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Article

Wine Companies' Profitability in the Old World: Working Capital's Impact

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Abstract: The purpose—The aim of this paper is to explain the relationship between working capital and profitability in the context of the wine industry. Design/methodology/approach—Artificial neural networks were used to analyze the relationship between working capital management and the profitability of Old World firms, based on a sample of 324 firms. Findings—The results suggest a positive relationship between the cash conversion cycle and the profitability of winery firms. Thus, an increase in the cash conversion cycle seems to increase wine companies' profitability. Thus, managers can generate shareholder value by increasing the cash conversion cycle to a reasonable level. Regarding days of payable outstanding, there is a negative influence of the average payment term on the profitability of wine companies. This leads to the fact that the longer a company takes to pay its creditors, the less profitable it appears to be. In terms of days sales outstanding, the results suggest the existence of a negative impact of the average collection period on the profitability of winery firms. In other words, a reduction in the number of days a firm receives payment for sales positively affects the firm's profitability. Finally, the results of the study show a positive relationship between days of outstanding inventory and the profitability of wineries, suggesting that wineries that maintain sufficiently high inventory levels have higher profitability. These results indicate that managers could create value for their shareholders if they managed their working capital more efficiently. Practical limitations/implications—The neural network can predict profits based on working capital management. However, the applied research methodology should be extended to other business typologies and wine firms of other countries to allow the generalization of results. Originality/value—This paper is the first study on the impact of working capital management on the financial performance of companies in the wine sector, particularly in the Old World. The results are an input to the wine business sector literature, one of the most representative of regional economies in the countries focused. The applied methodology can be adopted more broadly and underlies managerial implications. For future research, a similar analysis can be envisaged for the New World, and a comparison between the two blocks of countries, given the difference in characteristics and techniques of wine production, could be made.



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1. Introduction

Wine has been produced for thousands of years. The earliest evidence of wine is from ancient China (c. 7000 BC), Armenia (6000 BC), Persia (5000 BC), and Italy (4000 BC). As Old World wine further developed viticulture techniques, Europe would encompass three of the significant wine-producing regions. Today, the five countries with the greatest wine-producing regions are Italy, Spain, France, the United States, and China (Johnson 1989). In fact, in the last decades, wine has become a commonly consumed product, creating trade flows that have an impact both on traditional producing countries and on the so-called

New World (Anderson 2019). Balogh and Jám bor (2017) considered that comparative advantage plays an important role in the analysis of international trade flow but is often neglected in empirical studies on agriculture. The findings indicate that Bulgaria, Cyprus, France, Greece, Italy, Portugal, and Spain are the top classified European wine producers in the world market and have greater comparative advantages. Nevertheless, duration and stability tests reveal that those advantages have diminished for the majority of these countries. In regional terms, the wine cluster contributes to economic growth and the continued development of the regions. Larreina and Aguado (2008) argue that the specific characteristics of the Rioja wine cluster may be the cause of its recent performance, in which the wine cluster represents one-fifth of the regional GDP.

Galati et al. (2017) argue that international market success is more frequent among wineries with larger physical and economic size, greater international market experience, and that are managed by owner-entrepreneurs with high levels of education and foreign language proficiency and that develop and implement voluntary certification processes.

Several studies were conducted to assess the determinants of wineries' profitability. De Salvo et al. (2017) aimed to recognize the core factors of wineries' profitability specifically in Eastern Europe considering the concurrent influence of climate characteristics, vineyard geographies, winegrowers' features, and management practices on vineyards' profitability. This study suggests that climate attributes and human aspects, specifically the educational level of the winegrowers and the form of agriculture experienced, arise as the main determining factors. Bresciani et al. (2016) present the contrasts of economic and financial performance concerning family firms and non-family firms for the wine sector in Italy and France. The results confirm that the family variable is important for accomplishing good performance in economic and financial terms and providing firms with different features. Regarding economic performance, family firms in both countries outperform with respect to return on equity and return on assets, while only Italian non-family firms perform better in earnings before interest and taxes. Concerning financial performance, in Italy and France non-family firms have better performance than family firms in the current ratio and liquidity ratio; in contrast, family firms perform best in the solvency ratio. Dimitropoulos et al. (2019) argue that throughout a period of controlled lending, cash holdings and effective cash management could be a vital instrument for sustaining SMEs' viability and financial performance in the wine business. The results obtained from the Greek wine business showed that cash holdings positively influence the profitability and viability of organizations, confirming the precautionary theory of cash holdings. Pre-crisis, small- and medium-sized enterprises (SMEs) and large firms both took considerable advantage of cash holdings; however, after the crisis the favorable effect of cash was more obvious and substantial for SMEs. Rossi et al. (2012) analyze the level and character of the success of the strategic design process in attaining sustainable competitive advantages. The sample is built on a survey of 180 Campania wine corporations in Italy. Regarding the financial aspect, the results suggest that the low capital of companies and their high financial exposure contribute to two negative effects. On the one hand, high-interest spending has a negative influence on performance, as it further deteriorates operating income, which is already low; on the other hand, it makes many of the high-quality wine companies vulnerable to purchases from major worldwide winemakers. After the crisis, Migliaccio and Tucci (2019) stated that the industry has shown growing profitability. But, from the evaluation of the balance sheet and the evolution of financial indicators, there is a strong inequity and excessive levels of inventories. In addition, the debt situation has become disproportionate: the leading presence of third-party financing would force huge recapitalizations and possibly demand growth in self-financing, which is feasible due to the ever-increasing profitability. Credit policy should consider these results by demanding imperative attention from potential capitalizations that justify access to regulated financial markets.

