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ORIGINAL PAPER

On the customer lifetime value: a mathematical perspective

R. Ferrentino[1] · **M. T. Cuomo**[1] · **C. Boniello**[1]

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Abstract The customer lifetime value (CLV) is an important concept increasingly considered in the field of general marketing and in the management of firms, of organizations to increase the captured profitability. It represents the total value that a customer produces during his or her lifetime, or better represents the measure of the potential profit generating by a customer. The companies use the customer lifetime value to segment customers, analyze probability of churn, allocate resources or formulate strategies and, therefore, they increasingly derive revenue from the creation and from sustenance of long-term relationships with their customers. For this reason, the customer lifetime value is increasingly considered a touchstone for the management of customer relationships. In this article, the authors deepen the concept and use of customer lifetime value and present some mathematical models for its determination. There is many models for this purpose but most of them are theoretic, complex and not applicable. Though not exhaustive, the major contribution of this paper is that it provides a general mathematical formulation to estimate the CLV and that it has a context less specific compared to papers, present in literature, on the customer lifetime.

Keywords Customer lifetime value · Customer equity · Customer profitability · Customer retention · Persistence models

✉ R. Ferrentino
rferrentino@unisa.it

M. T. Cuomo
mcuomo@unisa.it

C. Boniello
cboniello@unisa.it

[1] Department of Economic and Statistics Sciences, University of Salerno, Fisciano, Salerno, Italy

1 Introduction

More and more firms are focusing on nurturing relations with customers for long lifetime and on obtaining subsequently higher profitability and growth; the companies, namely, increasingly derive revenue from the creation and from sustenance of long-term relationships with their customers. As a result of this approach, in recent years, the marketing activities and the performance evaluations are increasingly organized around relationships with customers rather than around products. In other words, the focus of firms has shifted from treating customers as an simple entity, involved in the business process, to treating them as a crucial component of their success. In particular, the importance of a customer is no longer judged by his or her single transaction with the firm, but rather by the series of transactions or potential transactions with the firm.The customers are considered, namely, in terms of ongoing relationships rather than in terms of transactions. In other words, the customer loyalty is important for increase in profitability and, consequently, the customer life cycle has taken a central role in marketing strategy compared to product life cycle considered in the past. From a firm's perspective, the customer life cycle can be best understood as a series of transactions between the firm and its customer over the entire time period during which the customer remains in business with the firm. The customer life cycle varies from business to business and from customer to customer and could be short or long depending on the nature of business of the firm, on the profile of its customers and on the interaction between the firm and its customers. As an example, older customers with a long history of transactions with a bank are more likely to be retained and hence have a longer life cycle as compared to younger customers newly acquired (Wheaton 2000). Because of this increase in importance of customers relationships, the activities of a firm are now geared more toward developing long-term relationship with a customers.

The companies must, therefore, to invest in relationships with customers and, for this, they have to decide with which potential customers to engage and they need information on the potential value of a relation. A useful measure of this potential value of a relation with customers is the *customer lifetime value* (CLV) that, therefore, can be defined as a discounted measure for future income. More precisely, the customer lifetime value is generally defined as the total net income that a company can expect from a customer or better as the value of all future profits obtained from a customer over the entire time that it relate with the company. According to some researchers Gruca and Rego (2005) and Payne et al. (2005) the companies, the firms, that are able to get the greatest annual increases in the value of their shares, are those who make investments to increase the internal satisfaction (of the employees) and the external satisfaction (of the clients). The satisfaction or the dissatisfaction of a customer indicates "a special feeling of pleasure or disappointment resulting from the comparison between the perceived performance of a product and its expectations" (Kotler and Keller 2007). Therefore, if the customer satisfaction level is high, his loyalty tends to increase, becoming "the main driver of financial performance in the long term". The satisfied customers allow, for example, to the companies to achieve an increase and a stabilization of the net cash flows and even the rise and consolidation of revenues (Fornell et al. 2006; Lambin 2008). If expectations exceed the performance of the product, the customer remains

dissatisfied; if the performance of the product coincide with the expectations the customer, the customer is satisfied while if the performance exceeds expectations, then the customer is enthusiast. In other words, the customer satisfaction feeds, powers the company's value, which in turn increases the satisfaction of the lenders that can invest in human resources, in know-how, in manufacturing processes and in products (Busacca and Bertoli 2009; Valdani and Busacca 1999). The customer satisfaction can be, then, defined as a "modus operandi" of the entrepreneur; is not, namely, simply a technique but a company's management philosophy and has become one of the most important issues on the agenda of management problems of enterprises (Busacca and Bertoli 2009; Valdani and Ancarani 2009). From the above, emerges the need, for businesses, oriented to the customer satisfaction, to develop capacity of interaction and co-production direct to understand in depth the cognitive system of customers and, at the same time, the need to acquire analytical systems to verify systematically the alignment between their cognitive system and that of the customers. In simple words, the analysis and the management of the *customer satisfaction* represent the conditions necessary to ensure to the company a future as a protagonist in the current political scenery. Obviously, this is inevitably subject to the company's ability to increase the value offered to customers, intended as a comparison between the benefits obtained from the products (goods and / or services) and the costs of various nature to these connected (Busacca and Bertoli 2009; Valdani and Ancarani 2009). Therefore, in marketing strategies, the satisfaction of the customer becomes decisive for the enterprise.

