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Determining the Influences of Macroeconomic Variables on Working Capital through Artificial Neural Network Modeling: The Case of Turkey

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Abstract

Finance and economics literature includes many attempts to determine the factors influential on working capital and working capital management. The present study aims to find out the relationships between working capital and macroeconomic variables. To this end, 11-year financial statement data of 128 companies traded at Borsa Istanbul from the 2003 to 2013 period were examined, and artificial neural network modeling was administered to the data obtained from these financial statements. The level of working capital, return on working capital, and cash conversion cycle were used as dependent variables and analyzed separately. Macroeconomic variables such as inflation, export index, import index, foreign exchange rate, interest rate, stock market index, gross domestic product, and gold prices were used as independent variables. The research findings show that there are relationships between working capital and macroeconomic variables; working capital is influenced by macroeconomic variables; the level of working capital is influenced most by export index and stock market index; return on working capital is influenced most by import index and stock market index; and cash conversion cycle, which represents working capital management, is influenced most by benchmark interest rate, gold prices, and foreign exchange rate.

Keywords: artificial neural networks, macro-economic variables, working capital

1. Introduction

Working capital is defined as short-term assets that are needed by enterprises to continue their activities. Working capital management is crucial for enterprises to continue their activities and increase their profitability. Working capital management is important to maximize the value of an enterprise because working capital investments are made in substantial amounts; managers allocate long time to working capital management; and the level of working capital is closely associated with volume of business and profitability.

In broad terms, working capital consists of current assets. Thus, cash, accounts receivable, and inventory which make up current assets are also the elements of working capital. These elements need to be managed separately to ensure an effective working capital management.

The level of working capital of an enterprise depends on many factors. Factors such as the volume of business of an enterprise, the maturity of its accounts receivable, the maturity of its debts, supply conditions, and inventory policy are influential on the level of working capital. However, besides internal factors, there are also exogenous factors influential on the working capital requirement of an enterprise.

This study aims to reveal the degree to what enterprises' levels of working capital are influenced by macro-economic variables and determine the variable that is most influential on the level of working capital. In this way, an attempt is made to find out working capital requirements correctly by determining the influences of exogenous factors on such requirements in a more clear way.

The order of this paper from here on (i.e. after introduction) is as follows: a brief discussion of factors influential on the level of working capital; literature review on working capital; research data; methodology; analysis; and finally general evaluation and conclusion based on the discussion of the findings obtained from analyses.

2. Factors Influential on the Level of Working Capital

Different enterprises may have different sizes, operate in different industries, employ different production techniques, and achieve different turnovers. These differences are very important for the working capital requirements of enterprises. In the literature, factors influential on working capital are divided into two: internal factors and exogenous factors.

Working capital requirement of a company depends on its characteristics and conditions. Working capitals are different when volumes of business are different, but they may also be different because of several reasons when volumes of business are the same (Aksoy, 2013, p. 67). In general, rise in volume of business brings about an increase in working capital requirement. However, different enterprises having the same level of activity may have different working capital requirements because of their internal differences. The basic reason is factors unique to enterprises.

Working capital requirement arises for an enterprise because of the inefficacy of its methods and processes. Among reasons that lead to an increase in working capital requirement are customers' delaying their payments, disruptions in production and distribution, problems resulting from suppliers, staff working unproductively, unexpected changes in demand level, recession, and inability to collect accounts receivable (Tomak, 2013, p. 15).

The most important factors influential on working capital requirement and the level of working capital are size and volume of business (Aksoy, 2013, p. 68). As stated in the beginning of this paper, working capital is defined as the money needed for enterprises to maintain their routine operations. For that reason, the volume of business of an enterprise is the key determinant of its working capital. Asset turnover, supply and sales conditions, liquidity, capacity, period of manufacture, cost of capital, and borrowing capacity are some other internal factors influential on the level of working capital.

The level of working capital is influenced by some exogenous factors besides internal factors. Aksoy and Yalçıner (2013) report that the level of working capital is influenced by such exogenous factors as tax practices, investment incentives, inflation, changes in economy, technological changes, and the levels of development of financial institutions.

Rising prices resulting from high inflation level wear away the working capitals of enterprises and lead to higher working capital requirements than expected (Akgüç, 1998, p. 208). In high inflation periods, the amount of cash held for transactions increases; increased sales due to inflation augment receivables; and inventories increase both in real terms and in monetary terms. Price increase expectations drive enterprises to increase their inventories (Sayılgan, 2003, p. 80).

In consideration of the foregoing, the present study aims to determine the relationships between the level of working capital and macro-economic variables. In this sense, an attempt is made to ascertain whether or not the levels of working capital of enterprises are influenced by macro-economic variables and what macro-economic variables influence the level of working capital more.

3. Literature Review

Working capital literature contains a lot of studies. These studies generally deal with measuring the levels of working capital, profitability, and performance of enterprises. While some studies aim to determine the working capital levels of enterprises, some others attempt to detect the factors influential on the level of working capital. Some of the studies included in working capital literature are given below.