Over the past few decades, many authors have specifically studied the relevancy of working capital and its effect on corporate profitability. A significant number of researchers have conducted studies in several countries within different markets and industries on

the value of efficiently managing working capital to maximize a firm's profitability and eventually improve a firm's performance. Working capital management is essential in industries as it influences the profitability and liquidity of the companies (Van Horne and Wachowicz 2008; Mandipa and Sibindi 2022). According to Russo (2013), the goal of managing working capital is particularly to maintain the ideal balance between all of the components of current assets. In this sense, obtaining solid knowledge about short-term financial operations through working capital management can allow the formulation of better strategies (Asare et al. 2022). Akinlo (2012) states that working capital management is an essential practice for companies. With the efficient management of working capital, firms could lower their reliance on external financing and use the released cash for additional investment and for enhancing the firm's financial flexibility. Working capital can be managed using the cash conversion cycle determinants, such as account receivable days, inventory days, and account payable days. According to Raheman and Nasr (2007), maximizing profit and neglecting liquidity costs can cause a firm's bankruptcy or insolvency. Hence firms must pursue an equilibrium point between liquidity and profitability using the three factors of the cash conversion cycle in the best way according to the characteristics of the firm's industry.

Although Deloof (2003) advocates that working capital management plays an essential role in determining a company's profitability, several studies that have been conducted on different firms and industries point out different results on how a company's performance in terms of profitability is influenced by the effective management of its working capital, specifically the cash conversion cycle. Insofar as there is no consensual position on this topic, the present study aims to determine not only what type of relationship exists concerning working capital management in terms of its components and the profitability of the companies, but also aims to explore this link specifically in wine sector companies.

2. Literature Review

The definition of working capital management is the supervision of the firm's current assets and the financing needed to provide the current assets (Van Horne and Wachowicz 2008). According to Bei and Wijewardana (2012), some companies should formally assume a policy of working capital management (WCM) aimed to lower the possibility of business failure and to improve business performance. Ross et al. (2017) explain the importance of working capital, stating that managing the firm's working capital is a day-to-day action that guarantees that the company has enough resources to continue its operations and prevent expensive stoppages. This involves several activities connected to the firm's receipt and disbursement of cash. In addition, excessive levels of current assets can easily stem from a substandard return on investment. But in companies with few current assets, there may be shortages and difficulties in sustaining regular operations (Van Horne and Wachowicz 2008). Agha (2014) considers that a company could increase its profit by managing working capital efficiently. Working capital management is widely seen as a valid instrument that can produce an impact on profitability and other financial indicators. According to Vishnani and Shah (2007), strategies and practices of working capital management have a deep influence on the profitability of companies. Nwankwo and Osho (2010) argue that efficient working capital management assumes a relevant part in establishing shareholder value, increasing business value, and growing businesses.

The effective management of working capital is critical for companies, mainly during the period of increasing investment opportunity set (Aktasa et al. 2015). Lind et al. (2012) suggest that with the efficient management of working capital, a company could enhance capital for additional strategic goals, decrease financial expenses, and boost profitability. Accordingly, financial managers have a concern regarding the management of working capital due to their responsibility of managing cash, marketable securities, accounts receivables, accounts payable, accruals, and other means of short-term financing. Only inventory management is out of its reach. Moreover, these management responsibilities require continuous, day-to-day supervision (Van Horne and Wachowicz 2008). These authors

considered that working capital can also be a significant indicator for investors because it measures liquid assets that provide a safety cushion to creditors. It is also crucial to measure the liquid reserve available to meet contingencies and the uncertainties surrounding the company's balance of cash inflows and outflows. To improve profitability and cash flow, many companies reduce investment in current assets through methods such as effective credit underwriting and the collection of receivables and just-in-time inventory management. Moreover, companies try to finance a large portion of their current assets through current liabilities, such as accounts payable and accruals, in an attempt to reduce working capital (Subramanyam and Wild 2009). Furthermore, working capital management requires two essential decisions: the analysis of the optimal level of investment in current assets and the appropriate mix of short-term and long-term financing used to support investment in current assets. These decisions may be further shaped by the trade-off that must be made between profitability and risk (Van Horne and Wachowicz 2008). On the one hand, conservative policies prefer reducing the risk arising from the decrease in investment in working capital, with a consequent decrease in profitability. On the other hand, aggressive policies tend to increase risk but also increase profitability (Smith 1980). To achieve this goal, working capital management should attain a balance between investing in inventories and customers and using supplier credit. Many previous studies have suggested that working capital management decisions influence firms' profitability. Several of them even suggest that an adverse association could exist between diverse measures of working capital and profitability (Soenen 1993; Beaumont Smith and Begemann 1997; Shin and Soenen 1998, 2000; Wang 2002; Deloof 2003; Lazaridis and Tryfonidis 2006; Baños-Caballero et al. 2014; Raheman and Nasr 2007; Ramachandran and Janakiraman 2009; Zariyawati et al. 2009; Gill et al. 2010; Erasmus 2010a, 2010b; Mansoori and Muhammad 2012; Ngwenya 2012; Napomech 2012; Makori and Jagongo 2013; Enqvist et al. 2014; Ukaegbu 2014; Onodje 2014; Eldomiaty et al. 2023). Nevertheless, Lyrouti and Lazaridis (2000), Sharma and Kumar (2011), Abuzayed (2012), and Akoto et al. (2013) realize a positive connection amongst cash conversion cycles, return on investment, and net profit margin. These studies were conducted using samples that included companies of diverse sectors. Deloof (2003), based on the noteworthy negative impact found concerning gross operating income and the day's inventory outstanding, accounts payable, and accounts receivable of Belgian firms, stated that executives can make value for shareholders through the reduction of the number of days sales outstanding and days inventory outstanding to a rational minimum. The same results were found by Baños-Caballero et al. (2014), who used a sample of 258 non-financial firms from the United Kingdom for the period of 2001–2007. The results suggest that there is a highly statistically significant U-shaped inverted association linking company performance and working capital. Moreover, the same kind of relationship was found with every element of the net trade cycle: accounts receivable to sales ratio, accounts payable to sales ratio, and inventories to sales ratio. In Cyprus, Charitou et al. (2010) explored the effect of working capital management on a company's financial performance and collected data from the annual reports of 43 industrial-listed companies on the Cyprus Stock Exchange for the period 1998 to 2007. The authors used the cash conversion cycle, including the stockholding period, debtor's collection period, and creditors payment period, for the independent variable, and they used return on assets as a dependent variable, which serves as a profitability measure. Using Pearson's correlation analysis, the results suggested that profitability had an inverse relation with the cash conversion cycle, including all its measures, days in receivables, days in payables, and days in inventory. These results show that the company's financial health is negatively related to all the measures of the cash conversion cycle. When the multivariate regression analysis model was applied to test the influence of working capital management in terms of the cash conversion cycle and the firm's profitability, the results indicated that the days in inventory had an inverse relationship with profitability, while the sales growth showed a positive coefficient with profitability. These results suggest that growth leads to more profitability, and high-leveraged companies are less able to make a profit since these companies have more default risk. Additionally,