The analysis of the customer lifetime value has received increasing attention both from the marketing practitioners and both from researchers from different domains because the customer lifetime value is rapidly gaining acceptance as a metric to acquire, to grow and to retain the "right" customer, the "profitable" customer. In Armstrong and Kotler (1996) the marketing is defined "the art of attracting and keeping profitable customers" and a profitable customer as "a person, household, or company whose revenues over time exceed, by an acceptable amount, the company costs of attracting, selling and servicing that customer". This excess is called own customer lifetime value (CLV).

Since not all customers are financially attractive to the firm, it is crucial that their profitability be determined and that resources be allocated according to the customer lifetime value. In other words, it is need to know how to calculate the CLV and maximize it under real business settings.

2 Research aims

The literature shows that the calculation of the customer lifetime value (CLV) is mainly used to support decisions about acquiring new customers, or, for instance, about the budget that can be spent on acquiring a new group of customers (Hughes 1996; Jackson 1994; Keane and Wang 1995). The idea is that the worth of a customer's relationship with an organization can be evaluated by adding up the revenues and the costs associated with servicing of customer over the lifetime of the relationship, taking into account future behaviours (such as churn and survival time) and the time value of money . In other words, the models utilized for estimate the customer lifetime value are a systematic way to understand and to evaluate a firm's relationship with its customers

and they are useful for the market segmentation and for the allocation, the acquisition and the retention of marketing resources.

There are many models for this purpose, but most of them are theoretic, complex and not applicable. Moreover, it lacks in these models a thorough and critical reflection on the determination of the CLV and it was precisely this lack to attract the attention of the authors and to encourage them in this research. In order to reconstruct, to expose and to synthesize this kind of reflection, the respective competences, in business and in mathematics, of the authors were intertwined.

The objective of this paper is to gain insight into the concept of the customer lifetime value, when focusing on relationship with customers, and to highlight the proper use of CLV to support building and maintaining relations with customers. Though not exhaustive, the major contribution of this paper is that it provides a general mathematical formulation to estimate the CLV and that it has a context less specific compared to previous papers, present in literature, on the customer lifetime. More precisely, the aim of this paper is to review various research articles that have appeared in the marketing literature and dealing the customer lifetime value, to summarize their findings, to take stock of the advances in modelling of CLV and to identify the areas for possible extensions and for future research. In others words, in this paper the authors first present a conceptual framework that shows how the customer lifetime fits in the value chain and what are its key drivers. Next, they present some general mathematical models for determination of customer lifetime value or better they offer a systematic general approach to the computation of CLV.

The paper is organized as follows. Section 2, after the introduction, presents the aim of the paper while Sect. 3 presents some definitions of CLV and describe the current research focus in CLV; in Sects. 4 and 5, instead, formally is introduced the substantial part, the plan of this paper; are, namely, provided some important modelling approaches present in literature and adopted to calculate and estimate the customer lifetime value. Section 6, finally, contains a general discussion on directions for future research and provides a conclusion. In other words, the article ends with some concluding remarks while the last part of this article represents the reviewed references.

3 The customer lifetime value: some definitions

This section gives an overview on some definitions of CLV which is an indicator that allows to appreciate the value of the customer in time and is able to take account both of the purchases made periodically that the stability and duration of future purchases (Busacca and Bertoli 2009).

As already said, the total net income that a company can expect from a customer is usually defined as customer lifetime value (CLV); more precisely, the CLV of a customer is the expected value of the profit that he will generate now and in the future or better during the entire customer life cycle.

In other words, the customer lifetime value is generally defined as the present value of all future profits obtained from a customer over his or her life of relationship with a firm, over the entire time that it relate with the firm. This concept of customer lifetime value is adopted from traditional marketing literature. It is similar to the discounted

cash flow approach used in finance but, however, there are two fundamental differences. First, the CLV is typically defined and estimated at an individual customer or segment level. This allows to differentiate between customers who are more profitable than others rather than simply examining average profitability. Second, unlike of approach used in finance, CLV explicitly incorporates the possibility that a customer may defect to competitors in the future.

In literature, there are different definitions of customer lifetime value.

In Gupta and Lehmann (2003) the CLV is defined as present value of all future profits generated from a customer. In Pearson (1996) CLV is defined as the net present value of the stream of contributions to profit that result from customer transactions and from contacts with the company. In Jain and Singh (2002) the customer lifetime value is the net profit or loss to the firm from a customer over the entire life of transactions of that customer with the firm. In Berger and Nasr (1998) the lifetime value of a customer for a firm is defined as the sum of the net of the revenues gained from company's customers over the lifetime of transactions after the deduction of the total cost of attracting, selling and servicing customers, taking into account the time value of the money.

According Gupta and Zeithaml (2006), the customer lifetime value is an indicator that allows to estimate and to measure the customer value over time expressed in terms of profits expected during the term of the relationship between the company and the customer. Courtheoux (1995), instead, states that estimation of the lifetime value of customers enables at marketers to evaluate ongoing programs to existing customers in terms of the changes wrought in the lifetime value of those customers. However literature shows that the calculations of CLV are mainly used to support decisions about acquiring new customers; for instance, about the budget that can be spent on acquiring a new (comparable) group of customers (Hughes 1996; Jackson 1994; Keane and Wang 1995).

Although there are several definitions of CLV, the ambiguousness still lies between these definitions and impedes the application of CLV. For instance, an huge confusion concerns today the meanings of two of the most important terms in interactive marketing:*customer lifetime value* and *customer profitability*.

In fact, the customer lifetime value has been defined,in literature, in different ways or better, in the literature, the CLV appears also under others different names such as lifetime value (LTV) (Kim et al. 2006), customer equity (CE) and customer profitability (Jain and Singh 2002). The difference between the definitions are rather small.