Mongrut et al. (2014) tried to determine the factors influential on working capital management in Latin American companies. They used an unbalanced panel data analysis for companies quoted on stock exchanges and observed that companies in Argentina, Brazil, Chile and Mexico were holding cash excesses that could destroy firm value. The results of this study indicate that cash conversion cycle, company's market power, future sales, and country risk are influential on the way Latin American companies manage their working capitals with significant differences among countries in the region.

Doğan and Elitaş (2014) attempted to identify the determinants of the working capital requirements of food companies traded at Borsa Istanbul. To this end, they used the financial data of 15 firms from the 2006 to 2012 period and employed multiple regression and correlation methods. The results of this study show that there are positive relationships between an enterprise's level of working capital and its cash conversion cycle, cash flow, and return on assets, a negative relationship between leverage and size, and a positive but statistically insignificant relationship between gross domestic product and interest rate.

Mohamad and Elias (2013) aimed to determine the important factors influential on working capital management in companies traded at stock exchange in Malaysia. To this end, they examined 150 publicly held companies from 7 different industries in the 2002 to 2011 period. They used cash conversion cycle and working capital as dependent variables and took debt, capital expenditure, free cash flow, gross domestic product, and firm growth as independent variables. They detected significant relationships between working capital and the independent variables.

Mansoori and Muhammad (2012) tried to determine the important factors influential on working capital management of the companies traded at stock exchange in Singapore. They found negative relationships between working capital management and firm size, operating cash flow, capital expenditures, and gross domestic product.

Abbadi and Abbadi (2012) attempted to identify the variables determining working capital in Palestinian industrial firms. They used a sample composed of 11 industrial firms traded at the Palestine Exchange. While working capital was used as dependent variable, some financial and economic variables such as cash conversion cycle, operating cash flow, return on assets, loan rate, and economic growth were used as independent variables. Parameters were predicted based on the panel data related to 11 industrial firms from the 2004 to 2011 period. It was concluded that cash conversion cycle, return on assets, and operating cash flow are significant determinants and are in a positive relationship with working capital requirements while leverage and firm size are significant determinants but are in a negative relationship with working capital requirements. It was seen, on the other hand, that economic variables such as interest rate, gross domestic product, and real growth rate have no significant influence on working capital.

Similarly, Nguyễn (2013) aimed to examine the factors influential on working capital requirement by using panel data of 265 companies traded at Ho Chi Minh Stock Exchange from the 2007 to 2012 period. It was concluded that firm size, profitability, and business cycle have positive and significant influences on the working capital requirements of Vietnamese companies. In addition, it was observed that the more a company uses financial leverages, the less working capital it needs.

Gill (2011) attempted to determine the factors influential on working capital requirements in Canada. The research sample consisted of 166 Canadian firms traded at Toronto Stock Exchange for a period of 3 years between 2008 and 2010. It was concluded that business cycle, return on assets, internalization of firm, and firm size are influential on working capital requirements in Canada.

Chiou et al. (2006) examined the factors influential on working capital management. Net liquidity balance and working capital requirements were used as measures of working capital management. It was seen that debt ratio and operating cash flow influence the working capital management of a company. However, they failed to obtain consistence evidence about the influences of business cycle, industry, firm growth, firm performance, and firm size on working capital management.

Büyükşalvarcı and Abdioğlu (2010) tried to determine the variables influential on the working capital requirements of firms before and during crisis and made an attempt to ascertain whether or not such variables varied. They concluded that increases in leverage ratio and assets ratio reduce working capital requirement.

Nazir and Afza (2009) examined the factors influential on the working capital requirements of companies. To this end, they examined 132 manufacturing firms from 14 industrial groups traded at Karachi Stock Exchange between 2004 and 2007. While working capital requirement was used as dependent variable, various financial and economic factors such as business cycle, level of economic activity, leverage, firm growth, operating cash flow, firm size, industry, return on assets, and Tobin's q were taken as the determinants of working capital management. It was found out that business cycle, leverage, return on assets, and Tobin's q are influential on working capital. Similarly, Taleb et al. (2010) tried to determine the factors influential on working capital by using 82 industrial firms traded at Amman Stock Exchange between 2005 and 2007. While working capital requirement was used as dependent variable, various financial and economic factors such as firm's business cycle, level of economic activity, leverage, firm growth, operating cash flow, firm size, return on assets, and Tobin's q were taken as independent variables. Simple and multiple regression analysis results indicated statistically significant relationships between working capital and all independent variables.

Saldanlı (2012) analyzed the influences of working capital managements and liquidities of BIST-100 index manufacturing industry firms on their profitability. It was concluded that increased liquidity ratio and more working capital influence profitability negatively. Likewise, Dursun and Ayrıçay (2012) focused on the relationship between working capital and gross profit in enterprises listed on Borsa Istanbul. They used data including the annual data of 120 manufacturing and commercial enterprises traded at Borsa Istanbul and 1200

observations. They found a negative relationship between working capital and gross profitability.

Aygün (2012) attempted to determine the relationship between return on assets and working capital for 107 manufacturing industry firms traded at Borsa Istanbul between 2000 and 2009. The financial data of the firms were subjected to regression and correlation analyses. An inverse relationship was detected between working capital and profitability. Akbulut (2011) examined the relationship between working capital management and profitability in manufacturing industry firms traded at Borsa Istanbul between 2000 and 2008 and reached a similar result to Aygün.

