Efficiency, Taxation, and Solvency Issues for SMEs: The Case of Greece, Italy, and Spain

Christos Floros, Christos Lemonakis, Efthalia Tabouratzi, Alexandros Garefalakis, and Constantin Zopounidis

Abstract This paper provides new insights into the efficiency of European firms using accounting and financial ratios. In particular, we discuss how the data envelopment analysis (DEA) method can be used with accounting and financial data to highlight the importance of firm profitability as a counterbalance to crisis-induced weakness in demand. We consider several DEA models for studying the technical, financial, and financing efficiency of firms, including a unique set of variables (inputs/outputs) for productivity analysis. Our results provide recommendations for financial managers and analysts dealing with European firms, especially from the southern parts of Europe, i.e., Greece, Italy, and Spain.

Keywords Efficiency · Accounting ratios · Financial ratios · DEA · European firms

C. Floros (✉) · E. Tabouratzi
Department of Accounting & Finance, Hellenic Mediterranean University, Crete, Greece
e-mail: cfloros@hmu.gr; tamthal@hmu.gr

C. Lemonakis
Department of Management Science and Technology, Hellenic Mediterranean University, Crete, Greece
e-mail: lemonakis@hmu.gr

A. Garefalakis
Department of Business Administration and Tourism, Hellenic Mediterranean University, Crete, Greece
e-mail: agarefalakis@hmu.gr

C. Zopounidis
Financial Engineering Laboratory, Technical University of Crete, Chania, Greece

Audencia Business School, Nantes, France
e-mail: kzopounidis@tuc.gr

P. Alphonse et al. (eds.), *Essays on Financial Analytics*, Lecture Notes in Operations Research, https://doi.org/10.1007/978-3-031-29050-3_4

1 Introduction

Businesses play an important role in all economies and are the main generators of employment and income as well as the drivers of innovation and growth. They are the engine of growth (Beck & Demirguc-Kunt, 2006). The manufacturing sector is a feature of fast-growing economies. What mechanism and how much tax and efficiency ratios affect the profitability index (return on assets—ROA) and solvency ratio are one of the main objectives of this research.

Profitability ratios are considered the most important financial ratios of a company that can be used to evaluate the desirable performance of a company in profitable situations. To relate taxes to profitability ratios, a company's costs and debt can be used. By determining the ratio of debt to assets and profits, as well as the return on assets, a correct decision can be made about granting different types of financial facilities to the companies under study.

Little attention has been paid to the relationship between ROA and solvency ratio with company values, especially for Greece, Italy, and Spain. Taxes can increase ROA and the solvency ratio and thus have a positive effect. Efficiency can increase ROA and solvency ratio and thus have a positive effect. Negative effects: Debtors have a negative impact on the solvency ratio.

Q1) Is ROA a key factor in explaining differences in taxation, efficiency, and other explanatory variables?
Q2) To what extent do efficiency and taxation affect solvency?

2 Methodology: Two-Stage Approach

Reviewing the efficiency and profitability of European (Greek, Spanish, and Italian) companies is important because many companies tend to negotiate their existence in competitive markets, change their business models, and increase their market shares (Voulgaris & Lemonakis, 2014). The economic crisis has been particularly hard on Greek companies. This study contributes to the existing literature in two ways: It is the first empirical study on the relationship between ROA, efficiency, taxation, and solvency ratio; we use two commonly accepted methods: data envelopment analysis (DEA) and panel regression.

In this study, we use data envelopment analysis (DEA), a nonparametric method for measuring relative efficiency, taxation, and solvency issues for SMEs of the European South, within a group of homogeneous decision-making units (DMUs) with multiple inputs and multiple outputs.

We use efficiency scores as indicators of firm performance (Mok et al., 2007; Floros et al., 2014). The efficiency estimates in our study are obtained using the DEA, which dates back to Charnes et al. (1978). We then examine the relationships between the efficiency scores of DEA and return on equity, taxation, and solvency.

3 DEA Description

The foundations of the data envelopment analysis (DEA) method were laid by Charnes et al. (1978), later developed further by Banker et al. (1984). Several DEA models have been developed; one of the well-known is the model of Charnes et al. (1978), known as the CCR model, and its extension by Banker et al. (1984), known as the BCC model. Depending on their orientation, these models are divided into input-oriented models (for a given level of output to minimize inputs) and output-oriented models (for a given level of input to maximize outputs) and by returns to scale into constant returns to scale (CRS model) and variable returns to scale (VRS model).

Data envelopment analysis (DEA) is a nonparametric mathematical programming approach to estimating frontiers. DEA is a method best suited for measuring relative efficiency by input and output elements of decision-making units (DMUs). DEA is an effective tool for analyzing the efficiency of many groups of companies, while it works relatively well with small samples of units. In addition, DEA can handle multiple inputs and outputs reported in different units of measurement and does not require knowledge of the functional form of the frontier (Charnes et al., 1994), while DEA can provide robust results (Seiford & Thrall, 1990).

Input (output)-oriented technical efficiency—TE measures address the questions, "By how much can input (output) quantities be proportionally reduced (expanded) without changing the output (input) quantities produced (used)?"

