation of a group within the credit cooperative sector (Chart 2). In this case, we call group Z to the merged entity. In practice, this group took legal form in 2009, when the power of becoming consolidated financial group was recognized, as established in Article 8 of Law 13/1985 of 25 May on investment ratios, capital and information obligations of

financial intermediaries. It should also be noted that the incorporation of a new entity to a cooperative group requires approval from the Bank of Spain.



Source: Own source.

Graph 2. Formation process of group Z, 2009–2011

3. A proposed model of survival analysis.

For several decades, there was a number of models to determine which are the main risk factors assumed by banks. They are known as "early warning models" and basically are in charge of predicting the likelihood that substantial change in the conditions of solvency and liquidity of banks. In sum, are equally useful to determine which are the main risk factors, that assume the merged entities. In this regard, Gomez-Gonzalez and Orozco (2009) defines it as a basic tool of regulators and supervisors to detect vulnerabilities and "health" of entities and the financial system as a whole. Moreover, this type of preventive studies, are more profitable than others in-situ studies, which involve direct monitoring of each entity (Brossard et al., 2006).

From the methodological point of view, the research approach is based on the use of survival analysis tool as a way to check the probability of occurrence of the merger of a particular entity in the time studied, and identify where certain extent affected the quantitative micromagnitudes therein (also defined as microeconomic factors of systemic risk). Specifically, we use the estimated Kaplan-Meier and Cox regression model, which will be applied to the concentration process conducted by Spanish credit cooperative sector from 2007 to the first quarter of 2012. In addition, there is a history of application of this technique, as is the work of Ayala, Borges and Colmenares (2007) in which the technique of survival analysis on the integration processes produced in Venezuelan banks is applied during the period 1996–2004.

I. Theoretical approach to survival model.

Survival analysis focuses on the study of a set of subjects defined for a particular event or event of interest, which can be termed as a failure after a given time interval (Klein and Moeschberger, 1997, Hosmer and Lemeshow, 1999, Lee and Wenyu, 2003). In the study that raises the event or incident shall be the completion of a merger or joining a group.

In the work of Cox (1984) there are 3 requirements to determine the time of failure:

- Moment (time) of start. In our study, the starting time is the year 2007, because it is the year for which the data is available, it is the starting year of the financial crisis and is also the year in which greater forming process of cooperative groups occurs.

– Scale of measurement over time. Measured in quarters, as information is obtained based on formal statements issued by the UNACC and is sectioned by quarters. By providing information on the total of 21 times, from 2007 to 2012.

– Event or event of interest. As discussed above, will be determined by the occurrence of a merger or joining a cooperative group.

The methods used in the research are the Kaplan-Meier and Cox regression model. It is important to note that both methods assume that subjects who leave the study before completion (censored events), will behave the same way as those who have been followed to the end (Martinez Gonzalez et al., 2007).

– **Survival and risk function.**

In the survival analysis is essential to consider the non-negative random variable T , representing this time duration or lifetime until the event of interest occurs defined (fusion/adhesion) can take the values $0 \leq t_1 \leq t_2 \dots$. The random variable T has:

– Probability density function:

$$f(t) = P(T = t) \tag{1}$$

Represents the probability of occurrence in time less than or equal to t of the event of interest.

– The survival function is defined as:

$$S(t) = 1 - F(t) = P(T > t) = \int_0^{\infty} f(u) du \tag{2}$$

expressing the probability of occurrence in a period of time longer than t of the event of interest occurs. Where $f(t)$ is the function that satisfies $\int_0^{\infty} f(t) dt = 1$.

In the case of having a discrete variable, the survival function will be defined:

$$S(t_i) = \sum_{i|t_i \geq T} f(t_i), i = 1, 2, \dots \tag{3}$$

Furthermore, it is important to define the role of risk function (hazard function) as that which includes the possibility of occurrence of the event of interest in the study time interval, i.e. the risk function of occurrence of the event of interest has not happened since at least the previous period. In our case study, the hazard function refers to the possibility that a merger occurs or adherence to a cooperative group, conditional on the immediately preceding period it occurred. This function can be described as:

$$h(t) = \lim_{\Delta t \rightarrow 0} \frac{P[t < T \leq t + \Delta t | T > t]}{\Delta t} \tag{4}$$

Thus, $h(t)\Delta t$ can be assumed to represent approximately the probability that a given individual "live" (still not be merged) when the event of interest present in the following period $t+1$.

It can be concluded that the survival function can be described, so that in the case of having a discrete variable is:

$$S(t_i) = \prod_{i=0}^{i-1} (1 - h(t_i)), i = 1, 2, \dots \tag{5}$$

– **Survival function estimator: Kaplan-Meier.**

Since in practice not always a parametric model for the survival function is provided, we recommend the use of nonparametric methods for estimation. This is the case of the Kaplan-Meier estimator (1958) survival function.

The Kaplan-Meier estimator uses all the information available for estimating the survival function of both processes, uncensored and censored. For any point in time represents the multiplication of a sequence of conditional probabilities of survival, resulting in the number of subjects or cases at risk (entities) and the number of events of interest (mergers) produced in an instant of time.

