

**Paper Title: Model dependency on customer lifetime value estimation**

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## **Model dependency on customer lifetime value estimation**

### **Abstract**

Customer lifetime value appeared as a central metric for marketing. One issue was the possibility of biased estimates that could interfere managerial policy. Literature review identified 56 papers with CLV modeling and real customer data were used to compare models. Results shows that deterministic models converge in high retention rates, but until 50% decision making can differ depending on the model: margin impact will be greater than retention in models with infinite projection. Models with finite projection will always be more impacted by retention rates. Retaining or acquiring customers have distinct priorities, which is an issue for managerial policy.

## **Introduction**

Customer lifetime value (CLV) and Customer Equity (CE) appeared as a central metric for marketing in the last years, especially in a time where marketing accountability is challenged and instigates a more profound marketing-finance interface (Germann, Ebbes, Grewal, 2015; Hanssens., Rust, Srivastava, 2009; Schulze, Skiera, Wiesel, 2012). However, this growing importance did not come without its questionings (Bendle, Bagga, 2017; Zhang, 2016). One latent issue was the possibility of biased estimates that could interfere in the managerial application of the CLV concept, since no study compared the existing models. This is central since CLV was developed to empirically analyze marketing efforts in financial terms (Kumar, Shah, 2009; Silveira, Oliveira, Luce, 2012).

To map the existing models, we did a literature review (check the appendix for the list of journals), covering the period of 1974-2018. There were 56 papers using CE/CLV estimation methods for marketing. This study tries to identify core differences on every approach and test it with real data, the first attempt to inspect for model dependency by a managerial perspective.

## **Customer Equity and Customer Lifetime Value**

Customer lifetime value (CLV) appeared first as “long run customer profitability” on a seminal Journal of Marketing article by Philip Kotler in 1974. Fifteen years later Donald Jackson, in 1989, tried to demonstrate a method for calculating the expected financial contribution of a customer. In the same year, Dwyer published an article entitled “Customer Lifetime Valuation to Support Marketing Decision Making” on the Journal of Direct Marketing. This article was the starting point of a central stream of research for marketing. Since then, many methods and models were developed to verify the potential of customers as assets that generate cash flows, from simple NPV models and Bayesian models to stochastic and portfolio allocation models.

CLV was defined by Kotler as ‘The present value of the future profit stream expected given a time horizon of transacting with the customer’ (Kotler, 1974). Little has changed since then: present value of all future profits generated from a customer (Gupta and Lehmann, 2003); net profit or loss to the firm from a customer over the entire life of transactions of that customer with the firm (Jain and Singh, 2002);

The main idea was to figure out the customer contributions, by using the net present value principle, in the same way as financial assets.

Customer Equity (CE) was introduced by Blattberg and Deighton (1995) in their paper “Manage marketing by the customer equity test”. The authors did not define CE explicitly, but we can understand that CE is more a method to determine the optimum level of acquisition and retention spending than a proper verification of customer expected contribution. The optimized expending would then reveal the maximum individual CE.

CE suffered an important change in its formal definition by the 2000s, when became the sum of all firm’s CLV. Now it is common to define CE as “The sum total of lifetime value of all customers of the firm represents the CE of the firm” (Kumar and Shah, 2009). The underlying logic is to assume that the firm customer base represents an asset that yields revenues over time, in the same way financial assets do. Therefore, the “equity” is not the individual CLV but the sum of the CLVs of all customers.

### **Customer Equity and Customer lifetime Value Models**

Literature review reveals that 56 models of CE or CLV were published between 1974 and 2018, at minimum, within journals indexed by Ebsco and Web of Science. Those are shown on this study appendix. The first conclusion is that there is not a standard way of calculation which brings, at same time, diversity of estimation possibilities and difficulty in comparing methods (and results). Forty-one studies relied on empirical data, seven with simulations and eight theoretical only. The references of each study were surveyed to capture more research that eventually is not indexed or failed to appear on search engines.