In the real business world, the CLV plays a major role in several of applications to business problems in many different industries; in particular, in the analysis of churn and in the management of the retention campaign, in the customer selection and in the allocation of marketing resource, in the fraud analysis, in the management of campaign credit and the management of collection risk. The customer lifetime value can help to select the right prospects on whom to focus, to offer the right additional products to existing customers and to identify the good customers who may be about to leave. Nowadays, the CLV is widely used as the basis for evaluating initiatives of Database Marketing and is also identified as a standard by the Database Marketing Institute (Hughes 2005).

There are several factors that account for the growing interest in concept of customer lifetime value (CLV). First, there is an increasing pressure in companies to make a marketing accountable; second, financial metrics such as stock price and aggregate profit of the firm or a business unit, do not solve the problem either. In other words, the second reason is the inefficiency of financial metrics. Third, the improvements in information technology have made it easy for firms to collect enormous amount of customer transaction data. This allows firms to use data on revealed preferences rather than intentions.

The total value of all customer relationships can be seen as an equity to the firm. Thus, the sum of the CLV for all customers, or better the sum of the lifetime values of the customers, current and potential, of the company, is often referred as a *customer equity* (CE):

$$CE = \sum_{i=1}^{I} CLV_i.$$

4 Models for calculation of CLV: a simple approach

In literature have been proposed many models dealing the customer lifetime value; many researchers, namely, have studied CLV and its managerial applications because, often, the CLV is used as a basic for making strategic or tactical decisions. In other words, the customer lifetime value should be an important construct in designing and in budgeting a number of marketing decisions such as customer acquisition programs.

The CLV models provide a systematic way to understand on which customer to focus upon, to estimate the lifetime value of a customer and to analyze the effects of different actions of the firm on this lifetime value and hence indirectly on the value of the firm. The choice of models for the determination of CLV is based on the observation of the customer behaviour; in fact, the changes of the technology make it feasible to understand and to track the customer behaviours in ways that were impractical, or even impossible, in the past (Jackson 1994).

This section gives an overview of the models specifically formulated to estimate CLV or better provides summaries of some key models and extends this calculation to obtain optimal methods of resource allocation to optimize CLV.

The major contribution of this section is that it provides, also if not exhaustively, a general mathematical formulation to estimate the CLV and that it has a context less specific compared to discussions, on CLV, of the papers present in literature. In fact, although there are many models on this topic, most of them are theoretic, complex and not applicable.

4.1 Basic components of a CLV model

In general, a CLV model has three basic components: customer's value over time, customer's length of service and a discounting factor, besides many other specific elements (Rosset et al. 2003).

- **Customer's value over time:**

The customer's value over time is generally indicated with: $V(t)$ for $t \geq 0$, where $t$is time and $t = 0$ is the present. In practice, the customer's future value has to be estimated for current data, using business knowledge and analytical tools.

- **Survival time or length of service of customer:**

The central challenge, the major problem in predicting and in calculating the CLV is the customer survival time or the length of service of customer, based on informations contained in company databases, unlike the monthly margin of customer can be obtained from an accounting model.

A model of length service describes the churn probability of customer over time. This is usually described by a "survival" function $S(t)$ for $t \geq 0$, which describes the probability that the customer will still be active at time t. It is possible, then, define $f(t)$ as the "instantaneous" probability of churn of the customer at time t:

$$f(t) = -dS/dt.$$

The quantity most commonly modelled, however, is the hazard function: $h(t) = -f(t)/S(t)$.

For Helsen and Schmittlein (1993) $h(t)$ is a more appropriate quantity to estimate $f(t)$.

- **Discounting factor:**

As argued in Pfeifer et al. (2004), the definition of CLV should connect the value concept contained in it to the finance concept of present value. In so doing, most of equations for the CLV calculation are consistent with the definitions of customer lifetime value and with the citation "discounted," "present value" or "taking into account the time value of money." Thus, a discounting factor is added in the CLV calculation to project future profit into present value: a discounting factor $d(t)$, which describes how much each \$1 gained in some future time t is worth right now. This function is usually given on the basic of business knowledge.

The essence of the challenge lies, of course, in estimating $V(t)$ and $S(t)$ in a reasonable way. In different business settings, for each different marketing objective, the CLV can be calculated differently. More precisely, when modeling CLV in a different context (or different business application) it is needs to be taken into account different issues. For instance, for the retention management, the CLV needs to be calculated before and after the retention effort; in other words, the manager would need to calculate several CLV for each customer, each incentive in each different business period (Rosset et al. 2003).

4.2 Basic model of CLV

The customers are the primary source of the company's profitability; therefore, if it is possible to estimate the value of current and future customers, it is possible to estimate much of the value of a company.

To calculate the value of a customer, loyal to the company for n years at a discount rate i, it is possible to use the formula of net present value (NPV) (Busacca and Bertoli 2009; Valdani and Ancarani 2009).

The basic model form, based upon the proposed definition, can be formulated so :

$$CLV = \sum_{i=1}^{n} \frac{(V_i - C_i)}{(1+d)^i}$$

where:

CLV = lifetime value of customer

i = period of cash flow from customer transaction

V_i = revenue from the customer in period i

C_i = total cost of generating the revenue V_i in period i

n = the total number of periods of projected life of the customer under consideration, the time horizon

d is the discounting factor.