As is seen above, most works on working capital tried to determine the factors influential on working capital. The works on factors influencing working capital generally dealt with internal and exogenous factors together. The present study aims to measure the influences of macro-economic figures on the level of working capital. Exogenous factors were included in the study as macro-economic figures. What makes the present study different from other studies in the literature is the measurement of the influences of macro-economic figures on the level of working capital.

4. Data and Variables Used in the Study

The purpose of this study is to determine the influences of macro-economic variables on the level of working capital. To this end, the year-end financial statement data of 128 companies from the 2003 to 2013 period were used. The year 2003 was taken as the starting point in order to rule out the negative effects of the crisis in 2000 and 2001.

The research sample consisted of 128 companies quoted on stock exchange between 2003 and 2013 among the real sector companies traded at the National Market in December 2014. 11-year data of 128 companies were used, and 1,408 observations were made. The annual balance sheet data of the companies were reached via Finnet Excel Analysis Module (Version 9.2.4.6.).

3 dependent variables were included in analyses: 1) working capital ratio, which represents the level of working capital; 2) return on working capital; 3) cash conversion cycle, which represents working capital management. In determining the dependent variables, an attempt was made to ensure that these variables would represent the level of working capital. Other studies in the literature dealing with this subject were taken as a reference. Similar dependent variables were used in Asmawi and Faridah (2012), Aygün (2012), Abbadi and Abbadi (2012), Doğan and Elitaş (2014), Akbulut (2011), and many other studies. The calculation of the dependent variables and their abbreviations as used in the model are summarized below.

Dependent variables:

1) The Level of Working Capital = Net Working Capital / Total Assets

2) Return on Working Capital = Net Profit / Total Current Assets

3) Cash Conversion Cycle = Days Sales Outstanding + Days Inventory Outstanding – Days Payables Outstanding

8 independent variables were used in analyses. The studies in the literature were taken into consideration in determining the independent variables, and macro-economic variables likely to influence working capital were included in analyses. One of the macro-economic variables included in the study is inflation rate. Change in producer price index was taken as inflation rate. Inflation data were obtained from the webpage of the Central Bank of the Republic of Turkey (CBRT) (www.tcmb.gov.tr). The second independent variable used in the study is foreign exchange rate. USD/TL was taken into consideration as foreign exchange rate. Foreign exchange rate data were taken from the webpage of CBRT (www.tcmb.gov.tr), too. The third independent variable adopted in the study is interest rate. The benchmark interest rates of the Central Bank of the Republic of Turkey were used in the study. The fourth independent variable employed in the study is gross domestic product. The relevant data were also acquired from the webpage of CBRT (www.tcmb.gov.tr). Annual changes in gross domestic product were taken into account in analyses. Another independent variable used in the study is gold prices. The data about gold prices were extracted from the webpage of CBRT (www.tcmb.gov.tr), too. Import and export indices were also taken as independent variables. The relevant data were obtained from the webpage of the Turkish Statistical Institute (www.tuik.gov.tr). The last independent variable of the present study is BIST-100 index, which is the benchmark index of Borsa Istanbul. BIST-100 index data were reached via Finnet Excel Analysis Module (Version 9.2.4.6.).

In determining the independent variables of the study, an attempt was made to choose the macro-economic variables likely to influence the level of working capital. The studies in the literature were taken as reference in

determining these independent variables, as in determining the dependent variables. It was tried to obtain more meaningful results by enriching analyses with additional variables such as foreign exchange rate, stock market index, import index, export index, and gold prices in addition to the macro-economic variables used by Doğan and Elitaş (2014), Mohamad and Elias (2013), Taleb et al. (2010), Mansoori and Muhammad (2012), and Büyükşalvarcı and Abdioğlu (2010). The list of the independent variables and their abbreviations as used in analyses are given below.

Independent Variables

1) Inflation = inf
2) Export index = exp
3) Import index = imp
4) Foreign exchange rate = USD/TL
5) Interest rate = int
6) Stock Market Index = BIST100
7) Change in Gross Domestic Product = GDP
8) Gold prices = gold

5. Methodology

The present study attempted to determine the influences of macro-economic variables on working capital through artificial neural network analysis. The literature review shows that artificial neural network analyses have been used in many fields. They have been employed in economic and financial studies, too.

Aygören et al. (2012) attempted to predict BIST-100 index through artificial neural networks. Akcan and Kartal (2011) used artificial neural network method in predicting the prices of stocks of ISE insurance index companies. Similarly, Aktaş (2003) employed artificial neural network method in determining financial failures. Just some of the studies in the literature involving the use of artificial neural network analysis were included in the present study. There was no need to include more.

Artificial neural networks are the computer systems developed for automatically (i.e. without getting any help) performing the skills of creating, producing, and discovering new information through learning, which is one of the qualifications of human brain. (Öztemel, 2003, p. 29) Artificial neurons developed for mathematically modeling the functioning of biological neurons are based on the following assumptions (Hamzaçelebi, 2011, p. 11):

- Information processing consists of simple elements called neurons.
- Signals are transmitted through connections between neurons.
- Each connection between neurons has a weight value.
- The net output of each neuron is obtained by making its net input go through an activation function.