Defining survival function gives us the Kaplan-Meier method, we obtain:

$$\hat{S}(t) = \prod_{t_i \leq t} \frac{n_i - d_i}{n_i}, i = 1, 2, \dots \quad (6)$$

definition of the parameters used in the function:

n_i – number of subjects at risk at the time temporarily.

d_i – number of "deaths" of subjects in the temporal moment t_i .

– **Proportional or regression hazards model of Cox.**

It will be essential to the study the proposal raised in the investigation to know if the risk of the event of interest occurs in different ways between different subjects because each has a number of features that will initially distinguish them from the rest. The way to implement this idea is based on identifying a set of explanatory variables denominated as microeconomic factors of systemic risk, and known in the Cox regression model as covariates (Fuentelsaz et al., 2004), that allow us to identify the heterogeneity of individual study subjects according to risk.

a) Definition of quantities defined as microeconomic factors of systemic risk in the model.

The way to deal with the heterogeneity presented by each subject is based on inserting in the model a number of endogenous features to differentiate various entities within a group. This will have a set of variables that may be defined in a vector so that:

$$X_{ij} = (X_{i1}, X_{i2}, \dots, X_{ip}), \quad (7)$$

where i corresponds to each of the subjects (entities) and j is the characteristics of each.

In order to study the heterogeneity and the "health" in economic and financial terms, presented by each of the entities comprising Spanish cooperative financial system has been proposed as a method to introduce a series of ratios or magnitudes in the model approach. These ratios are considered as explanatory variables of the model and will be determined as microeconomic factors of systemic risk. In practice, it has been used on the financial information available to each group entity through public financial statements by UNACC.

For the selection of the explanatory variables of the model, we have taken into account the work of Aching (2006) and Palomo and Sanchis (2010). In both cases, are discussed the effects of mergers on concentration and efficiency of Spanish rural bank sector. In addition, we have taken into account the regulations of Basel II and III on to the solvency of financial institutions. Therefore, we have proceeded to create a mix of ratios or covariates, ranked in 5 pillars or magnitudes (Table 1).

Other authors who have also used the ratios or covariates approach with the aim of the health study presented by financial institutions and have in mind the above indicators proposed for the study have been Bunn and Redwood (2003) and Zamundio (2007).

Table 1. Magnitudes of application of the model

Magnitude	Reference
Solvency	Basel III, Aching (2006)
Liquidity	Basel III, Aching (2006)
Leverage	Basel III, Aching (2006)
Efficiency	Palomo & Sanchis (2010), Server & Melian (2001) & Belmonte (2007)
Profitability	Palomo & Sanchis (2010) & Aching (2006)

Source: Own

In summary, the group of ratios or covariates, which will be determined as microeconomic factors of systemic risk, proposed for the aforementioned variables are:

Table 2. Ratios or model covariables

Magnitude	Ratio of covariable	Expression
Solvency	Total Solvency Ratio	Total Assets / Total Liabilities
Liquidity	Immediate Liquidity	Total Current Assets Account (Cash and central banks) / Current Liabilities Accounts (Deposits and Debits)
Leverage	Leverage Ratio	Total Liabilities / Equity
Efficiency	Efficiency to Total Assets	Exploitation / Total Assets
	Gross Operating Income	Exploitation / Ordinary Income
Profitability	Net Economic Performance	Profit for the year / Total Assets
	Net Financial Profitability	Profit for the year / Equity

Source: Own

b) Cox regression model and survival function.

It is a semiparametric model as it is lowered in a parametric technique, i.e. expressed as a regression model with a specific functional form, but, on the other hand, is not a pure parametric technique, since it does not have an exact functional form for distribution which collects survival times (Allison, 1984).

In this case, the Cox regression presents a risk model $h(t)$, based in the time and covariates designed. It is presented as the product of two terms, measuring the effect of covariates vector defined on the hazard function. The Cox regression model is defined as:

$$h(t; x) = h_0(t) \cdot r(x), \tag{8}$$

where $h_0(t)$ is the baseline risk function, and $r(x)$ the function of the values of the vector of covariates for each subject (entity). The latter can be interpreted as the risk at the instant of time t for a given subject, which has x_i covariates relating the risk of a subject (entity) with the vector of covariates equal to zero (Ayala et al., 2007).

Due to the non-negativity presented by the function $r(x)$, the Cox regression model, for each subject (entity) can be presented as:

$$h(t; x) = h_0(t) \cdot e^{(\beta_1 x_1 + \beta_2 x_2 + \dots + \beta_p x_{p_i})}, \tag{9}$$

where β is a vector of unknown parameters $\beta = (\beta_1, \beta_2, \dots, \beta_p)$.