Charitou et al. (2010) found from the regression of profitability against days payable and the control variables that days payable had a negative significant impact on profitability. In Finland, Enqvist et al. (2014) studied the effect of working capital management on a firm's profitability in distinct business cycles. Enqvist et al. (2014) collected data from Nasdaq OMX Helsinki stock exchange-listed firms over 18 years. Enqvist et al. (2014) considered working capital management in the form of a cash conversion cycle with all its components, including the number of days for accounts receivable, the number of days for accounts payable, and the number of days for inventory, as independent variables. The authors considered return on assets as the measure of the firm's overall profitability and both the gross operating income and non-financial assets as the dependent variables. The results of the regression model showed a statistically significant negative correlation between the cash conversion cycle and both measures of profitability, return on assets and gross operating income. Accordingly, Enqvist et al. (2014) suggested that firms can increase value by maximizing their working capital efficiency. In Greece, Lazaridis and Tryfonidis (2006) used a sample of 131 listed firms on the Athens Stock Exchange from 2001 to 2004. Lazaridis and Tryfonidis (2006) adopted Pearson's correlation model and the results obtained show that there is a negative correlation between net operating income with outstanding sales days, outstanding payment days, and the cash conversion cycle. The regression model that Lazaridis and Tryfonidis (2006) applied exposed a highly significant negative association between profitability and the cash conversion cycle and a highly significant negative association between the gross operating profit with the number of days for accounts payable, and the same type of relationship existed between the gross operating profits with the number of days for accounts receivable. However, Lazaridis and Tryfonidis (2006) found an insignificant negative correlation between gross operating profit and the number of days for inventory. Those studies obtained similar evidence of the influence of the cash conversion cycle, the average number of days within which supplier invoices are paid, the customers' credit period, the number of days for inventory, and the firm's profitability. In line with the literature review, the results point to the negative impact on a firm's profitability of the cash conversion cycle, the average period to receive, and the number of days for inventory. Regarding the number of days of accounts payable, the results suggested that this has a negative effect on the firm's profitability. Thus, unlike the previous results, these results are not in accordance with the postulate in the literature review which advocates that to improve profitability, companies must try to finance current assets through current liabilities such as accounts payable (Subramanyam and Wild 2009). The authors suggest some explanations. According to Deloof (2003), the negative relation between profitability and accounts payable shows that firms will take more time to pay their bills if they are less profitable. Baños-Caballero et al. (2014) argued that this finding means that when the firm holds an ideal level of investment in its working capital, then it will balance expenses and benefits which ultimately maximize the company's performance. Charitou et al. (2010) explained that the less profitable the company is, the more time it takes to repay its duties and obligations.

Other studies showed inconsistent results (Gill et al. 2010; Zawaira and Mutenheri 2014). Gill et al. (2010) used a sample of 88 American firms listed on the New York Stock Exchange for a period of 3 years from 2005 until 2007. The authors considered the cash conversion cycle, average period to receive, average payment period, and average collection period as independent variables and gross operating profit (profitability) as the dependent variable. The regression analysis showed that (i) there was a statistically significant negative association between the number of days of accounts receivable and profitability and (ii) no statistically significant association between profitability and both the number of days of accounts payable and the number of days inventory. In contrast, Gill et al. (2010) found a positive significant relationship between the cash conversion cycle and profitability, showing that the longer the cash conversion cycle, the higher the profitability of the firm. Zawaira and Mutenheri (2014) explored the influence of working capital management on the profitability of firms recorded on the Zimbabwe Stock Exchange for