Such features of artificial neural networks as matching, parallelism, learning, and adaptation are used in linear and non-linear processes. Artificial neural networks are algorithmic and non-numeric information processing systems with a feature of parallelism. They simply consist of a lot of internally interconnected elements called artificial neurons (Zurada, 1992, p. 321)

Every input has its own weight value. After inputs are multiplied by their weight values, they are added up. After the threshold value is added to this value, it is subjected to "f" transfer function. In general, log-sigmoid, tan-sigmoid, and linear transfer function types are used as transfer functions.

A backpropagation-based and multilayered network was used in this study. A typical backpropagation network has one input layer, one output layer, and minimum one hidden layer. There is no theoretical limit to the number of hidden layers (Elmas, 2003, p. 70) Scaled Conjugate Gradient (SCG), Brodyen-Fletcher-Goldfarb-Shanno (BFGS), and Levenberg–Marquardt (LM) learning algorithms were used in training our network.

There are various backpropagation methods. The simplest one is gradient descent. In this method, weights are updated oppositely to gradient, which is seen in Equation 1.

$$w(k+1) = w(k) - \eta \nabla J(k) \quad (1)$$

In Equation 1, η is learning coefficient, and $\nabla J(k)$ is the gradient of error in the kth iteration. The selection of

learning coefficient is important. When a too small coefficient is selected, too many iterations are needed to diminish the error to the required level. However, when a too big coefficient is selected, necessary values cannot be found, and the network works unstably.

5.1 Scaled Conjugate Gradient (SCG)

Learning coefficient is constant in the gradient descent method, and it is not always the shortest cut of reaching the most appropriate values. In most of conjugate gradient methods, step length is adjusted in every iteration. The error is minimized with a search of conjugate gradient direction. Conjugate gradient methods make a search in every iteration. Thus, the response of the network to inputs has to be calculated for each search over and over. The line search algorithm which causes time delay is not used with the scaled conjugate gradient method.

It employs more iterations in comparison to other conjugate gradient methods. However, the number of calculations considerably decreases in each iteration. In addition, almost the same memory is needed as other conjugate methods (Demuth & Beale, 2002, p. 2).

5.2 Brodyen-Fletcher-Goldfarb-Shanno (BFGS)

The Newton method is an alternative to the scaled conjugate gradient because it finds the most appropriate point rapidly. The basis of the Newton method is given in Equation 2.

$$w(k+1) = w(k) - H_k^{-1}\nabla J(k) \tag{2}$$

In Equation 2, H refers to the Hessian matrix (the second error derivative). The Newton method generally reaches the most appropriate value faster than the conjugant gradient method. However, calculating the Hessian matrix slows down the method for multilayered sensors. The calculation of second derivatives is not necessary in some methods which are based on the Newton method. These methods are called Quasi-Newton methods. In every iteration, approximate Hessian matrix is updated (upgrading is the function of gradient). Among these Quasi-Newton methods, the most successful one is Broyden- Fletcher-Goldfarb-Shanno (BFGS) update.

Though it finds the most appropriate point in fewer iterations in comparison to the conjugate gradient method, it makes more calculation in every iteration and needs more memory (Demuth & Beale, 2002, pp. 2-17).

5.3 Levenberg-Marquardt (LM)

The Newton method is as showed in Equation 3:

$$H(x_k)\nabla P_k = -J^T(x_k).e(x_k) \tag{3}$$

Since it is difficult to calculate the H value, an approximation of H value is used to obtain the Gauss-Newton algorithm illustrated in Equation 3. The Jacobian matrix involves the first derivative of network errors. Thus, calculation can be made through standard backpropagation algorithms that are less complex than the Hessian matrix.

$$J^T(x_k).J(x_k)\nabla P_k = -J^T(x_k).e(x_k) \tag{4}$$

In this equation, J refers to the Jacobian matrix, and e refers to the network error matrix. The Levenberg-Marquardt method gives very fast results if matrix sizes are kept small or inputs are few (Demuth & Beale, 2002, pp. 6-8).

6. Analysis and Findings

As stated in the previous chapter, artificial neural network analysis was used for determining the influences of macro-economic variables on working capital. A separate model was formed for each dependent variable. In this way, 3 separate analyses were made for 3 dependent variables. SPPS 20 (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.) statistical package was used. Evaluation was made through the scaled conjugate gradient method. The analysis results and the obtained findings are given below.

6.1 Analysis for the Level of Working Capital

The artificial neural network graph obtained through the artificial neural network analysis involving 1408 observations and employing the level of working capital as dependent variable is given below.