The numerator, therefore, is the net profit that has been obtained at each period while the denominator transforms the net profit value into the current value. Consequently, the basic CLV model becomes:

$$CLV = \sum_{i=1}^{n} \frac{Profit_i}{(1+d)^i}$$

where $Profit_i$ is the profit gained from customer i at time n and d is the discounting factor. The Profit is gained when revenues are larger then associated costs. Consequently, the CLV model can be split into two parts. Mathematically this becomes

$$CLV_i = \sum_{i=1}^{n} \frac{V_i}{(1+d)^i} - \sum_{t=1}^{n} \frac{C_i}{(1+d)^i}$$

The previous equality is all that is needed to calculate CLV. The discount factor can be easily determined from business rules, but the difficulty lies in estimating the future revenues and the costs for every customer.

The calculation model above is the basic model that ignores the fluctuation of sales and costs. In this model, namely, it is assumed that all cash flows take place at the end of a time period.

The evaluations of customer value in previous studies have treated prediction method with regression models simply based on profits from customers to calculate the future value of customers. That is to say, considering the changing profit contribution obtained from customers in the past, the existing models calculate the future worth and then define the CLV of customers with the projected value of the future worth. Therefore, the CLV model above is not capable of considering potential values of customers, not available from the past profit contribution, which would be able to be the profits of companies. Last, the models mentioned above do not considered the defection of customers. Although there is a customer who has very high value to our company, this information can conclude improper marketing strategies if don't pay

careful attention to the possibility of the customer defection. Hence, it is reasonable to consider the probability of individual customer's churn rather than to consider only the total decreasing rate of whole customers. Verhoef and Donkers (2001) used two components, current value and potential value, to segment the customers of an insurance.

For Gupta and Zeithaml (2006) and Reinartz and Kumar (2003) the customer lifetime value is, thus, calculated:

$$CLV = \sum_{t=0}^{T^*} \frac{p_t - c_t}{(1+i)^t} - AC$$

where:

p_t = price paid by the customer at the time t
c_t = direct cost of the firm to serve the customer at the time t
AC = acquisition cost of the customer at the time t_0
$p_t - c_t$ = contribution margin for the customer at the time t
i = discount rate or cost of capital for the firm
T^* = time horizon for estimating CLV.

If in the formula is inserted also the probability r_t that the customer remains faithful for a number of foreseen years, (r_t is the probability of customer repeat buying or being alive at time t) the previous formula is modified in the following

$$CLV = \sum_{t=0}^{T^*} \frac{(p_t - c_t)\, r_t}{(1+i)^t} - AC$$

In this formula is introduced, compared to the previous, a prudent variable r_t that takes into account, in determining the value of the customer, the retention probability of the customer or, likely, the probability to repeat the purchase in the interval t. Here it is considering the lifetime value of an customer that yet to be acquired and, for this, is present the acquisition cost (AC). If it wants computing the expected residual lifetime value of an existing customer, the term AC not must be included.

The above formula, however, for operational purposes and for decision-making purposes, has difficulties of application for the large amount of information which it needs. According to Gupta and Lehmann (2003) it is possible, instead, resort to a transparent approach, practical and widely used both by leaders that by investors of the company, approach which does not require a significant amount of data and is easy to adopt.

To reach this simplification it is necessary to propose three hypotheses:

- the profit margins remain constant during the life cycle of a client;
- the rate of retention (loyalty) is constant in time;
- the value of its life cycle is respected on an infinite horizon

According to previous assumptions:

$$CLV = \sum_{t=0}^{T^*} \frac{(p_t - c_t)\, r_t}{(1+i)^t} - AC = m\left[\frac{r}{(1+i-r)}\right] - AC$$

In Gupta and Lehmann (2003) is also showed that if margins $p_t - c_t$ and retention rates are constant over time and is used an infinite time horizon, then can be obtained the following expression:

$$CLV = \sum_{t=0}^{\infty} \frac{(p_t - c_t)\, r_t}{(1+i)^t} = m \frac{r}{(1+i-r)}$$

subtracting the AC for newly acquired customers.

Ultimately:

$$CLV = m \left[\frac{r}{(1+i-r)} \right]$$

In other words, CLV is equal to the margin m multiplied by a factor$(r/1+i-r)$.

The factor, $(r/1+i-r)$, is called the *multiplier of the margin* and depends on the level of customer loyalty (retention) of clients "r" and the discount rate of the company "i". The multiplier of the margin represents the present value of the prospective duration of the customer relationship (Farris et al. 2008).

The value of the multiplier of the margin increases with increasing of r and with decreasing of i.

The retention rate "r" in turn depends on the amount of the product, the price, the service for the customer, and a multitude of activities related marketing. For most companies, the retention rates are placed in the space of 60–90 %. "

When retention rate is 90 % and discount rate is 12 %, the margin multiple is about four. Moreover, if the margins grow at a constant rate "g", the margin multiple becomes $r/[1+i-r\,(1+g)]$. When first-period margin is guaranteed from all customers, for example, through upfront payment, then the margin multiple is $1+(r/1+i-r)$.

In spite of this simple formulation, researchers have used different variations in modelling and estimating CLV. Some researchers have used an arbitrary time horizon or expected customer lifetime (Reinartz and Kumar 2000; Thomas 2001), whereas others have used an infinite time horizon (e.g., Fader et al. 2005; Gupta et al. 2004). In Gupta and Lehmann (2003) is showed that using an expected customer lifetime generally overestimates CLV, sometimes quite substantially.

4.3 Different approaches

Different approaches to evaluate the customer lifetime value can be found in literature. Here now are described some between the various modeling approaches.

It is important to point out that most modelling approaches ignore the competition because of the lack of competitive data. Finally, how frequently is updated the CLV depends on the dynamics of a particular market. For example, in markets where margins and retention may change dramatically over a short period of time (e.g., due to competitive activity), it may be appropriate to reestimate CLV more frequently.