the period of 2010–2012. [Zawaira and Mutenheri \(2014\)](#) findings revealed the following results: profitability is not associated with the receivable collection period, inventory conversion period, cash conversion cycle, quick ratio, current asset to total asset ratio, current liabilities to total asset ratio, debt ratio, or the age of the company. However, [Zawaira and Mutenheri \(2014\)](#) found a negative and significant relationship between the payable deferral period and profitability. The results obtained revealed some inconsistency. Finally, [Ngwenya \(2012\)](#) considered the relationship between working capital management and profitability for a sample of 69 listed firms on the Johannesburg Stock Exchange (JSE) for the period of 1998–2008. [Ngwenya \(2012\)](#) found a statistically significant negative relationship between gross operating profit and the cash conversion cycle and the number of days for accounts receivable. However, [Ngwenya's \(2012\)](#) findings showed a significant positive relationship between gross operating profit and the number of days payable and the number of days inventory. The signals obtained are in accordance with the signals expected for the variables cash conversion cycle, number of days for accounts receivable, and number of days payable. However, regarding the number of days inventory, the signal is different from what was expected. According to the literature review, to improve profitability, many companies reduce investment in current assets using methods such as just-in-time inventory ([Subramanyam and Wild 2009](#)). [Mun and Jang \(2015\)](#) explored the effect of U.S. restaurant firms' working capital on profitability and the results showed a significant inverted U-shaped correlation between working capital and a company's profitability (return on assets). According to [Mun and Jang \(2015\)](#), the firm's cash level is an essential element for efficiently managing working capital. [Tahir and Anuar \(2015\)](#) studied the relationship between working capital management and the profitability of firms in the Pakistani textile sector. The authors suggest that the average collection period in days, the level of net working capital, the current assets to operating revenue ratio, the current assets to sales ratio, and the current liabilities to total assets ratio have a negative effect on return on assets. The authors found evidence that profitability is positively influenced by average payment terms in days, inventory turnover in days, the cash conversion cycle, the net trade cycle, the cash turnover ratio, and the current assets to total assets ratio. Another relevant result consists of the findings of [Korent and Orsag \(2018\)](#) and [Baños-Caballero et al. \(2014\)](#), which suggest that there is no linearity in the relationship between working capital investment and firm performance. This implies the recognition that an optimal level of working capital must be determined that allows for a cost–benefit balance and enables performance maximization ([Baños-Caballero et al. 2014](#)). Most of the studies carried out on this topic have a generic scope. This suggests that the results obtained on the influence of the cash conversion cycle, days of payable outstanding, days of receivable outstanding, and days of inventory outstanding on profitability are generic. Thus, most of the previous studies do not reflect the specificities of the different sectors. For instance, in the wine sector, the most expensive wines are older wines. However, the wine aging process requires companies to store wine until the process is complete. Hence, it is expected that for the wine sector, lengthening the days of inventory outstanding will increase the wine firm's profitability.

As above, this is unquestionably the divergence of opinions between the nature and the direction of the relationship between working capital and companies' performance. This divergence may be due not only to the business sector, where the empirical research is carried out and the cultural and economic features of the context analyzed, but also to the methodological options adopted in each research study.

Thus, this study aims to focus specifically on the wine industry sector in the Old World and adopt artificial neural networks as its data analysis method. This methodological option for the artificial neural networks has to do with the fact that this technique does not require data to be linearly related.

The research question aims to gauge the influence of the level of working capital, as measured by the cash conversion cycle (CCC) on the profitability of Old World wine companies.

The aim of this research is to make a contribution to an issue that is recognized as significant to financial management as working capital management in the wine industry, specifically in Old World countries.

In this regard, the main objective of this study is to provide empirical evidence on the effects of working capital management and its components on corporate profitability in the wine industry in the Old World.

3. Methodology

This section discusses the company sample and variables encompassed in the study, the distribution patterns of data, and the statistical techniques used to explore the relationship between working capital management and its components and profitability.

3.1. Sampling

The companies under analysis are winemakers from France, Italy, Spain, and Portugal. The data refer to the period from 2016 to 2018 and include 4109 companies. Data were collected from the AMADEUS database established by Bureau van Dijk, which encompasses financial and economic data on European companies.

To analyze the existence of extreme values that could have an inflated influence on the results, outlier detection was carried out. Thus, some companies were removed from the analysis because they could induce bias, not only in the mean calculation but also in the estimation of other indicators. In fact, as the mean was highly influenced by the presence of scattered data, it was necessary to use statistical metrics that are not influenced by outliers. An example of this type of metric is quartile analysis. Quartile analysis uses the median, which focuses on the sequence of values, instead of the mean. After removing outliers, the final sample covers 324 companies and 521 business years.

Table 1 describes the dataset. In this table, it is possible to make assumptions on how companies manage their working capital management (WCM), e.g., the average cash conversion cycle is 215 days; this means that a company must wait for 215 days to obtain the return on the investment in production. Another example is the average time for the companies to pay their suppliers of 106 days. Also, these companies have a stage period of 214 days on average.

Table 1. Descriptive statistics of the data of the companies.

Variables	Mean	Std. Dev.	Min	25%	50%	75%	Max
Debtors	1,163,816	1,718,702	14,480	335,944	626,710	1,311,120	22,956,744
Creditors	825,754	1,618,518	9872	139,097	308,921	623,846	20,670,937
Sales	4,069,775	5,564,611	77,648	1,188,850	2,210,682	4,919,809	64,148,910
Material Cost	2,791,986	4,011,406	40,600	692,265	1,408,038	3,463,680	48,748,677
EBITDA	262,102	218,781	27,488	123,345	191,457	316,886	1,581,659
Operating Revenue	4,185,585	5,693,465	96,240	1,247,103	2,314,339	5,110,864	66,402,318
Profit Margin	2.25%	5.24%	−33.04%	0.2%	1.22%	3.70%	34.03%
Cash Flow	193,931	136,391	41,580	97,527	151,850	253,812	686,222
Long-term Debt	1,010,007	1,612,254	0	124,808	405,925	1,257,393	19,370,285
Days Pay Outstanding	106	67	12	47	100	154	328
Days Inventory Outstanding	214	77	92	150	200	273	455
Days Sales Outstanding	106	32	54	83	102	123	233
Cash Cycle	320	90	193	246	299	387	588
Cash Conversion Cycle	215	79	−4	170	210	268	436

To investigate the consequences of working capital management on wine sector firms' profitability, earnings before interests, taxes, depreciation, and administration (EBITDA) were used as the dependent variable. The independent variable, working capital management, was calculated using the average payment period, days of inventory outstanding, and the average number of days within which supplier invoices were paid.

The cash conversion cycle represents the number of days between the receivable's due date and the payable's due date. A negative number means that the company does not have the cash from its sales in due time to pay to its suppliers (Das 2015). The cash conversion cycle was estimated as the number of days sales outstanding plus the number of days inventory outstanding minus the number of days payable outstanding. As the cash conversion cycle becomes longer, the need for net investment in current assets becomes greater, and therefore so does the need for financing current assets. The cash cycle represents the total number of days starting with the payment of the inventory and the time it takes to receive the value of its sale (Bodie and Merton 2000).