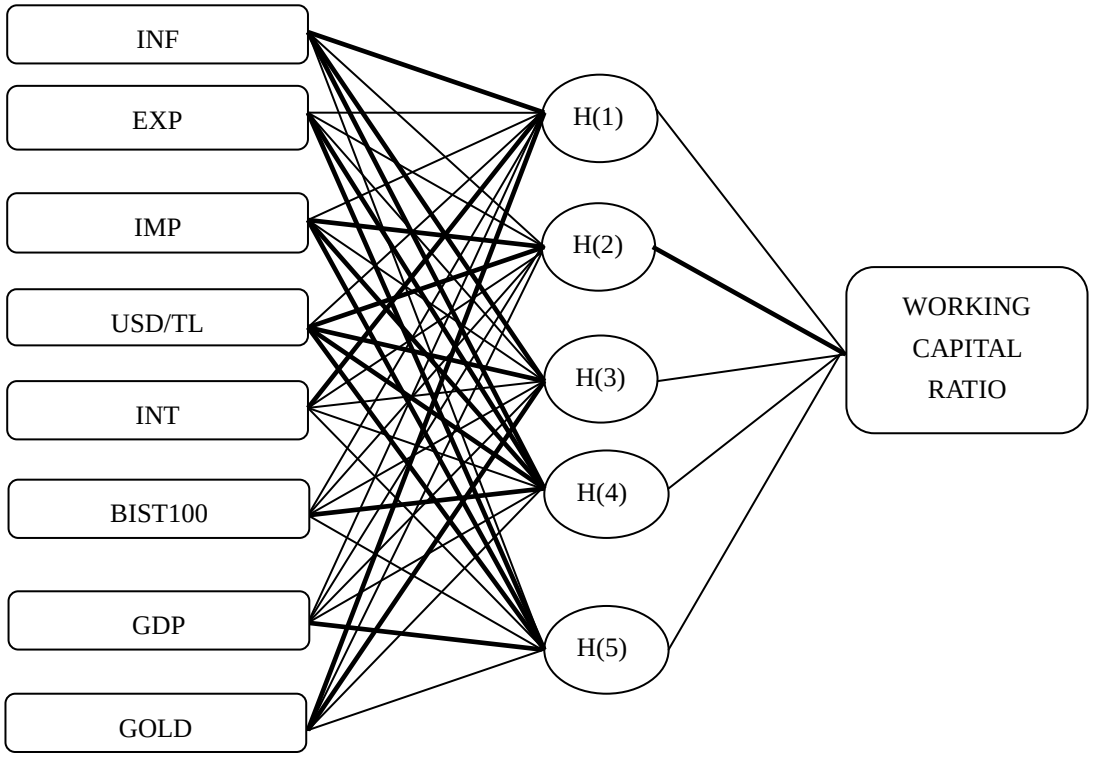

Figure 1. The artificial neural network structure showing the influence of macro-economic variables on the level of working capital

The neural structure used in the model is shown in Figure 1. The model consists of 1408 observation sets about the level of working capital. In the model, hyperbolic tangent was used as hidden layer activation function; identity was used as output layer activation function; and sum of squared errors was used as error function.

Table 1. The importance levels of the variables

Variables	**Importance Levels**
inf	17.50%
exp	100.00%
imp	28.50%
usd/tl	20.00%
int	22.50%
bist100	90.00%
gdp	21.30%
gold	16.30%

The Table 1 summarizes the influences of macro-economic variables on the level of working capital by importance level. The analysis results indicate that the level of working capital is influenced most by export index (100.00%) and then stock market index (90%), import index (28.5%), benchmark interest rate (22.5%), gross domestic product (21.3%), foreign exchange rate (20%), inflation (17.5%), and gold prices (16.3%) respectively. The graph concerning the importance rating of the independent variables is given below.

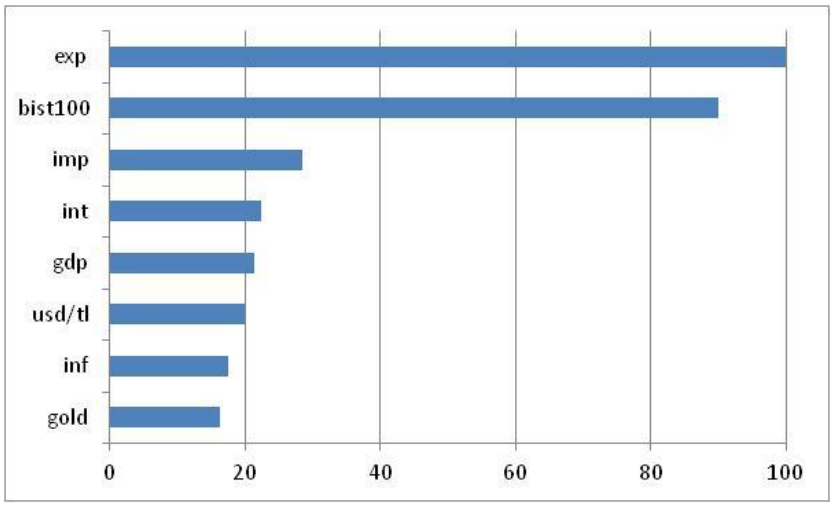

Figure 2. The graph concerning the importance rating of the independent variables

The Figure 2 shows the degrees to what the independent variables influence the dependent variable (from the most important to the least important). In other words, an artificial neural network was developed in order to show the degrees to what the level of working capital is influenced by macro-economic variables (from the most important variable to the least important variable). As it is clear from the Figure 2, the level of working capital of the enterprises included in the research sample is influenced most by export index. It is followed by stock market index. These two variables influence the level of working capital substantially. Other variables influence the level of working capital at normal and similar levels. The variable that influences the level of working capital least is gold prices.

