

THE RELATIONSHIP BETWEEN MACROECONOMIC VARIABLES AND ROMANIAN CORPORATE DEFAULT RATES BETWEEN 2002-2008

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During its 20 year history of market economy, Romania experienced the most severe downturn in 2009, which resulted in many cost, mainly because of the output loss. These conditions forced several firms to declare bankruptcy and to stop their activity. The aim of this research is to assess the relationship between the corporate default rates and the macroeconomic processes in the case of Romania for the period comprised between 2002Q1-2008Q4.

For this, based on the relevant literature, we ranked the potential explanatory variables of the default rates into seven groups: cyclical indicators, household indicators, corporate indicators, external sector indicators, price stability indicators and interest rates, loans to private sector and finally the capital market indicators. Some studies base their results only on accounting data, others only on market data. Our study focuses on both, since this seems to be an adequate approach in capturing most of the processes.

Similar to the banks' loan portfolio structure, we conducted analysis for five sectors: industry, construction, agriculture, services and the overall economy. For each sector the average default probability at time t is modeled as a logistic function of many general and sector-specific macroeconomic variables. The use of logistic regression was motivated by its ability to account for fractional data between 0 and 1.

We found that at least one variable from each group has a significant explanatory power regarding the evolution of the default rates in all five sectors analyzed. In some cases the sign of the variables was the opposite of what the economic theory would have suggested, but it has to be taken into account that Romania posted the picture of an overheated economy during the analyzed period. Another important conclusion was that many variables were significant through their lagged value, which indicates an even better supervision of the evolution of the specific variables. From all the variables, the volatility of the BET-C index proves to be the most important in predicting the evolution of the default rates, as it didn't proved to be significant only for the construction sector. The evolution of FDI and the volatility of the BET-C index proved to be very important in determining the evolution of the corporate default rates, as well. The first was a very important factor in the financing of companies, especially during the analyzed period, and the risk meter is something that never should be disregarded when it comes of analyzing default rates.

Keywords: corporate default rate, macroeconomic processes, economic imbalances, logistic regression, lagged effects.

JEL codes: C22, C51, C52, E32, G32, G33

I. Introduction

In conformity with a research made by the World Bank in 2001, in the period comprised between the end of the 1970s and the end of the 20th century there were 112 bank crises in 93 countries all over the world. Most of these crises caused significant economic downturns in developed countries, as well as in emerging economies (see Wolf, M (2010)). The crises had considerable costs, which affected the whole society (the economic growth remained under its potential level, most of the banks got into governmental property, therefore their debts became the nation's debt (1)). To avoid these costs, several researchers proposed the analysis of the effect of macroeconomic factors on the probability of default in the financial and corporate sector. The aim of this paper was to conduct such an analysis in Romania for the period comprised between 2002Q1-2008Q4.

II. Literature review

We ranked the potential explanatory variables of the default rates into seven groups: cyclical indicators, household indicators, corporate indicators, external sector indicators, price stability indicators and interest rates, loans to private sector and finally the capital market indicators.

Among the **cyclical variables** the most frequently analysed are the real GDP growth, the seasonally adjusted nominal GDP, the value of the GDP-gap, industrial output change and its seasonally adjusted change, the industrial distance to default and the economic activity indicator. Bonfim, D. (2008), Monnin, P. and Jokipii, T. (2010), Boss, M. et al. (2009) and Castrén, O., Déés, S. and Zaher, F. (2008) found significant the effect of the real GDP on PD, but at the latter authors robustness problems evolved. Ali, A. and Daly, K. (2010) found significant the effect of the nominal GDP, Bonfim, D. (2008) the effect of economic activity indicator and Hol, S. (2006) the effect of the GDP-gap on PD. Bos, M. et al. (2009) and Hol, S. (2006) proved the significance of the industrial production index, but the former discovered robustness difficulties.