By analyzing the models captured it was possible to identify two core elements in CLV estimation: net present value (NPV) concept and relationship nature (contractual or not). The NPV relied on margins, discount rate, and projected period. Retention rates were used in contractual settings, while buying probability were used in non-contractual (stochastic) contexts.

All models considered some sort of contribution margin – revenues minus costs, margin per product, margins per client, among others. These margins were steady, is expected that a client will contribute this amount while he is ‘alive’. In general, there is not a verification to compare expected margin with real empirical contribution in the studies surveyed. Discount rate is used in line with the idea

that customer is a cashflow generating asset, although the exact value of this variable is less justified – managerial decision or an arbitrary value set by authors. This rate has not been discussed broadly because, in theory, depends on non-marketing related factors. The projected period was an arbitrary choice by the authors as well – months, weeks, years, quarters, with or without perpetuity.

Literature review revealed that majority of CLV models has one of these forms: margin with retention rate, or a margin associated with buying probability, both discounted at present value. In the first case we have:

$$CLV = \sum_{t=1}^T \frac{m \cdot r^t}{(1+d)^t}$$

Where:

m = contribution margin;

r = retention rate;

t = time period;

T = end of period;

d = discount rate

Three variations were found. Gupta Lehman (2003) consider that the first margin occurs after the relationship is already initiated ( $t_1$ ):

$$CLV = \frac{m \cdot r}{1+d-r}$$

Pfeifer (2011) states that margin starts at  $t_0$ :

$$CLV = \frac{m+md}{1+d-r}$$

And Hogabe et al. (2002) predicate that margins occur at the end of first period:

$$CLV = \frac{m}{1+d-r}$$

Models with retention rates have little estimation diversity. Minor alterations exist, such projection period, the margin timing, perpetuity adding, and continuous modeling. On the other side, probability based CLV models (non-deterministic) have major differences: survey based, historic data, firmographics, Bayesian estimation, Pareto/Negative Beta, Beta Binomial/Gamma-Gamma distributions, among others. This represents an obstacle to compare model results and managerial policy directly.

## Method

After this first research, we designed criteria to classify the models developed on every study. Three elements were considered: the use of net present value concept, the relationships nature and the number of future clients. We then classified all the models following these criteria, looking for a way to maintain comparability between models in each 'nest'. To make the comparison effort simpler, only deterministic (non-probabilistic) CLV models were consider at this stage. That is because deterministic approaches have simpler methods for managers to apply in a daily basis, contrasting with complex models developed for academic research.

Real customer data were used to compare models and see through a managerial perspective. Data contained information from a private stock brokerage firm from Brazil, which included historical monthly margins and net deposits from 10,232 customers in the period 2011-2013.

Since CLV is an individual metric, we need some sort of estimate for transaction margin and retention, even when there is a large customer base. By analyzing the full base, an intermediate segment was identified<sup>1</sup>. This cluster was chosen for CLV estimation since it is, theoretically, possible to apply policies for increasing its' contribution. Inputs for estimation are: margin = R\$424.09 (month); retention = 88.9%(month); discount rate = 11% (year)<sup>2</sup>. Expected customer lifetime value's (E(CLV)) in chosen models are below.

<b>Model</b>	<b>E(CLV)</b>	<b>Difference</b>
Gupta e Lehmann (2003) <sup>3</sup>	R\$ 10,965.67	-
Berger e Nasr (1998) <sup>4</sup>	R\$ 11,389.76	3,87%
Gupta e Lehmann (2003)* <sup>5</sup>	R\$ 22,191.99	102,38%
Hogabe et al. (2002)	R\$ 22,410.65	104,37%
Pfeifer (2011)	R\$ 22,616.08	106,24%

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<sup>1</sup> Cluster analyses was applied in the full base to identify possible customer segments by margins generated on Brazil's Bovespa Stock market (software used was IBM's SPSS). We found a solution with three segments: a high, medium and low trading profiles.