6.2 Analysis for Return on Working Capital

The artificial neural network graph obtained through the artificial neural network analysis involving 1408 observations and employing return on working capital as dependent variable is given below.

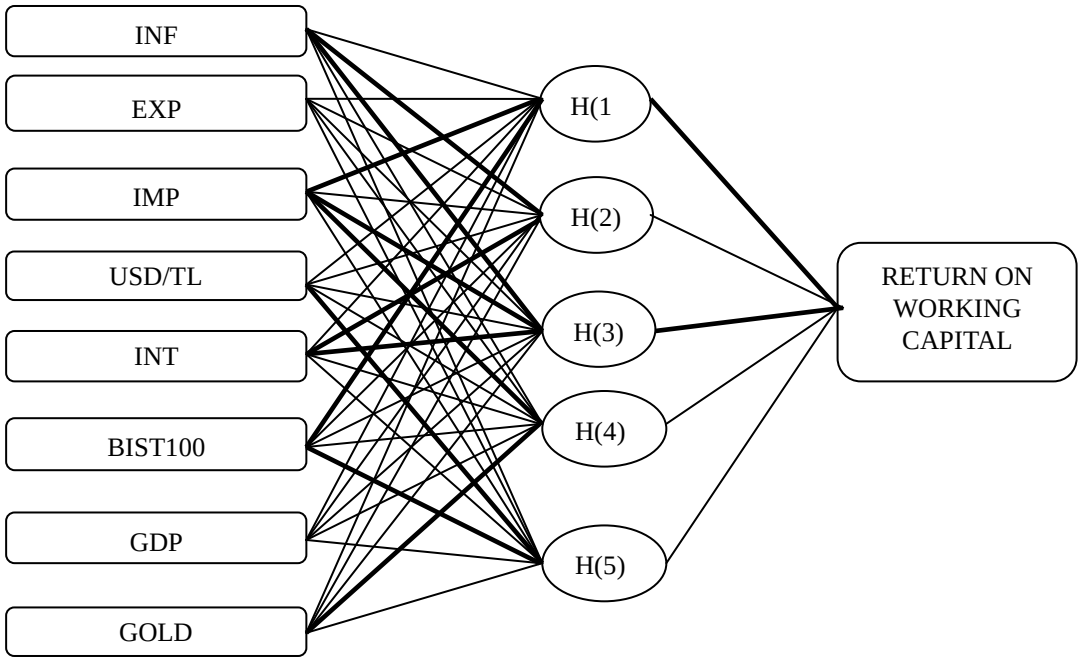

Figure 3. The artificial neural network structure showing the influence of macro-economic variables on return on working capital

The neural structure used in the model is shown in Figure 3. The model consists of 1408 observation sets about return on working capital. In the model, hyperbolic tangent was used as hidden layer activation function; identity was used as output layer activation function; and sum of squared errors was used as error function.

Table 2. The importance levels of the variables

Variables	Importance Levels
Inf	33.80%
Exp	56.00%
Imp	100.00%
usd/tl	22.20%
Int	58.80%
bist100	64.00%
Gdp	43.40%
Gold	53.80%

The Table 2 summarizes the influences of macro-economic variables on return on working capital by importance level. The analysis results indicate that return on working capital is influenced most by import index (100.00%) and then stock market index (64%), benchmark interest rate (58.8%), export index (56%), gold prices (53.8%), gross domestic product (43.4%), inflation (33.8%), and foreign exchange rate (22.2%) respectively. The graph concerning the importance rating of the independent variables is given below.

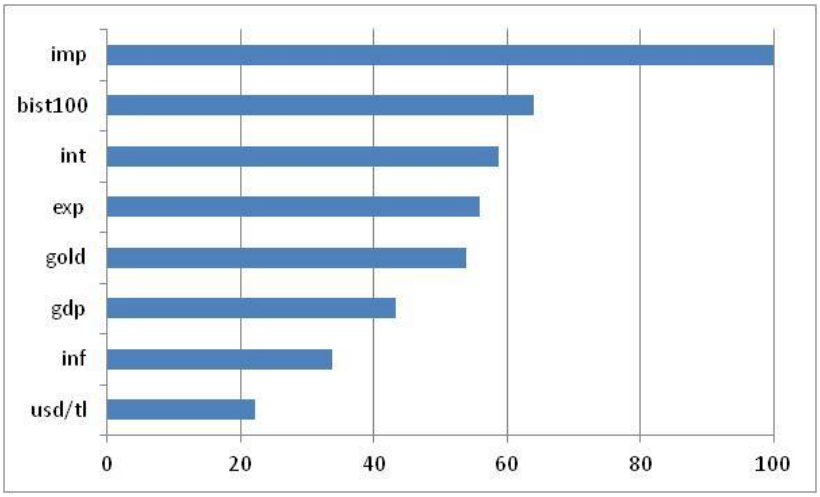

Figure 4. The graph concerning the importance rating of the independent variables

The Figure 4 shows the degrees to what the independent variables influence the dependent variable (from the most important to the least important). In other words, an artificial neural network was developed in order to show the degrees to what return on working capital is influenced by macro-economic variables (from the most important variable to the least important variable). As it is clear from the Figure 4, the return on working capital of the enterprises included in the research sample is influenced most by import index. It is followed by stock market index. These two variables influence return on working capital substantially. Other variables influence return on working capital at high and considerable levels. The variable that influences return on working capital least is foreign exchange rate.