The second category consists of the **money market indices**: consumer price index, short term/long term real and nominal interest rates, M1 money supply, average nominal interest rates, average lending interest rates for corporate bank loans. In Liu, J.'s (2004) research the average short and long term nominal interest rates, while in Boss, M. et al.'s (2009) investigation besides the short term nominal interest rates, the consumer price index influences significantly the PD. According to Hol, S. (2006) the money supply combined with firm specific financial indicators (2) are relevant explanatory variables of the PD. Finally, the last significant indicator of this group is the average lending interest rate for corporate bank loans analyzed by Bonfim, D. (2008). The next group is related to the **outstanding loans**: the growth rate of the loans and bank loans-GDP ratio. The former indicator was found significant on PD by Bonfim, D. (2008), and the latter one by Ali, A. and Daly, K. (2010).

The fourth category consists of the **capital market indicators**: the US treasury notes' yields with three and six months maturity, the real stock prices, the capital market index change, the S&P500's and some specific companies' yields and the slope of the yield curve. Castrén, O., et al. (2008) point out that the capital market indices and yield curve's slope (calculated as the difference of the long and short term yields) determines significantly the PD. In the study of Duffie, D. et al. (2006) the S&P500 and the Treasury notes' yield with three months maturity proved to be significant in relation with the PD.

Among the **household's indicators**, the consumption, consumption/GDP ratio, unemployment rate, employment rate, the annual growth rate of the disposable income and the growth rate of the household's income were studied. Boss, M. et al. (2009) found significant the unemployment rate in the case of a standard regression model, but in other model specifications their lags were also found significant in relation to the PD.

The indicators of the corporate sector include the Gross Fixed Capital Formation (GFCF), the average labor productivity, the real investments, investment in fixed assets, and the ratio of the mentioned variables and real GDP. In this group there are also included the following: unit labor

cost, real corporate debt and birth rate. In Liu, J.'s (2004) article the birth rate of the companies shows two opposite effects regarding the corporate default rates: on short term the growth of the rate decreases the value of the dependent variable, while on long term increases them. This relationship is examined with an ECM model, but the author did not find any explanations for the observed behavior of the dependent variable. Boss, M. et al. (2009) proved the significant influence of the unit labor cost and the investment in fixed assets/GDP ratio on the PD using a standard regression model. Both in the case of the unemployment rate, and also in the case of the unit labor cost their lagged values proved to be significant regarding the PD.

The last analyzed variable group is the **external sector**, which includes the real exports, the real exports to GDP ratio, oil prices, euro/US dollar real exchange rate and the exchange rate index. Boss, M. et al. (2009) found significant the lagged values of the real exports to GDP ratio, the oil prices and the real exports in explaining the evolution of the PD using different specifications of the standard regression model.

III. Methodology

For each sector the average default probability at time t is modeled as a logistic function of many general and sector-specific macroeconomic variables. The initial logistic regression equation can be noted as:

$$DR_{t,s} = \frac{1}{1 + e^{-X \cdot \beta}}, \quad (1)$$

where $DR_{t,s}$ denotes the sector-specific corporate default rates, X denotes the matrix of the explanatory variables, while β is a column matrix representing the coefficient estimates. The used methodology, based on the work of Papke and Wooldridge, mentined in the paper of Boss, M. et al. (2009) allows the estimation of the default probabilities directly but, in contrast to common logistic regression models, it explicitly accounts for fractional data between 0 and 1. The large number of analyzed macroeconomic variables indicated the use of a model selection process, which helped to find the optimal multivariate model. The estimated models were sorted by the value of the adjusted R-squared and the value for the quasi-likelihood estimator, according to Boss, M. et al. (2009).

IV. Data and macroeconomic dynamics

With the aim of better understanding some of the links between credit risk and macroeconomic developments at an aggregate level, we built up correlation matrices between a large set of macroeconomic variables and corporate default rates. These matrices may provide a guideline of the cyclical co-movement between default rates and other macroeconomic variables, which can later be used as explanatory variables under a regression analysis framework.

1. Data

The corporate default rates were given by the Romanian National Commerce Office, in quarterly data, for each industry.