The days payable outstanding (DPO) is the number of days for accounts payable and indicates the average time it takes wine firms to pay their suppliers. This was computed as $365 \times [\text{accounts payable (AP)}/\text{purchases (P)}]$. The greater the value, the longer firms take to resolve their payment responsibilities to their suppliers.

Days inventory outstanding (DIO) was estimated as $365 \times [\text{inventories (I)}/\text{purchases (P)}]$. This variable shows the average number of days of stock held by a wine sector firm. Longer storage times represent a bigger investment in inventory for a certain level of operations.

The days sales outstanding (DSO) is computed as $365 \times [\text{accounts receivable (AR)}/\text{sales (S)}]$. This variable corresponds to the average number of days that a wine sector firm takes to collect payments from its customers. As the value increases, the investment in accounts receivable increases.

3.2. Artificial Neural Network Procedures

In recent years, the importance of data analysis for obtaining more information on certain products has been growing and the most-used method has been artificial intelligence (AI).

At the beginning of artificial intelligence, the problems to be solved were difficult to solve for human beings, but relatively simple for computers. These problems were usually described as a list of mathematical rules. However, the real challenge appears when the goal is to solve problems that are simple for the human being, but which do not obey formal rules that are intuitive and automatic—for example, recognizing words or faces in an image (Goodfellow et al. 2016).

The artificial neural network (ANN) uses brain processing as the basis for creating algorithms that can be employed to model complex patterning and prediction problems. The choice for this methodological technique was based on the idea that ANNs have the capability to learn and model non-linear and complex relations, and this is very important because in real life many of the relations between inputs and outputs are non-linear and also complex. In addition, ANNs can generalize, as after learning from the initial inputs and their relations, they can also infer unseen relations in unseen data, allowing the model to generalize and predict in unseen data. In fact, unlike many other prediction techniques, ANNs do not impose any restrictions on the input variables (with respect to the distribution).

In addition, several studies have evidenced that ANNs allow better modeling of heteroscedasticity, that is, data with high volatility and non-constant variance, due to their ability to learn hidden relationships in the data without imposing any fixed relationship in the data. This is very helpful in forecasting financial time series, where the volatility of the data is very high (Gevrey et al. 2003).

Supervised neural networks learn through a dataset that has both the variables and the results. By iterating over each row of data, it will calculate the best possible pattern and compare it with the expected result. By evaluating the neural network with a formula like mean squared error, we can evaluate how much it missed the target value (Cortez and Neves 2000). One practical example is trying to solve an XOR (exclusive or) gate. This is a function that only returns a true value when one, and only one, of the variables is true.

The difficulty in these cases is the fact that the result is not linearly correlated, e.g., for $A = 0$ the result increases as B also increases. On the other hand, for $A = 1$, the result must decrease as B increases. A linear model would have to apply different coefficients based on the value of the variables.

The equation to predict the value of the neural network is the following:

$$x = \sum_{n=1}^n [i_n w_n + b]$$

where:

x = Result

i = Input value i

w = Weight i

b = Bias x

n = Number of input values

The previous equation computes the value of a single neuron in the neural network based on its input value and a random weight and bias.

The next equation calculates the value of a hidden layer's neuron based on the results of the previous layer's neurons on the network by applying a random weight and bias for each one and summing them all together.

$$y = \sum_{n=1}^n [x_i w_i + b]$$

where:

y = Result

x = Previous neuron result x

w = Weight x

b = Bias y

n = Number of neurons in the previous layer

The next equation calculates the value of the neuron of the output layer, which is responsible for the result of the network (prediction), by applying a random weight and bias for each neuron of the hidden layer and summing all the neurons together.

$$p = \sum_{n=1}^n [y_i w_i + b]$$

where:

p = Output

y = Previous neuron result y

w = Weight y

b = Bias p

n = Number of neurons in the previous layer

Finally, at the end of each iteration, the result will be compared to the expected value and then corrected in the next iteration. The function that measures the difference between the predicted and the expected result is called a loss function. The most-used loss function is the mean squared error:

$$MSE = \frac{1}{n} \sum_{i=1}^n (Y_i - \hat{Y}_i)^2$$

where:

MSE = Mean squared error

n = Number of predicted values

Y_i = Expected value

$\hat{Y}_i$ = Predicted value

4. Results and Discussion

4.1. Pearson's Correlation

The relation between working capital management and profitability variables was analyzed using Pearson's correlation.

Table 2 shows the Pearson correlation coefficients for all variables. The results suggest that there is a statistically significant negative relation between the cash conversion cycle and the profitability measure EBITDA. This outcome is consistent with the results of [Deloof \(2003\)](#), [Baños-Caballero et al. \(2014\)](#), [Charitou et al. \(2010\)](#), and [Enqvist et al. \(2014\)](#). This result indicates that the time gap between the expenses with the purchases of raw materials and the collection of sales of finished products can be very long, and that by decreasing this time gap it is possible to increase the profitability of the wine company. Thus, this negative correlation suggests that shortening the cash conversion cycle leads to higher profitability. The days outstanding payable and the days outstanding sales show a positive and significant correlation with the profitability measure. Concerning days of payable outstanding (DPO), the results showed that lengthening the number of days payable outstanding (DPO) positively affects the wine company's performance in terms of profitability.

Table 2. Pearson correlation results between the working capital variables and the EBITDA.

Variables	Pearson Correlation	
	Pearson (r)	Significance (p)
Cash Conversion Cycle	−0.47	0
Days Pay Outstanding	0.19	0
Days Inventory Outstanding	−0.35	0
Days Sales Outstanding	0.1	0.2
Cash Cycle	−0.27	0

Regarding days of sales outstanding (DSO), the empirical evidence suggests that lengthening the limits for clients to pay may enhance wine firms' profitability, since the granting of greater payment facilities may raise sales.