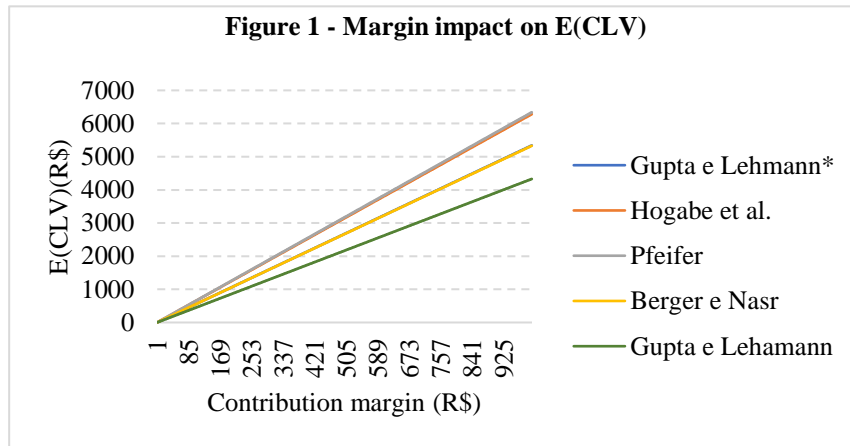
<sup>2</sup> Brazil's SELIC base interest rate on this period at that time.

<sup>3</sup> Number of projected periods was 36.

<sup>4</sup> Same as footnote 3.

<sup>5</sup> Asterisk denotes Gupta e Lehmann (2003) infinite projection model.

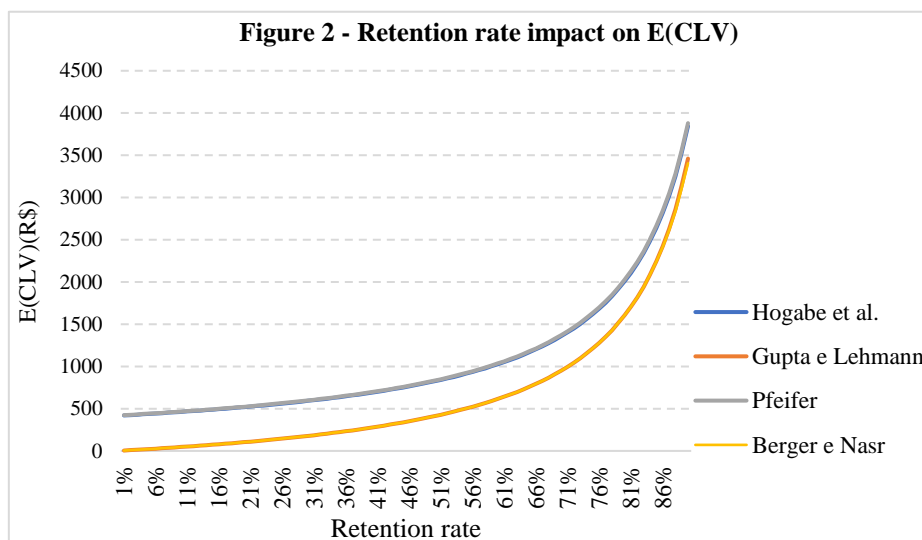
First it was established a margin interval (R\$0-R\$1,000) to address its impact on expected CLV. This interval covers a hypothetical but possible variance in contribution margins. Results are shown on Figure 1.



Source: elaborated by the authors.