Researchers build separate models for customer acquisition, retention, and margin or sometimes combine two of these components. For example, Thomas (2001) and

Reinartz and Kumar (2005) simultaneously captured customer acquisition and retention. Fader et al. (2005) captured recency and frequency in one model and built a separate model for monetary value.

However, the approaches for modeling CLV differ across researchers.

For instance, references Rust et al. (2000) and Kumar and Venkatesan (2004) develop individual level CLV models based on marketing theory, whereas Rosset et al. (2003) proposes a segment level CLV model based on pre-determined segments; in Pfeifer and Carraway (2000), then, an approach build on the Markov chain. As stated earlier, Pfeifer and Carraway (2000) proposed, for to evaluate the customer relationships, the use of variables capturing the recency (time elapsed since the last purchase), frequency (total number of purchases) and monetary value (total generated income) of a customer; these variables are used to define the states in the Markov model.

Expanding the basic model, many researchers, including Berger and Nasr (1998), have proposed CLV calculation models, which reflect the fluctuation of sales and costs (Blattberg and Deighton 1996; Jain and Singh 2002):

$$CLV = \sum_{i=0}^{n} \pi\,(t) \times \frac{1}{(1+d)^i}$$

where $\pi\,(t)$ is the function of customer profits according to time t; formulating with precise $\pi\,(t)$ is the most important factor in calculating CLV precisely.

There are other different approaches to this problem or better several different formulations for calculating CLV. Here a brief review of each one:

(a) In Pfeifer and Carraway (2000) is proposed a Markov model for modelling customer relationships, to calculate CLV.
In Markov model, the possible states of relationships with a customer are counted; the probability of moving from one state to another in a single period is called transition probability. If the number of possible states is n, an $n \times n$ transition probability matrix P represents the transitions between states; this matrix has to multiplied by the reward vector for every period, which results in the value derived from a customer in that period. Consequently:

$$CLV = \sum_{t=0}^{T} \left[(1+d)^{-1} P\right]^t R$$

This equation shows how the vector CLV is calculated using a Markov chain. This vector contains the expected future value of a customer for every future state s ($s = 1, \ldots\ldots T$) at time t = 0, with T periods ahead. Furthermore d is the discount rate of money, P is the Markov matrix containing switching probabilities between states and R is the reward vector containing the monetary contribution of each state.
P and R are assumed to be constant over time.

The advantages of Markov model is as follow:

– this model is flexible. This flexibility is needed to model different kinds of customer relationship situations.
– markov model, can be used both for customer retention and customer migration models.
– markov model is probabilistic, which is useful in uncertain situations.
– markov is a model that can be used in decision-making.

The companies can use Markov chain model to evaluate proposed customer relationships and manage and improve them. Markov chain model is also helpful in retention and termination decisions.

In Rust et al. (2000) is argued that the "lost for good" approach understates CLV because it does not allow a defected customer to return. Others have argued that this is not a serious problem because customers can be treated as renewable resource and lapsed customers can be reacquired .It is possible that the choice of the modelling approach depends on the context. For example, in many industries (e.g., cellular phone, cable, and banks), customers are usually monogamous and maintain their relationship with only one company. In other contexts (e.g., consumer goods, airlines, and business-to-business relationship), consumers simultaneously conduct business with multiple companies, and the "always a share" approach may be more suitable.

The interest in customer retention and customer loyalty increased significantly with Reichheld and Sasser (1990) who found that a 5 % increase in customer retention could increase firm profitability from 25 to 85 %. In Reichheld (1996) is also emphasized the importance of customer retention.

(b) In Carpenter (1995) and Dwyer (1998) is used this formula:

$$CLV = \left\{ GC \times \sum_{i=0}^{n} \frac{r^i}{(1+d)^i} \right\} - \left\{ M \times \sum_{i=0}^{n} \frac{r^{i-1}}{(1+d)^{i-0,5}} \right\}$$

where
– GC: expected yearly gross contribution margin for each customer
– M: relevant promotion costs for each customer in one year
– n: length of the period of cash flows
– r: retention rate in 1 year
– d: discount rate in 1 year
– the time period is constant.

If the sales happen more than once a year, the formulations is as follow:

$$CLV = \left\{ GC' \times \sum_{i=0}^{pn} \frac{\left(r'\right)^i}{(1+d)^{\frac{i}{p}}} \right\} - \left\{ M' \times \sum_{i=0}^{pn} \frac{\left(r'\right)^{i-1}}{(1+d)^{\frac{i-0,5}{p}}} \right\}$$

If the sales happen less than once a year:

$$CLV = \left\{ GC' \times \sum_{i=0}^{\frac{n}{q}} \frac{\left(r'\right)^i}{(1+d)^{iq}} \right\} - \left\{ M' \times \sum_{i=0}^{n} \frac{\left(r'\right)^{\frac{i-1}{q}}}{(1+d)^{i-0,5}} \right\}$$

(c) The model below is used in Reichheld (1996) and in Reichheld and Sasser (1990):

$$CLV = \sum_{i=0}^{g} \left\{ \left[ht^2 + v \right] \times \left[\frac{r^t}{(1+d)^t} \right] \right\} + \sum_{t-q+1}^{n} \left\{ \left[\left[hg^2 + v \right] + \left[N \left(1 - e^{-t+g} \right) \right] \times \left[\frac{r^t}{(1+d)^t} \right] \right] \right\}$$

For previous models, if a customer leave the transactions with the company and return after a period, he will be treated as a new customer. The migration model helps not to consider such customers as new ones (Dwyer 1998). In this case is used a migration model:

$$C_i = \sum_{J=1}^{i} \left[C_{i-j} \times P_{t-j} \times \prod_{K=1}^{j} \left(1 - P_{t-j+k} \right) \right] \quad (P_t = 0)$$

After reviewing these five models, Berger and Nasr, explain relationship marketing, which is a process in which a company tries to make a relationship with a customer, and maintains it and makes profit from it (Armstrong and Kotler 1996). The companies need to quantify this relationship to calculate the profits obtained (Berger and Nasr 1998). Carpenter (1995) presented a model to quantify the relationship between a company and its users.