The correlation coefficients were calculated for five sectors: agriculture, industry, construction, services and for the overall economy. The data used for the analyses refer to the period comprised between 2002Q1 – 2008Q4. For each sector we used both the general and also the sector specific, seasonally adjusted (3) macroeconomic variables. Furthermore, where it was indicated the quarter - on - quarter change of the variables was taken into account in order to highlight their dynamic effects on the default rates.

Further on we focus on presenting the most significant correlation coefficients for each group of variables (4) regarding the overall economy, industry and services, since these two sectors represent the most important parts of the economy.

In the case of the **overall economy** within *the cyclical variables* the change of the nominal GDP, within the *households* the gross average wages, within the *corporate sector* the nominal GFCF, within the *external sector* the loans lent by foreigners, within *the price stability and interest rates* group the interest rates for existing loans denominated in Euro, within the *loans to private sector* the outstanding loans to households and finally within the *capital market* the value of the BET-C index stood out from the rest of the variables.

For the **industry** sector within the first group of variables the change of the nominal GDP, within the households the gross average wages, within the third group the nominal unit labor cost index, within the fourth group the FDI, within the fifth group the inflation rate, in the penultimate group the outstanding amount of bank loans lent to the industrial sector, and finally in the last group the value of the BET-C index was the most significant.

For the **services** sector within the cyclical variables the change of the nominal GDP, from the households the gross average wages, within the third group the ratio of nominal GFCF and GDP, within the fourth group the FDI, within the fifth group yet again the inflation rate, in the penultimate group the outstanding amount of bank loans lent to the services sector, and finally in the *capital market* the value of the BET-C index proved to be the most correlated with the default rates.

2. Results for the econometric analysis

(Table nr. 1) presents the estimated coefficients and *p* values for each analyzed sector. For the overall economy six variables were found to be significant in explaining the movements of the corporate default rates. No variables from the external sector were found to be significant. Even though the theory suggests a negative relationship between default rates and real GDP, the results are contrarian with this. This shouldn't be a surprise in the case of Romania, as during the analyzed period a highly overheated economic activity was observable. Bonfim, D. (2009) highlighted a similar relationship between credit overdue and real GDP growth. This relationship implies that a period of robust economic growth is usually followed by an increase in the number of defaulted firms with a lag of 1.5 to 2 years. The positive relationship between the lagged private real consumption and the dependent variable, similarly to the real GDP, could be explained with an overheat of the private consumption. Furthermore, both increased volatility of the BET-C index and interest rates have a positive effect on default rates which is in line with the theory. Other significant variables were the lags of real labor productivity index and loans to households.

In the model built for the industry sector four variables were found to be significant in explaining the movements of the industrial corporate default rates. Unfortunately, no variables from households, corporate sector and loans to private sector were found to be significant. A general observation for this model can be that from every group of variables the lagged ones became significant. Our results regarding the relationship between the industrial default rates and inflation rate doesn't prove to confirm the theory, as the relationship between the lag of inflation rate and default rate is negative. Among the group of cyclical variables the lagged values of industrial GVA were found to be significant in explaining the industrial corporate default rates. In contrary to the theory, which indicates a negative relationship, in our model the relationship between the two variables is positive. The explanation could be the same as for the overall economy. From the group of foreign sector the lagged total FDI proved to be significant and its relationship with the corporate default rates is positive. From the group of capital market the lagged volatility of BET-C is significant.

In columns 7 and 8 we can see which macroeconomic variables were significant from different categories for the construction sector. In the case of this model there weren't significant variables from the group of price stability and interest rates. As we can see, the nominal GDP has a negative coefficient, this can be interpreted as when the value of the nominal GDP is decreasing (in other words, there is a recession), the value of the default rates is increasing. It can be seen

that there is a positive coefficient for the change of the average unit labor cost in the industrial sector lagged with five periods. This may suggest that the increase of the unit labor cost in the construction sector will increase in five periods the default rates.

For the agriculture sector we can see that there weren't significant variables from the group of price stability and interest rates and from loans to the private sector. The real labor productivity lagged with three periods has a negative coefficient, this meaning that if the real labor productivity decreases in the agricultural sector, it will increase in three periods the default rate. It is interesting too that if the net average wages increase they will increase in a half year the value of the default rates as well. Furthermore, the table shows that if the RON appreciates against the EURO the default rates will increase again.