Between days of inventory outstanding (DIO) and EBITA, there is a negative and statistically significant correlation. The result is also consistent with those presented by [Deloof \(2003\)](#), [Charitou et al. \(2010\)](#), and [Enqvist et al. \(2014\)](#). Based on this outcome, wine companies' profitability can become better by decreasing the number of days of inventory, e.g., maintaining inventory for less time can also increase profitability.

4.2. Artificial Neural Network Estimation

The neural network used in this research study is composed of an input layer that accepts five variables—(i) the cash conversion cycle, (ii) the cash cycle, (iii) the days payable outstanding (DPO), (iv) the days sales outstanding and (v) the days inventory outstanding—by two hidden layers that transform the inputs and an output layer that predicts the expected result, in this case the earnings before interest, taxes, depreciation, and amortization. Each hidden layer consists of 16 neurons that randomly assign different weights to each input.

Figure 1 represents the dispersion of the cash conversion cycle by the EBITDA. This figure shows that there is no linear association between the number of days of the cash conversion cycle and the profitability. Neural networks can evaluate nonlinear data and it is expected that this network will be able to obtain a relation between the WCM variables and the profitability of the companies.

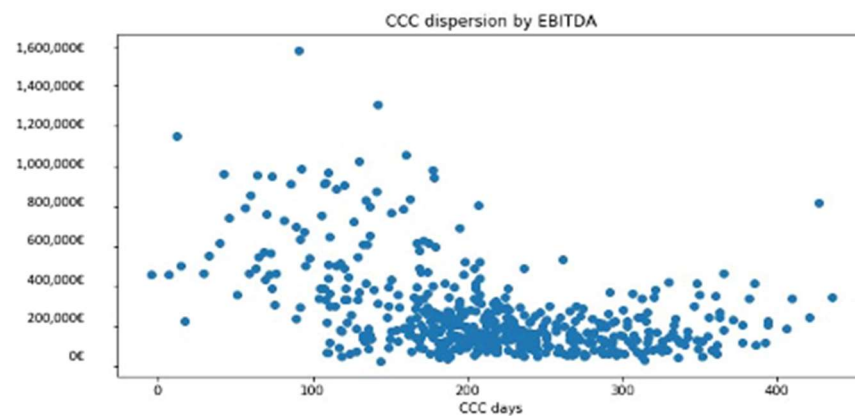


Figure 1. Cash conversion cycle dispersion by EBITDA.

This neuronal network has been tested with different parameters and the performance of its training is shown by the evolution of the loss function, represented in Figure 2. The network was tested with 50, 100, 200, 500, 1000, 2000, and 3000 iterations (or epochs), but from the 200th onward, there was no significant improvement in its performance. The final neural network was trained for 200 iterations. This neural network had 417 data rows as a training-set, 52 rows as a validation-set, and 52 rows as a test-set.

In Figure 3, three charts, each with a different loss function, are represented. The first chart (Mean Squared Error) shows the cost function used to evaluate the network during the iterations. The second (Absolute Error) and the third chart (Mean Squared Logarithmic Error) were used to test what would be the best performing loss function. In this network, the best-performing loss function was the Mean Squared Error—Equation (2).

The predicted value was obtained through the network and the expected value was the actual value of a randomly chosen company. In Figure 4, the deviation of the predicted value against the expected value could be analyzed. As can be seen, the neural network cannot predict the exact value of the EBITDA. The difference for most cases is not high, but it is not zero either.

Although there is little difference between the predicted value and expected value, this difference becomes significant in the network's reliability. This means that it is not possible to accurately predict the value of profitability based on working capital. For a better understanding of the error between predicted and expected values, Figure 3 shows the mean absolute percentage error at each iteration of the network. This chart shows that the neural network has an error margin of about 4.4% (minimum value).

Figure 5 represents the influence of the independent variables on the predicted values of the neural network. In this chart, the longer the bar, the higher the contribution. The variables may have a positive influence (increase in value) or a negative influence (decrease in value). In other words, a positive influence means that the variable will be used to increase the predicted value, while the negative influence will be used to decrease the predicted value.

The findings suggest that the cash conversion cycle, cash cycle, and days inventory outstanding have a positive impact, while days sales outstanding and days payable outstanding have a negative effect on the neural network's predicted values.

These results are inconsistent with those obtained from the Pearson's correlation analysis and those obtained in other studies. The results suggest that there is a positive correlation between the cash conversion cycle and the measure of profitability EBITDA. This outcome seems to predict that decreasing the cash conversion cycle is associated with the lower profitability of wine firms. These conclusions corroborate the findings of Sharma and Kumar (2011), Karadagli (2012), Abuzayed (2012), and Gill et al. (2010), which obtained the same evidence. However, they are inconsistent with the results of Deloof (2003), Baños-Caballero et al. (2014), Charitou et al. (2010), and Enqvist et al. (2014). In

fact, in the present research study, the days of payable outstanding (DPO) and days of sales outstanding (DSO) both reveal a negative relationship with the profitability measure.