(d) In Rust et al. (2000) is developed an approach to determine CLV that incorporates customer-specific brand switching metrics. In this study, the Markov model is used to model customer's probability of switching from one brand to another by transition matrix (Kumar and George 2007). This model is an aggregate level approach.

$$CLV_i = \sum_{t=0}^{T_{i,j}} \frac{1}{\left(1 + d_j\right)^{\frac{t}{f_i}}} V_{ijt} \times \pi_{ijt} \times B_{ijt}$$

(e) For Ahmadi et al. (2011) the models of CLV should include three elements: market risk affecting customer cash flow, flexibility of firm reacting to changes and cost of customer attraction and cost of customer retention. By considering these factors and four kinds of buyer seller relationships (Reinartz and Kumar 2000; Cannon and Christian 2001), the research presents the following model of CLV:

- $$CLV = \sum_{t=0}^{n} \left(\frac{m \times q}{(1+i)^t} - A_t \right)$$

when environmental risk is low and suppliers are flexible or not. In both cases is used simple NP analysis.
Or:

- $$CLV = m \times q_0 - A_0 + \frac{(p \times u + (1-p) \times d) \times m \times q_0}{1+i} - A_1$$

  when environmental risk is high and suppliers are not flexible. In this case is used extended NPV.
  Or:

- $$CLV = \sum_{t=0}^{n} \frac{\max\left(m \times q_t\,(s) - s\ , m \times q_t\right)}{(1+i)^t} - A_t$$

  when environmental risk is high and suppliers are flexible. For this case is used the real options analysis This shows that real option analysis determines future cash flow of a customer and calculates CLV more accurate than models based on NPV (Ahmadi et al. 2011).

(f) In Blattberg et al. (2001) the customer lifetime value is the sum of three components, which are: return on acquisition, return on retention and return on add-on selling. This model is an aggregate model (Kumar and George 2007).

The formulation is as follow:

$$CLV(t) = \sum_{i=0}^{I} \left[N_{i,t}\alpha_{i,t}\left(s_{i,t} - c_{i,t}\right) - N_{i,t}B_{i,a,t} + \sum_{k=1}^{\infty} N_{i,t}\alpha_{i,t}\left(\prod_{j=1}^{k}\rho_{j,t+k}\right) \times S_{i,j+k} - c_{i,j+k} - B_{i,r,t+k} - B_{i,AO,t+k}\right)\left(\frac{1}{1+d}\right)^k \Bigg]$$

$N_{i,t}$: number of potential customers at time t for segment i
$\alpha_{i,t}$: acquisition probability at time t for segment i
$\rho_{i,t}$: retention probability at time t for a customer segment i
$B_{i,a,t}$: marketing cost per prospect (N) for acquiring customers at time t for segment i
$B_{i,r,t}$: marketing costs in time period t for retained customers for segment i
$B_{i,AO,t}$: marketing costs in time period t for add-on selling for segment i
d : discount rate
$S_{i,t}$: sales of the product/services offered by the firm at time t for segment i
$c_{i,t}$: cost of goofs at time t for segment i
I: the number of segments
i: the segment of designation
t_0: the initial time period (Kumar and George 2007).

The research of Hwang et al. (2004) proposes a model to measure CLV and considers three factors which were not mentioned in previous studies of CLV (past profit contribution, potential benefit and defection probabilities of customer) and that also represent a framework to analyze customer value and segment them based on their values. The value of customer is divided to three groups and the segmentation of customers is related to them. The groups are: current value, potential value and customer

loyalty. In this model customer defection and cross-selling opportunities in business in attended to:

$$CLV_i = \sum_{t_i=0}^{N_{i\pi}} \pi_p\,(t_i)\,(1+d)^{N_i-t_i} + \sum_{t_i=N_i+1}^{N_i+E(i)+1} \frac{\pi_f\,(t_i)+B\,(t_i)}{(1+d)^{t_i-N_i}}.$$

5 Current value, use and applications of CLV

The CLV models have a variety of uses in all kinds of business organizations. Particular use of such models, however, will depend upon the type of products and of customers that a firm has. The firms having few and identifiable customers might benefit from models that measure the lifetime value of individual customers while the firms having large number of customers with small sales to each customer might benefit from models that help segment customer on the basis of lifetime value.

The CLV models can be very useful in helping the firms make strategic as well as tactical decisions: strategic decisions in terms of identifying who are its customers and their characteristics and which customers go in the long run, and tactical decisions in terms of short-term resource allocations among marketing variables and the focus of marketing activities. The CLV models help quantify the relationship of the firm with its customers and subsequently allow the firm to make more informed decisions in a structured framework. The CLV models also help a firm to know who are the profitable customers; the customer profitability provides a metric for the allocation of marketing resources to consumers and market segments. The marketing efforts are best directed at the most profitable consumers (Mulhern 1999). More precisely:

(a) Current value

Calculating the current value of a customer is usually a straightforward calculation based on the current or recent information of a customers: the usage, the price plan, the payments, the collection efforts, etc. The statistical techniques for modelling the customer value along time include the forecasting, the trend analysis and the time series model.