6.3 Analysis for Cash Conversion Cycle

The artificial neural network graph obtained through the artificial neural network analysis involving 1408 observations and employing cash conversion cycle as dependent variable is given below.

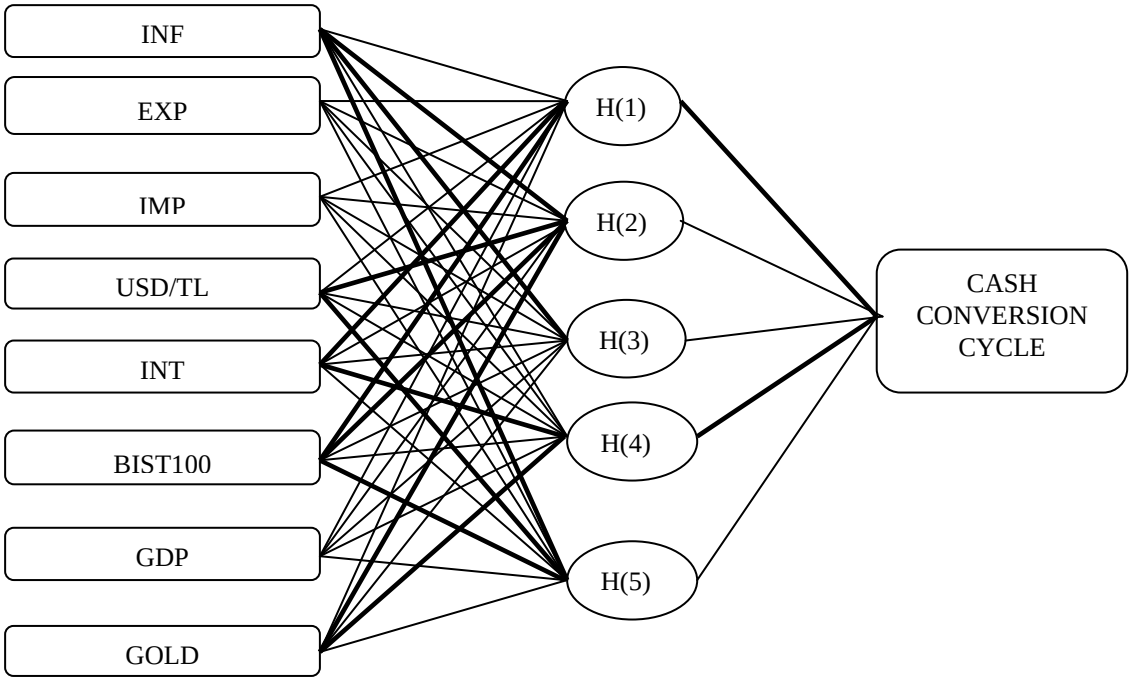

Figure 5. The artificial neural network structure showing the influence of macro-economic variables on cash conversion cycle

The neural structure used in the model is shown in Figure 5. The model consists of 1408 observation sets about cash conversion cycle. In the model, hyperbolic tangent was used as hidden layer activation function; identity was used as output layer activation function; and sum of squared errors was used as error function.

Table 3. The importance levels of the variables

VARIABLES	LEVELS OF IMPORTANCE
inf	48.30%
exp	55.70%
imp	30.00%
usd/tl	79.20%
int	100.00%
bist100	39.40%
gdp	54.00%
gold	86.90%

The Table 3 summarizes the influences of macro-economic variables on cash conversion cycle by importance level. The analysis results indicate that cash conversion cycle is influenced most by benchmark interest rate (100.00%) and then gold prices (86.9%), foreign exchange rate (79.2%), export index (55.7%), gross domestic product (54.0%), inflation (48.3%), stock market index (39.4%), and import index (30%) respectively. The graph concerning the importance rating of the independent variables is given below.