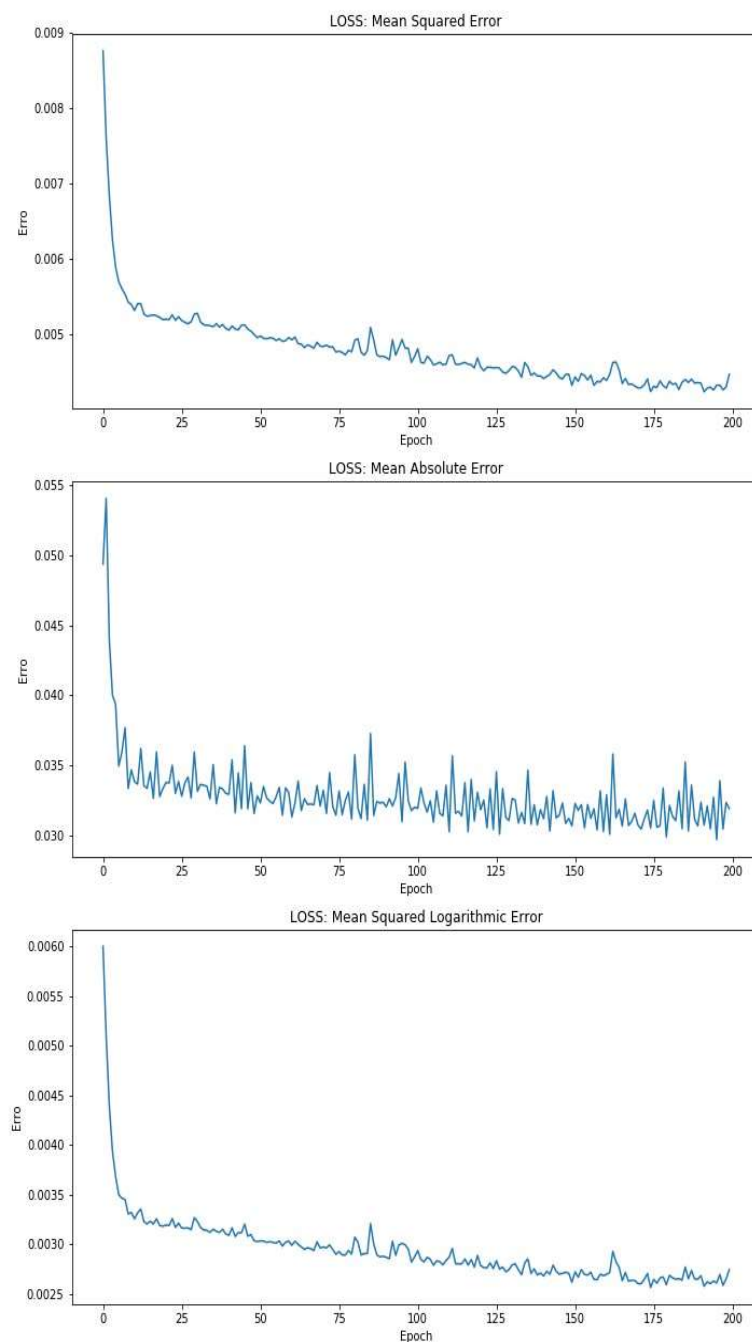


Figure 2. Loss functions—from top to bottom: Mean Squared Error, Mean Absolute Error, and Mean Squared Logarithmic Error. These functions evaluate the performance of the predicted values against the expected values and were used to save the best ANN model.

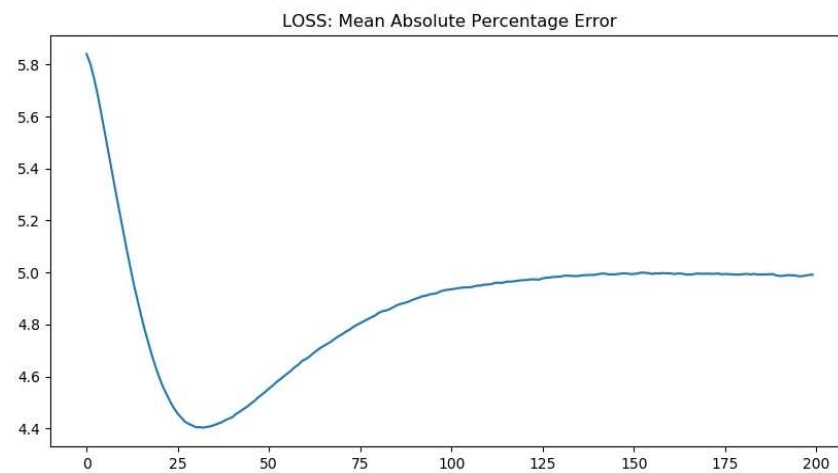


Figure 3. Loss function—Mean Absolute Percentage Error—This function evaluates the predicted values against the expected values and shows the percentage error at each iteration of the network.

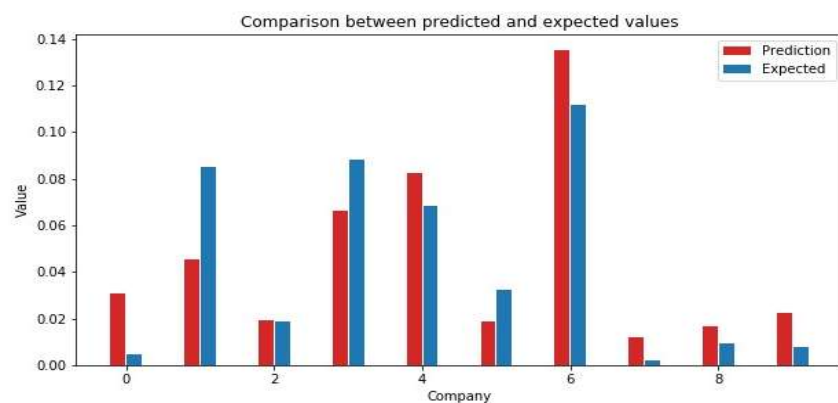


Figure 4. Neural network prediction results—the difference between predicted and expected values. In this chart, it is possible to see that the neural network cannot predict the exact value of the EBITDA, but that it is not that far from it.