However, the complexity of modelling and the predicting the various factors that affect future value (seasonality, business cycles, economic situation, competitors, personal profiles and more), make the prediction of future value a highly complex problem. Some factors can raise huge difficulty to calculate CLV in a more precise way. These factors are network effect, option leader, word-of-mouth, budget constraint, seasonality, business cycle, economic situation, personal profiles, competitor effect, size of the market, channel communications, share-of-wallet, etc. These factors are hard to calculate in a precise way since their nature of ambiguousness. The simplest way to deal with these factors is just considering the current value as the future value, thus excluding those factors completely. Despite the difficulty, many researchers use managerial methods to estimate those factors but this it is out of the scope of this research project.

(b) Current use

In the empirical study conducted by Hoekstra and Huizingh (1999), the current use of the customer lifetime value is investigated in the real world business and some of their study results are listed below. CLV was calculated by 24 % of the companies. When comparing between industries, the highest scores were found for the publishing companies (35 %) and the lowest for the automobile dealers (12 %). Performing CLV analyses seems to be a quite recent phenomenon. Almost all companies (90 %) have calculated CLV for five years or less; 45 % of these companies have calculated for three years or less. With respect to the management level in which the CLV information is used, are distinguished three levels: top-management, marketing management, and operational management. Not surprisingly, the CLV information is used mostly by marketing management (91 %). Top management follows with 50 % while operational management use the CLV analyses in only 43 % of the companies. On average two management levels use CLV information, while in five companies (23 %) all three management levels use CLV information.

Either calculating or not calculating the CLV is not related to the general background variables such as the number of employees, the revenues, the market share and the number of customers, the average yearly number of contracts per customer, and the average yearly number of transactions per customer. However, two more specific characteristics, the importance of direct marketing and the sophistication of the customer information system, showed significant results. Larger is the proportion of revenues following from direct marketing, more often the companies calculate the customer lifetime value CLV. More is sophisticated the customer information system, more is likely that the customer lifetime value is calculated (t test, $p = 0.055$).

(c) Applications

The models for the calculation of the customer lifetime value has a wide range of applications. To be specific, these application areas can be the churn analysis and the retention analysis, the fraud analysis, the campaign management, the credit and collection risk management, the cross-and-up selling, customer selection and the resource allocation. And these application areas lies in all kinds of industries, especially in direct marketing, in telecommunication company, in marketing oriented company (both manufactures and retailers) and so forth. Some of the applications of the CLV analysis are listed below:

- Special services (e.g., premium call centers and elite service) and offers (concessions, upgrades, etc.) based on CLV—the more valuable a customer, the more irresistible services and offers could be subject to satisfactory profit margins for the business.
- Targeting and managing unprofitable customers.
- Segmenting customers, marketing, pricing and promotional analysis based on CLV.
- Sizing and planning for future market opportunity based on cumulative CLV.

Some of these applications would use a single CLV score computed for every customer. Other applications require a separation of the survival time and of the value component for effective implementation, while even others would sue either the survival or value term and ignore the other components of CLV.

6 Concluding remarks and future perspectives for research

In this paper, were presented several models and several empirical insights that have been adopted to address the customer lifetime value and were discussed several studies dealing with CLV; more precisely, many models have been researched to calculate the customer lifetime value of a customer, customer lifetime value that is has become an increasingly important concept in both academia and practice. However, all the models proposed for calculating CLV have some limitations; for example, in the current models of CLV some limitations have to be addressed to make them useful in practice.

Given the relevance of this topic and the increasing focus of researchers on CLV, the authors hope in the growth of marketing research in this area.

Moreover, as already mentioned, it is common knowledge that loyal customers stay longer with a firm and are more profitable because they are cheaper to serve, they pay higher prices and they refer new customers, and so on. However, most of these propositions have not been tested rigorously through research. Some research papers do address these propositions to find contradictory evidence. It will be interesting to see how future research will take care of customer loyalty and subsequently of CLV. A number of important marketing issues need re-examination in light of the influence of new technologies on marketing. As an example, the internet makes it easier for consumers to visit different providers with a click of a button, opening up, namely, to numerous opportunities of purchase but hinders the providers to lock the customers. However, the absence of personal interaction makes difficult for customers to trust a new vendor easily (Reichheld and Schefter 2000).

In conclusion, the development of mathematical models to measure the CLV, models that take into consideration factors underlying behaviour of the repeat purchase (and, thus, customer satisfaction and existence of competition, for examples), remains a challenge for future researchers.

The authors hope, namely, to have provided, through this paper, a small step in research on the CLV and also useful and interesting research directions; they believe, however, that is still needed a significant research. The huge potential of customer lifetime value can be exploited in years to come.