In the case of the services sector, it can be seen that there weren't significant variables only from the external group. The highest impact on the default rates are caused by the changes in private real consumption and loans to households, both posting a negative relationship. For the services sector, the contemporaneous value of the volatility of the BET-C index was significant, indicating a positive relationship. Furthermore, the results show that interest rates for EURO denominated newly issued loans increase the probability of default in the next period.

V. Conclusions

Our aim with this research was to assess the relationship between the corporate default rates and the macroeconomic processes in the case of Romania for the period comprised between 2002Q1-2008Q4. In our analysis we employed a total number of 81 variables, which were combined differently for the following sectors: agriculture, industry, construction, services and the overall economy. Furthermore, these variables were ranked into seven groups: cyclical indicators, household indicators, corporate indicators, external sector indicators, price stability indicators and interest rates, loans to private sector and finally the capital market indicators.

Summarizing the results group-by-group can give a comprehensive overlook of the results obtained. Regarding the cyclical variables the nominal GDP and the real GDP proved to be significant in explaining the corporate default rates, not just for the overall economy, but for certain sectors, as well. On the other hand, in two cases (Industry and Services), sector specific cyclical indicators (GVA) showed high explanatory power regarding the dependent variable.

Eventually, for the household sector the private real consumption and the gross and net average wages, for the corporate sector the average labor productivity and labor cost, for the external sector the RON/EURO exchange rate, Total FDI and real Exports to GDP ratio, for price stability and interest rates the inflation rate and both EURO and RON interest rates, for loans to the private sector both the outstanding loans to households and firms, and finally for the capital market group the volatility of the BET-C index and the level of the index shows high explanatory power.

Overall, at least one variable from each group has a significant explanatory power regarding the evolution of the default rates. In some cases the sign of the variables was the opposite of what the economic theory would have suggested, but it has to be taken into account that Romania posted the picture of an overheated economy during the analyzed period. Another important conclusion is that many variables were significant through their lagged value, which indicates an even better supervision of the evolution of the specific variables. From all the variables, the volatility of the BET-C index proves to be the most important in predicting the evolution of the default rates, as it didn't proved to be significant only for the construction sector.

VI. Notes

1. From the 112 mentioned bank crises in the case of 27 the fiscal costs exceeded 10% of that specific country's GDP. Furthermore, in the case of 47 states the cumulative output remained with more than 10% under the potential level in the following years.

2. For example: average cash amount/debt amount, average financial coverage indicator, average liquidity, long term value of the firm, average firm size.
3. We were seeking to use only seasonally adjusted data, but in some cases only seasonally unadjusted data was available.
4. The used macroeconomic variables:
 - Cyclical indicators: Nominal GDP sa., Nominal GDP sa. (%), Real GDP sa., Real GDP sa. (%), GVA sa. Industry, GVA sa. Industry (%), GVA sa. Construction, GVA sa. Construction (%), GVA sa. Agriculture, GVA sa. Agriculture (%), GVA sa. Services, GVA sa., Services (%).
 - Household indicators: Private real consumption sa., Private real consumption sa. (%), PCR/GDP sa., Unemployment rate sa., Gross average wages, Gross average wages(%), Net average wages, Net average wages(%).
 - Corporate indicators: Nominal GFCF sa., Nominal GFCF sa. (%), Real GFCF sa., Real GFCF sa. (%), GFCF/GDP sa. (nom.), GFCF/GDP sa. (Real), Average real labor productivity nsa., Avg. real labor productivity nsa. (%), Labor cost index (industry) sa., Labor cost index sa. (Industry) (%), Labor cost index sa. (Construction), Labor cost index sa. (Construction) (%), Labor cost index sa. (Services), Labor cost index sa. (Services) (%).
 - External sector indicators: Gross nominal exports sa., Gross nominal exports sa. (%), Gross real exports sa., Gross real exports sa. (%), Real Exports/GDP sa., Total FDI nsa., Total FDI nsa. (%), FDI abroad nsa., FDI in Romania nsa., Foreign FDI nsa. (%), Total FDI/GDP sa., Total FDI/GDP nsa., Loans abroad nsa., Loans abroad nsa. (%), Loans to Romania nsa., Loans to Romania nsa. (%), RON/EUR nominal exch. rate nsa., RON/EUR nominal exch. rate nsa. (%), RON/EUR real exch. Rate index, German Real GDP sa., German Real GDP sa. (%), French Real GDP sa., French Real GDP sa. (%), Italian Real GDP sa., Italian Real GDP sa. (%).
 - Price stability indicators and interest rates: Inflation rate, Interest rates for outstanding corporate loans (RON), Interest rates for newly issued corporate loans (RON), Interest rates for outstanding corporate loans (EUR), Interest rates for newly issued corporate loans (EUR).
 - Loans to private sector: Outstanding loans to households nsa. (LtH), Outstanding loans to households nsa. (%), Outstanding loans to firms nsa. (LtF), Outstanding loans to firms nsa. (%), LtH/GDP, LtF/GDP, Outstanding loans to firms nsa. (Industry), Outstanding loans to firms nsa. (%) (Industry), Outstanding loans to firms nsa. (Construction), Outstanding loans to firms nsa. (%) (Construction), Outstanding loans to firms nsa. (Agriculture), Outstanding loans to firms nsa. (%) (Agriculture), Outstanding loans to firms nsa. (Services), Outstanding loans to firms nsa. (%) (Services).
 - Capital market indicators: BET-C index value, BET-C volatility (yearly), BET-C yield.