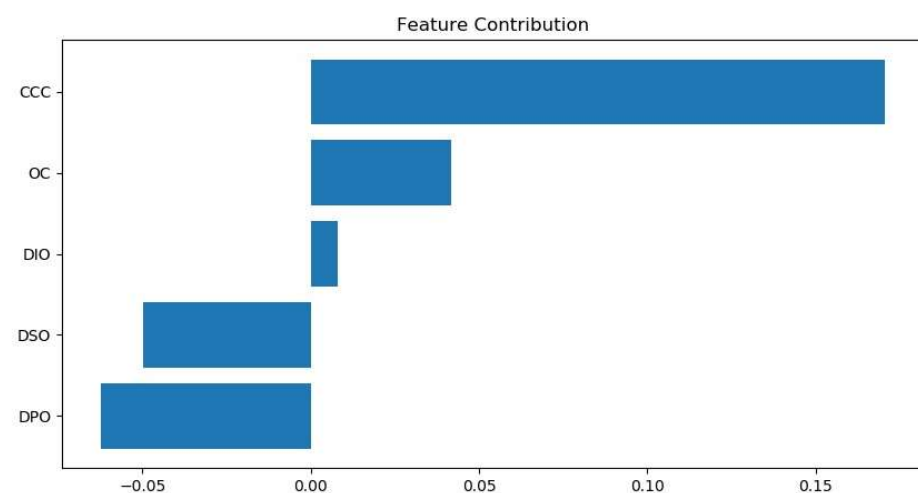


Figure 5. Feature contribution for the predicted values.

According to the above-mentioned findings, there is a negative relation concerning days of payable outstanding (DPO) and wine companies' profitability. [Enqvist et al. \(2014\)](#) suggested that less profitable companies need to take more time to pay their bills; accordingly, a shorter account payable cycle will improve the firm's profitability. [Deloof \(2003\)](#) stated that firms that present less profitability tend to delay their payments. The

negative impact on profitability can be explained by a deterioration of the relationship with suppliers and a consequent increase in acquisition cost. Between days of inventory outstanding (DIO) and EBITA there is a positive relationship. The result is consistent with the one presented by [Abuzayed \(2012\)](#). The results suggest that a wine firm's profitability can also be increased by strengthening the number of days of inventory, so that maintaining inventory for extended periods can also increase profitability.

Due to days of sales outstanding (DSO), the evidence suggests that extending the number of days of sales outstanding negatively influences profitability. Thus, shortening the time limit for clients to pay can enhance profitability. Consequently, a more restricted credit plan which gives customers less time to pay increases profitability ([Deloof 2003](#)).

5. Conclusions

The wine industry consists mostly of small- and medium-sized enterprises. Working capital management is particularly critical when it comes to small- and medium-sized companies. Most companies have a large amount of money invested in working capital. Thus, working capital management can be expected to have a significant impact on the profitability of companies.

Earlier literature such as [Sharma and Kumar \(2011\)](#), [Karadagli \(2012\)](#), and [Gill et al. \(2010\)](#) observed a positive relation between profitability and the cash conversion cycle of Belgian firms. The present findings suggest a positive relationship between profitability, measured through EBITDA, and the cash conversion cycle, which is employed as a measure of working capital management efficiency for wine firms. Therefore, managers ought to pay special attention to working capital management in the wine business, especially if they manage small- and medium-sized companies.

Regarding days of payable outstanding, prior studies found a negative relationship between this variable and the profitability of the firm ([Deloof 2003](#); [Charitou et al. 2010](#); [Enqvist et al. 2014](#)). Our results suggest that a wine firm's profitability is lower with an increase in the number of days of payable outstanding. Thus, it can be inferred that less profitable wine companies take longer to pay their invoices, taking advantage of the credit term granted by their suppliers. Concerning days of receivable outstanding, preceding studies found a negative influence of this variable on the profitability of companies ([Deloof 2003](#); [Charitou et al. 2010](#); [Enqvist et al. 2014](#)). The present research also found a negative correlation between these variables. The negative relationship between days of receivable outstanding and wine firms' profitability indicates that more profitable firms will follow a reduction of their average period to receive payments.

The result suggested that increasing the average number of days to receive payments from clients, even though it might increase profitability since better payment facilities may promote sales, similarly has a negative influence on profitability, since a more restraining credit policy gives customers less time to make their payments rise profitability ([Deloof 2003](#)).

Finally, previous theoretical research ([Deloof 2003](#); [Charitou et al. 2010](#); [Enqvist et al. 2014](#)) predicts a negative relationship involving the day's inventory outstanding and profitability. Nevertheless, [Abuzayed \(2012\)](#) observed a positive correlation between these variables. The present results are in line with those findings.

The value of the study stems from the fact that it can be inferred that working capital management has different impacts on firms' profitability measures depending on the industry. The results are presented for only one sector and only one geographic region, the Old World. Thus, the evidence obtained considers the specificities of the wine sector. In this sector, the most expensive wines are those with the highest quality, which is related to the wine aging process. [Costanigro et al. \(2007\)](#) suggest that aging influences wine prices. The results showed that, for fine wines, the wine aging function shows increasing marginal returns. The results are in line with this evidence since it was found that a wine firm's profitability can be made superior by increasing the number of days of inventory. Consequently, possessing inventory for longer periods can increase profitability. Consequently,

wine industry managers can establish profits for wine companies by correctly controlling the cash conversion cycle and preserving to an optimum level accounts receivable, accounts payable, and inventory. In a global market, where the wine sector is very competitive and characterized by the existence of a large number of players, efficient and effective working capital management becomes relevant. This article presents a previously unavailable analysis of the effect of working capital management on the financial performance of companies in this sector. This article is an asset for all those interested in this sector as it allows a better understanding of the impact of working capital management. Furthermore, it will be possible to better identify and manage the constraints arising from the management of working capital in the wine sector, contributing to strengthening its performance and competitiveness. Furthermore, the study only refers to internal factors and does not consider external factors (Lazaridis and Tryfonidis 2006). Future research could further explore overcoming these limits. Given that the wine sector is divided between the Old World and the New World depending on the characteristics of the wines produced in these two regions and the production methods they adopt, it would be important to carry out an identical analysis in companies in the New World. Furthermore, it would be interesting to make a comparison between the two blocks of countries to assess whether the differences in characteristics and wine production techniques alter the effect of working capital management on company performance.

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