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References

Ahmadi K, Taherdoost H, Fakhravar S, Jalaliyoon N (2011) A new model for evaluating customer lifetime value in high risk markets. In: International Conference on Social Science and Humanity, IPEDR vol 5, IACSIT Press, Singapore

Armstrong G, Kotler P (1996) Priciples of marketing, 7th edn. Prentice-Hall, Englewood Cliffs

Benoit DF, Van D (2009) Benefits of quantile regression for the analysis of customer lifetime value in a contractual setting: an application in financial services. Expert Syst Appl 36(7):10475–10484

Berger PD, Nasr NI (1998) Customer lifetime value: marketing models and applications. J Interact Mark 12(1):17–30

Blattberg R, Deighton J (1996) Manage marketing by the customer equity. Harvard Busi Rev 74(4):136–144

Blattberg R, Getz G, Thomas JS (2001) Customer equity: building and managing relationships as valuable assets. Harvard Business School, Boston

Busacca B, Bertoli G (2009) Customer value. Soddisfazione, fedeltà, valore, Egea
Cannon JP, Christian H (2001) Buyer-seller relationships and customer firm costs. J Mark 65(January):29–43
Carpenter P (1995) Customer lifetime value: do the math. Mark Comput 1:18–19
Courtheoux R (1995) Customer retention: how much to invest. DMA, Research and the Customer Lifecycle, New York
Dwyer FR (1998) Customer lifetime valuation to support marketing decision making. J Direct Interact Mark 12(1):17–30
Fader P, Hardie Bruce GS, Lee (2005) Counting your customers the easy way: an alternative to the Pareto/NBD model. Mark Sci 24(2):275–284
Farris PW, Bendle TN, Pfeifer PE, Reibstein DJ (2008) Marketing metrics. Pearson, USA
Fornell C, Mithas S, Morgeson F, Krishnan MS (2006) Customer satisfaction and stock prices: high returns, low risk. J Mark 70(1):3–14
Gruca TS, Rego LL (2005) Customer satisfaction, cash flow, and shareholder value. J Mark 69(3):1–130
Gupta S, Lehmann DR, Stuart JA (2004) Valuing customers. J Mark Res 41(1):7–18
Gupta S, Zeithaml V (2006) Customer metrics and their impact on financial performance. Mark Sci 25(6):718–739
Gupta S, Lehmann DR (2003) Customers as assets. J Interact Mark 17(1):9–24
Hoekstra JC, Huizingh EKRE (1999) The lifetime value concept in customer-based marketing. J Mark Focus Manag 3(4):257–274
Helsen K, Schmittlein DC (1993) Analyzing duration times in marketing: evidence for the effectiveness of hazard rate models. Mark Sci 11:395–414
Hughes A (1996) Database marketing has arrived; determining the bottom line. In: Proceedings of the DMA 79th Annual Conference, New Orleans
Hughes A (2005) Strategic database marketing, 3rd edn. McGraw-Hill, New York
Hwang H, Jung T, Suh E (2004) An LTV model and customer segmentation based on customer value: a case study on the wireless telecommunication industry. Expert Syst Appl 26:181–188
Jackson DR (1994) Strategic application of customer lifetime value in the direct marketing environment. J Target Meas Anal Mark 3:9–17
Jain D, Singh SS (2002) Customer lifetime value research in marketing: a review and future directions. J Interact Mark 16(2):34–46
Keane TJ, Wang P (1995) Applications for the lifetime value model in modern newspaper publishing. J Direct Mark 9(2):59–66
Kim S, Jung T, Suh E, Hwang H (2006) Customer segmentation and strategy development based on customer lifetime value: a case study. Expert Syst Appl 31:101–107
Kotler P, Keller K (2007) Marketing management. Pearson, New Jersey
Kumar V, Venkatesan R (2004) A customer lifetime value framework for customer selection and resource allocation strategy. J Mark 68:106–125
Kumar V, George M (2007) Measuring and maximizing customer equity: a critical analysis. J Acad Mark Sci 35:157–171
Lambin JJ (2008) Market-driven management. Marketing strategico e operativo, McGraw-Hill, Milano
Mulhern F (1999) Customer profitability analysis: measurement, concentration, and research directions. J Interact Mark 13:25–40
Payne A, Frow P, Cranfield School of Management, UK (2005) Customer relationship management: from strategy to implementation ANZMAC 2005. In: Conference Business Interaction, Relationships and Networks, pp 85–93
Pearson S (1996) Building brands directly: creating business value from customer relationships. MacMillan Business, London
Pfeifer PE, Mark EH, Robert MC (2004) Customer lifetime value, customer profitability, and the treatment of acquisition spending. J Manag Issues 2:110–124
Pfeifer PE, Carraway RL (2000) Modeling customer relationships as Markov chains. J Interact Mark 14:43–55
Reichheld F (1996) The loyalty effect. Harvard Business School, Boston
Reichheld F, Schefter P (2000) E-loyalty: your secret weapon on the web. Harvard Bus Rev 78:105–113
Reichheld F, Jr Sasser W E (1990) Zero defections: quality comes to services. Harvard Bus Rev 68(5):105–111

Reinartz W, Kumar V (2005) Balancing acquisition and retention resources to maximize customer profitability. J Mark 69:63–79
Reinartz W, Kumar V (2000) On the profitability of long lifetime customers: an empirical investigation and implications for marketing. J Mark 64:17–35
Reinartz W, Kumar V (2003) The impact of customer relationship characteristics on profitable lifetime duration. J Mark 67:77–99
Rosset S, Neumann E, Eick U, Vatnik N (2003) Customer lifetime value models for decision support. Data Mining Knowl Discov 7:321–339
Rust RT, Zeithaml V, Lemon KN (2000) Driving customer equity—how customer lifetime value is reshaping corporate strategy. The free press 1230 Avenue of the Americas, New York
Thomas J (2001) A methodology for linking customer acquisition to customer retention. J Mark Res 38(2):262–268
Valdani E, Ancarani F (2009) Marketing strategico. I risultati delle strategie di marketing, Egea, Vol, p 3
Valdani E, Busacca B (1999) Customer-based view. Finanza Marketing e Produzione 2:95–131
Verhoef PC, Donkers B (2001) Predicting customer potential value an application in the insurance industry. Decis Supp Syst 32:189–199
Wheaton P (2000) The Life cycle view of customers. US Banker 110:77–78