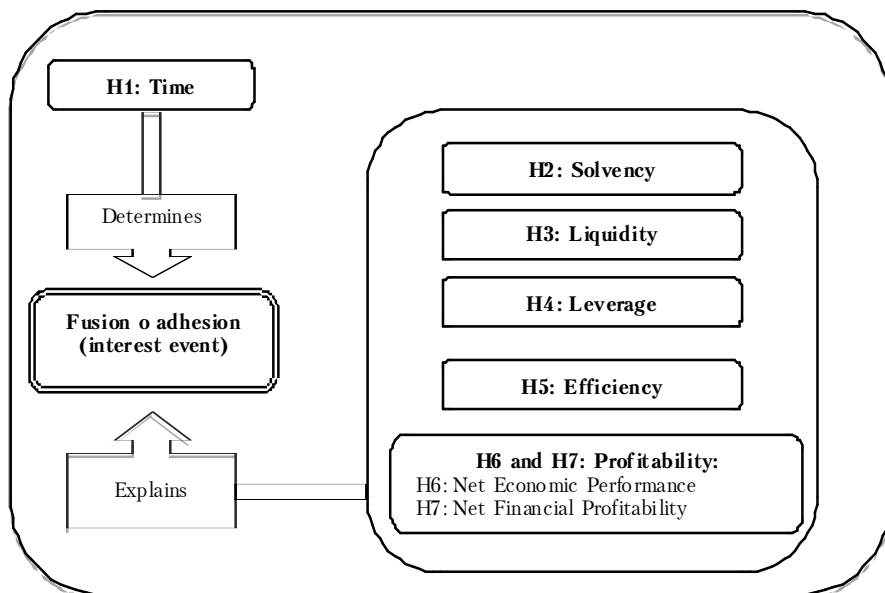
Finally we present the survival function based on the assumption Cox model, defined as follows:

$$S(t | x) = S(t) e^{-x\beta} \tag{10}$$

II. Scenario approach.

After the presentation of the different survival analysis techniques to be applied to the model, we present various scenarios that will arise:

- H1: The time variable determines the merger process.
- H2: The solvency plays a direct and positive influence in the merger process of the group.
- H3: Liquidity plays a direct and positive influence in the merger process of the group.
- H4: The leverage plays a direct and positive influence in the merger process of the group.
- H5: The efficiency plays a direct and positive influence in the merger process of the group.
- H6: The profitability plays a direct and positive influence in the merger process of the group.
- H7: The financial profitability plays a direct and positive influence in the merger process of the group.



Source: own

Graph 3. Model for detecting systemic risk factors in the process of cooperative financial system concentration

4. Expected results.

Once exposed the problem of the study, as well as the tools to be used as a method to meet the assumptions made in the model definitely raised, the results expected will be presented. To do this, all calculations are carried out using the R-Project software, specific for the performance of the Cox regression model.

First, and as a way to validate the model, we will conduct an analysis of reliability and consistency of it through the Cox regression model. This analysis is done

through a series of tests and contrasts offered by the R-Project software, such as proof of the likelihood ratio, Wald test and pointing, which is to verify the null hypothesis (as $H_0: \beta = 0$), i.e. the vector of variables in the model is 0; in this way it is intended to validate the joint model contrasts. Also as a way to dismiss or choose the whole model and check the consistency of it, we study the value provided by the R-squared and the adjusted value of the previous.

In providing a good adjustment, this will check if the time variable influences and determines the mergers that have occurred in the financial cooperative system for formation of cooperative groups in the time period studied, and therefore the application of the Cox regression model is valid for our initial approach.

After checking the adjustment, and finding that the time variable is determining the process of restructuring the financial cooperative sector for our proposed model we will verify that (if these exist) microeconomic systemic risk factors defined for the model explaining the merger process that have led organizations to the formation of cooperative groups, i.e. which of them are significant for the model, and what proportion have affected each of them.

5. Conclusions.

Since the beginning of the international financial crisis, the impact on the international banking system has been particularly important, as it led to the disappearance of many entities. So, in a turbulent and rapidly changing environment, the ongoing regulatory changes, Basel II and III, G20 meetings, intended to bring back normality to international finance to return on the path of growth to the real economy.

In Europe sphere, more specifically, in the case of Spain, the EU directives and national decrees seek to tackle the tough financial crisis. However, in European context the problem is even more complicated, because of the interconnection of banks, which lack a single financial supervisor and nationalism prevents having common financial rules.

In this scenario, Spanish financial system has undergone major policy changes from 2008 to now. This is a great process of reforms aimed primarily at promoting concentration of the banking system to ensure the survival of many financial institutions through mergers and joining larger groups. This is the case of the credit cooperative sector, which is in an ambitious process of concentration, in order to earn credit and obtain an optimum size to compete with big banking groups that are being formed in Spain.

However, there is evidence that the concentration of entities may pose a major risk to future survival, due to the conditions in which sometimes they materialize. That is why the main objective of this study was to answer the need for a preventive tool that provides answers to the opportunity to participate in the process of redimensioning.

Technically, the answers provided by the theoretical model have been proposed based on the analysis of survival, specifically in the method of Kaplan-Meier and the Cox regression model. In any case, the objective is clear: to identify the incidence of a number of variables, especially time, to determine the process of concentration of the credit cooperative sector.

In sum, this theoretical model aspires to become a system of warning and detection of certain magnitudes that are especially significant in the field of Spanish cred-

it cooperatives and may have some importance in the successful conclusion of a process of concentration. Moreover, the validity of this model for the sector of Spanish credit cooperatives may be the start for a similar study for other European cooperative entities.

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