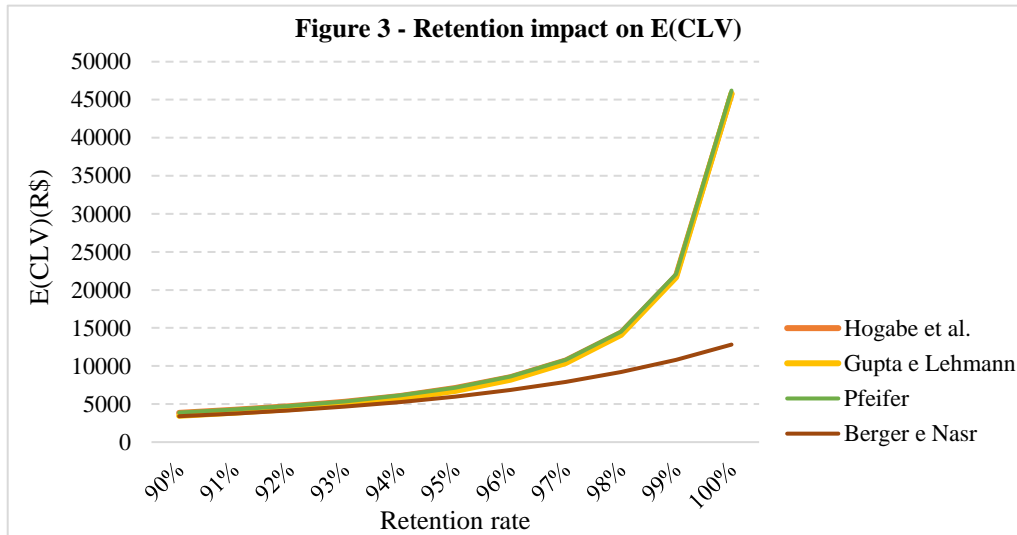
Figure shows that Pfeifer (2011) and Hobane et al. (2002) are the most impacted by margins, followed by Berger and Nasr (1998) and Gupta and Lehmann (2003)\*, and finally Gupta and Lehmann (2003).

Next analysis shows retention rate impact on E(CLV) four models. To better investigate its effect, this rate was divided in two segments, 0-90 and 90-100 per cent. Figure 2 shows that models converge starting at 70%. Retention has an increasing impact on E(CLV), mainly at 70% approximately.



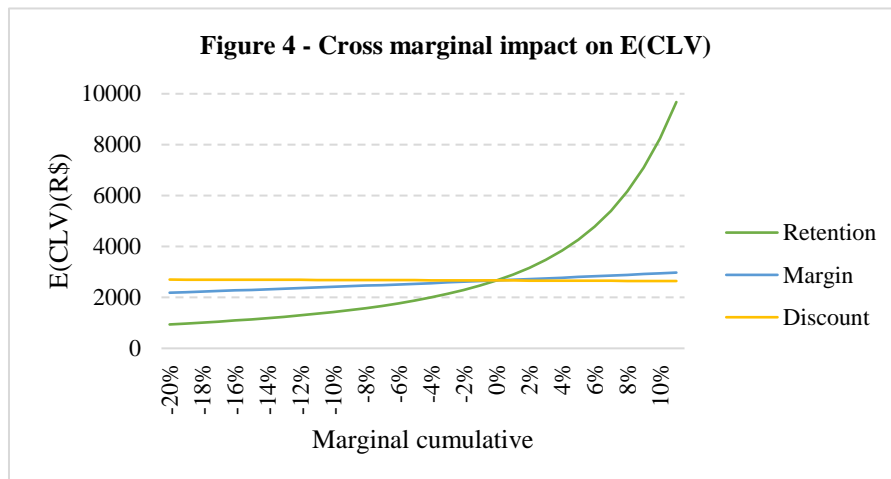
Source: elaborated by the authors.

Figure 3 shows that from 95% the impact has a substantial divergence on models with infinite projection. From a managerial perspective, models with perpetuity will reward E(CLV) aggressively in contexts with high retention. For example, when retention is on 99% the E(CLV) by Berger is R\$10.808 while E(CLV) with perpetuity is R\$21.680, almost 101% higher. Managers should be cautious in adopting models with infinite projection that can over evaluate E(CLV).



Source: elaborated by the authors.