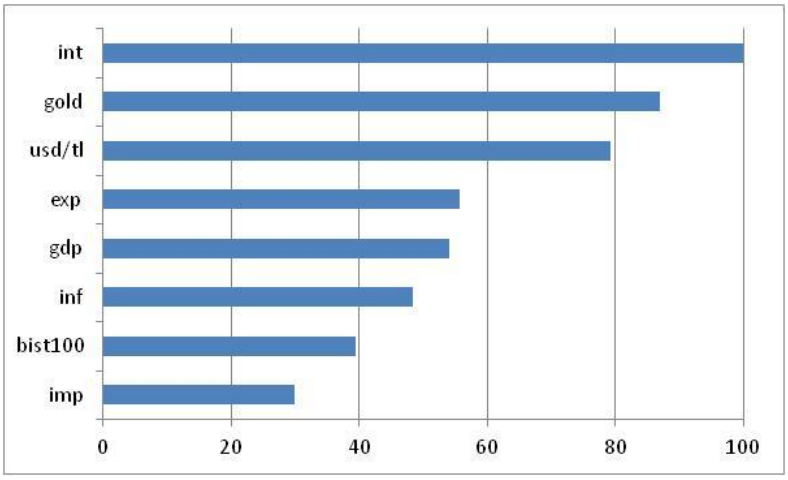

Figure 6. The graph concerning the importance rating of the independent variables

The Figure 6 shows the degrees to what the independent variables influence the dependent variable (from the most important to the least important). In other words, an artificial neural network was developed in order to show the degrees to what cash conversion cycle is influenced by macro-economic variables (from the most important variable to the least important variable). As it is clear from the Figure 6, the cash conversion cycle of the enterprises included in the research sample is influenced most by benchmark interest rate. It is followed by gold prices and foreign exchange rate. These two variables influence cash conversion cycle substantially. Other variables influence cash conversion cycle at high and considerable levels. The variable that influences cash conversion cycle least is import index.

7. General Evaluation and Conclusion

The influence of working capital on an enterprise's profitability and performance is important. The studies in the literature support this view. Aygün (2012) and Akbulut (2011) report that a level of working capital which is higher than it has to be affects a company's profitability and performance negatively. Therefore, it is quite important for the performance of an enterprise that its level of working capital be determined correctly.

A lot of factors are taken into consideration in determining the levels of working capital of enterprises. Surely, internal factors are the most important ones among these factors. However, exogenous factors should also be taken into account in determining the levels of working capital of enterprises. In the present study, the influences of macro-economic variables that are exogenous factors on the level of working capital, return on working capital, and working capital management were examined separately. What makes the present study different from other studies in the literature is that macro-economic variables are used as independent variables and artificial neural network modeling is employed as analysis method. The analysis results are summarized in the table below.

Table 4. Summarized analysis results

The Level of Working Capital		Return on Working Capital		Cash Conversion Cycle	
Variables	**Importance Level**	**Variables**	**Importance Level**	**Variables**	**Importance Level**
Exp	100.00%	imp	100.00%	Int	100.00%
bist100	90.00%	bist100	64.00%	Gold	86.90%
imp	28.50%	int	58.80%	usd/tl	79.20%
Int	22.50%	exp	56.00%	Exp	55.70%
gdp	21.30%	gold	53.80%	Gdp	54.00%
usd/tl	20.00%	gdp	43.40%	Inf	48.30%
Inf	17.50%	inf	33.80%	bist100	39.40%
gold	16.30%	usd/tl	22.20%	Imp	30.00%

As is clear from the table above, working capital ratio, which represents the level of working capital, is influenced most by export index. The second most important variable is stock market index. It is stated in the literature, as mentioned in the literature review chapter of this paper, that an enterprise's level of activity is the most important variable influential on its level of working capital. Thus, it is normal that the level of working capital is influenced most by export level. This finding is consistent with the literature. Since stock exchange index is an indicator of overall economic situation and stability in a country, it is not surprising that it has a high influence on the level of working capital. The fact that the other variables have a low influence on the level of working capital implies that macro-economic variables are influential on the level of working capital, but such influences are not very important.

It is seen in the table above that return on working capital is influenced most by import index and stock exchange index. Like the level of working capital, an enterprise's return on working capital is substantially influenced by its activities and general situation in the country. However, return on working capital is influenced by the other macro-economic variables more in comparison to the level of working capital. Especially benchmark interest rate, gold prices, gross domestic product, and inflation have a big influence on return on working capital.

The table above shows that cash conversion cycle is influenced most by benchmark interest rate, gold prices, and foreign exchange rate. Macro-economic variables are seen to have the highest influence on cash conversion cycle among dependent variables. It is something expected that enterprises take into consideration macro-economic figures in managing the elements of working capital.

All in all, it is realized that macroeconomic variables are influential on working capital; the level of working capital is influenced most by export index and stock exchange index; return on working capital is influenced most by import index and stock exchange index; and finally cash conversion cycle is influenced most by benchmark interest rate, gold prices, and foreign exchange rate. The results of this study are partly consistent with the literature. Mohamad and Elias (2013) concluded that there is a significant relationship between gross domestic product and the level of working capital; Doğan and Elitaş (2014) found out that there are positive, but statistically insignificant relationships between the level of working capital and gross domestic product and interest rate; Mansoori and Muhammad (2012) reported that there is a negative relationship between gross domestic product and working capital management; and Abbadi and Abbadi (2012) determined that economic variables such as interest rate, gross domestic product, and real growth rate have no significant influence no working capital.

The literature does not contain many studies examining the influences of macro-economic variables on working capital. Thus, in this paper, not much comparison can be made with the results of other studies in the literature. However, a big contribution may be made to the literature if more economic variables are focused on; internal factors are examined besides macroeconomic factors; and the relationships between macroeconomic variables and working capital are determined for the companies not traded at the exchange.

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