Table 1: Results for the econometric analysis

		Overall economy		Industry		Construction		Agriculture		Services	
		Coefficient	Lag of variable	Coefficient	Lag of variable	Coefficient	Lag of variable	Coefficient	Lag of variable	Coefficient	Lag of variable
	Constant	-18.0386*** (0.00001)	-	-18.6634*** (0.00529)	-	-6.88358** (0.03836)	-	-10.9335*** (0.00001)	-	-3.79269 (0.1463)	-
Cyclical variables	Nominal GDP sa. (%)					-8.29408** (0.01860)	-				
	Real GDP sa.	0.000193748*** (0.00011)	5					0.0000561656* * (0.02170)	3		
	GVA sa. industry			12.9567** (0.03777)	5						
	GVA sa. services									0.0110089** (0.0251)	4
Households	Private real consumption sa. (%)	5.80199** (0.01327)	4							-4.78416* (0.0595)	3
	Gross average wages					0.00319292*** (0.00256)	-				
	Net average wages(%)							2.51802** (0.04918)	2		
Corporate sector	Average real labor productivity nsa.	0.00572784*** (0.00029)	2					- 0.00774716*** (0.000097)	3	0.00752352*** (0.0001)	2
	Labor cost index sa. (construction)					2.81094* (0.08917)	5				
External sector	Real Exports/GDP sa.							6.68051*** (0.00483)	2		
	Total FDI nsa.			0.000160575** (0.01404)							
	RON/EUR nominal exch. rate nsa. (%)					-2.8321*** (0.00012)	1	-1.16338*** (0.00288)	-		
Price stability and interest rates	Inflation rate			-0.0649178*** (0.00298)	3						
	IR_O_RON	0.03809** (0.04545)	3								
	IR_N_EUR									0.170774* (0.0547)	1
Loans to the private sector	Outstanding loans to households nsa.	-0.754387* (0.06402)	4								
	Outstanding loans to households nsa. (%)									-1.5783*** (0.0021)	3
	Outstanding loans to firms nsa. (%)					6.49966** (0.01774)	2				
Capital market	BET-C index value					-0.0004205** (0.02558)	4				
	BET-C volatility (yearly)	1.13602** (0.03775)	3	1.42833* (0.06769)	3			1.93739*** (0.00057)	1	0.781511* (0.0720)	-
	Adjusted R-squared	0.930142		0.829331		0.863473		0.851494		0.910175	
	Log-likelihood	14.32392		1.197292		4.212762		14.56706		11.81074	

Source: authors' calculations

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