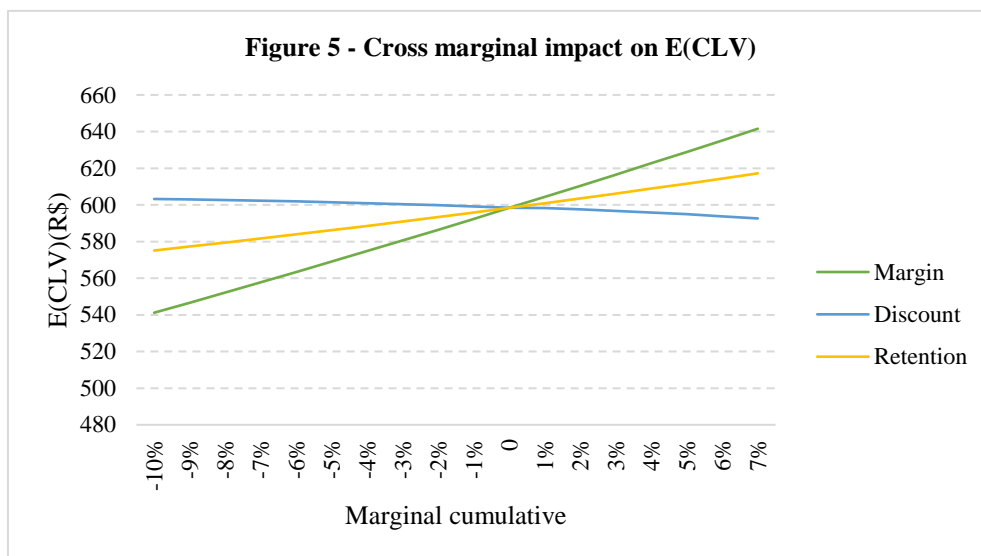
Another central analysis is the impact of retention against margins, to address in which policies are better suited. All models showed that, in this case, the marginal impact of retention is higher than margins and discount rate, as expected. It is proved, then, that policies who increase retention have high leverage, while increasing margins by up and cross-selling has little impact. This conclusion is shown in Figure 4.



Source: elaborated by the authors.



Despite this, there are differences when we change the retention rate. Until the rate of 50%, models with infinite projection are impacted by margins in a greater value than retention – Figure 5. The same is not true with finite models, where the retention rate always has more impact. This implies that managerial policies can be altered depending on the model chosen, especially in contexts with low retention.



Note: starting retention fixed at 30%.  
Source: elaborated by the authors.

Finally, margins have a steady marginal impact of 1% in every case, and the discount rate has an almost insignificant impact, less than 0,1%.

## Conclusion

Customer lifetime value had great visibility in recent years' marketing literature, by its capacity to merge customer centrality concept with empirical verification, following a marketing-finance interface. This study was an effort to verify model dependency on CLV estimation and its impact on managerial decision making. The research shows that deterministic models converge if retention rates are high, but until 50% decision making can differ depending on what model is used: margin impact will be greater than retention in models with infinite projection. On the other side, models with finite projection will always be more impacted by retention rates. So, the policy of retaining or acquiring new customers can have distinct priorities, which is an issue for managerial policy.

This study has some limitations: first, only deterministic models were considered, and a variety of probabilistic models exist. Managerial policy under this kind of model has to be discussed. Second, as CE is the sum of CLV's business, there are indirect implications in need of study. There was not, as well, discussions on how to developed an optimal model for managers to use in decision making. Finally, future studies could investigate managers impressions about model dependency to access if this imply in changing the way of estimating CLV.

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**Appendix – List of papers analyzed**

Authors	Metric	Journal	Year	Empirical?
Kotler	CLV	Journal of Marketing	1974	No
Dwyer	CLV	Journal of Interactive Marketing	1989	Yes
Keane and Wang	CLV	Journal of Direct Marketing	1995	Yes
Blattberg e Deighton	CE(CL V)	Harvard Business Review	1996	No
Bitran and Mondschein	CLV	Management Science	1996	Yes*
Berger and Nasr	CLV	Journal of Interactive Marketing	1998	Yes*
Pfeifer and Carraway	CLV	Journal of Interactive Marketing	2000	Yes*
Reinartz and Kumar	CLV	Journal of Marketing	2000	Yes
Verhoef and Donkers	CLV	Decision Support Systems	2001	Yes
Berger and Nasr	CE(CL V)	Omega	2001	Yes*
Hogan et al.	CLV	Journal of Service Research	2002	No
Libai, Nayarandas e Humby	CLV/CE	Journal of Service Research	2002	No
Jain and Singh	CLV	Journal of interactive Marketing	2002	No
Berger, Weinberg, and Hann	CLV	The Journal of Database Marketing & Customer Strategy Management	2003	Yes
Drèze and Bonfrer	CLV	Quantitative Marketing and Economics	2003	Yes*
Gupta and Lehmann	CLV	Journal of Interactive Marketing	2003	Yes
Reinartz and Kumar	CLV	Journal of Marketing	2003	Yes
Rosset, Neumann, Eick, and Vatnik	CLV	Data Mining and Knowledge Discovery	2003	No
Gupta, Lehmann, and Stuart	CLV	Journal of Marketing Research	2004	Yes
Rust, Lemon, and Zeithaml	CLV	Journal of Marketing	2004	Yes
Venkatesan and Kumar	CLV	Journal of Marketing	2004	Yes
Hwang, Jung, and Suh	CLV	Expert Systems with Applications	2004	Yes
Pfeifer and Bang	CLV	Journal of Interactive Marketing	2005	Yes
Lewis	CLV	Journal of Marketing	2005	Yes*
Malthouse and Blattberg	CLV	Journal of Interactive Marketing	2005	Yes
Ryals	CLV	Journal of Marketing	2005	Yes
Kumar, Shah, and Venkatesan	CLV	Journal of Retailing	2006	Yes
Crowder, Hand and Krzanowski	CLV	European Journal of Operational Research	2007	Yes
Donkers, Verhoef, and Jong	CLV	Quantitative Marketing and Economics.	2007	No
Fader and Hardie	CLV	Journal of Interactive Marketing	2007	Yes
Fader, Hardie, and Jerath	CLV	Journal of Interactive Marketing	2007	Yes
Tirenni et al.	CE/CL V	Marketing Science	2007	Yes
Haenlein, Kaplan, and Beeser	CLV	European Management Journal	2007	Yes

Venkatesan, Kumar and Bohling	CLV	Journal of Marketing Research	2007	Yes
Aeron et al.	CLV	Database Marketing & Customer Strategy Management	2008	Yes
Borle, Singh, and Jain	CLV	Management Science	2008	Yes
Kumar, Venkatesan, Bohling, and Beckmann	CLV	Marketing Science	2008	Yes
Villanueva, Yoo, and Hanssens	CE	Journal of Marketing Research	2008	Yes
Wiesel and Skiera	CLV/CE	Journal of Marketing	2008	Yes
Sublaban and Aranha	CE	Journal of Business Research	2009	Yes
Kumar and Shah	CLV/CE	Journal of Marketing	2009	Yes
Fader and Hardie	CLV	Marketing Science	2010	Yes
Fader, Hardie, and Shang	CLV	Marketing Science	2010	Yes
Braun	CLV	Marketing Science	2011	Yes
Chan, Wu and Xie	CLV	Marketing Science	2011	Yes
Rust, Kumar, and Venkatesan	CLV	International Journal of Research in Marketing	2011	Yes
Pfeifer	CLV/CE	Journal of Interactive Marketing	2011	Yes
Schmitt, Skiera and Bulte	CLV	Journal of Marketing	2011	Yes
Skiera, Bermes and Horn	CE	Journal of Marketing	2011	Yes
Schulze, Skiera Wiesel	CE/CLV	Journal of Marketing	2012	Yes
Tuxel and Dixit	CLV	Journal of Business and Industrial Marketing	2013	Yes
Klein and Kolb	CE/CLV	Omega	2015	Yes*
Safari, Safari and Montazer	CLV	Marketing Intelligence and Planning	2016	Yes
Jerath, Fader and Hardie	CLV	European Journal of Operational Research	2016	Yes
Kumar and Pansari	CLV	Journal of International Marketing	2016	Yes
Kumar and Zhao	CLV	Journal of Marketing Research	2016	Yes
Kumar	CLV	Journal of Marketing	2018	No

Note: \* denotes simulated data.

Source: elaborated by authors.