(a) DEA-CRS and DEA VRS Models

Charnes et al. (2018) proposed DEA and assumed constant returns to scale (CRS). It measures the efficiency of each decision-making unit (DMU), which is the maximum of the ratio of weighted output to weighted input. Banker et al. (1984) proposed a variable return to scale (VRS) model. The VRS assumption allows the measurement of purely technical efficiency (PTE), i.e., the measurement of technical efficiency without the scale efficiency. If the efficiency scores obtained from CRS model and the VRS model are different, this indicates that the DMU has scale inefficiency.

(b) DEA-CRS Model

Theoretical Formulation of the DEA-CRS Model

To measure the efficiency of each DMU, T.J. Coelli (1996) presented a mathematical linear programming equation calculating the ratio of all outputs over all inputs. The formula is as follows:

$$\min_{\theta,\lambda^{\theta}}, \text{ s.t.}$$

$$-y_i + Y\lambda \geq 0, \theta x_i - X\lambda \geq 0, \ \lambda \geq 0.$$

where the symbol θ is a scalar and refers to the efficiency of a unit and takes values within the closed interval [0, 1]. Also, λ is an N*1 vector of constants, where it represents the percentage of the other units in the virtual unit.

In DEA method, the problem to be solved is to determine the values of θ. DMUs with values of θ equal to 1 operate at optimal efficiency, while DMUs with values of θ less than 1 are inefficient.

The linear programming problem above is under the assumption of constant returns to scale (CRS), introduced by Charnes, Cooper, and Rhodes in 1978. In difference, another condition, $N1'\lambda = 1$, is added to the linear programming problem under the variable returns to scale (VRS), introduced by Banker, Charnes, and Cooper in 1984—leading to different results in terms of efficiency.

(c) Theoretical Formulation of the DEA-VRS Model

The total technical efficiency (OTE: overall technical efficiency) is equal to the result obtained from the application of the data envelopment analysis methodology, under constant scale odds (CRS model). SE (scale efficiency) is achieved by using the VRS model. The relationship between CSR and VRS is given below:

$$^{\mathrm{TE}}\,\mathrm{CRS}^{=\mathrm{TE}}\,\mathrm{VRS}^{\mathrm{X\ SE}}$$

The CRS linear programming problem can be easily modified to account for VRS by adding the convexity constraint, $N1'\lambda = 1$, to provide

$$\min\theta, \lambda\ \theta,$$

$$\text{s.t.}$$

$$-\mathrm{yi} + \mathrm{Y}\lambda \geq 0, \theta\mathrm{xi} - \mathrm{X}\lambda \geq 0, \mathrm{N1}'\lambda = 1,$$

$$\lambda \geq 0.$$

where $N1$ is an $N \times 1$ vector of ones. This approach forms a convex hull of interesting plans which envelop the data points more tightly than the CRS conical hull; this provides pure technical efficiency scores which are greater than or equal to those obtained using the CSR model.

1. Panel Regression

In this study, EGLS models are used, with a balanced panel data. Data were treated for outliers at 5% level. There is no indication that the data structure is characterized by period specific efficiency, competitiveness, and exports of agricultural firms in the referring period heteroskedasticity and contemporaneous and between-period covariance. The independent variables were selected on the basis of theory and international literature.

More specifically, we propose the following model (Model 1):

$$\begin{aligned} &\text{ROA} \quad \text{BEFORETAXi or Solvency Ratioi} \\ &= \text{a1} + \text{a2 COLLECTIONPERIODi} + \text{a3} \\ &\text{LOGTAX} + \text{a4 VRSOUTPUTi (or CRSOUTPUT)} \\ &\quad + \text{a5 LOGDEPRAMORTi} + \text{a6 LOGDEBTORSi} + \text{a7 LOGINTERPAIDi} \\ &\quad + \text{a8 LOGWORKINGCAPITALi} + \text{a9 LOGENTERPRISEVALUEi} \\ &\quad + \text{a10 LOGPROVISIONSi} + \varepsilon\text{i} \quad \text{(Model 1)} \end{aligned}$$

where

Dependent Variables

- ROA = return on assets ratio (with income before taxes)
- Solency_ratio: Solvency ratio is a measure of a firm's ability to meet its debt and other obligations. It indicates whether a company's cash flow is sufficient to meet its short-term and long-term liabilities [= (Net income + depreciations) / (short- + long-term liabilities)]

Independent Variables

- vrsoutput: VRS output orientation for DEA analysis
- crsoutput: CRS output orientation for DEA analysis
- Collection_period: collection period of demand in days
- Log_Tax: logarithm of taxes paid in the EUR
- Log_DeprAmort: logarithm of depreciation and amortizations account from firms' financial statements
- Log_Debtors: logarithm of the debtors' account in the EUR
- Log_Interpaid: logarithm of interest paid in banking institutions and elsewhere in the EUR
- Log_Workingcapital: logarithm of firms' working capital = current assets – current liabilities per year
- Log_Enterpricevalue: logarithm of firms' market value in the EUR
- LogProvisions: logarithm of firms' provisions accounts per year

The above variables are used to derive relationships between dependent variables and independent ones, on the basis of the results obtained from the application of DEA methods for the countries under review.

2. Data

We consider a large amount of recent data (source: Amadeus DataBase) and apply several DEA methods (DEA-CRS vs. DEA VRS) and panel regressions to examine our hypotheses for Greece, Italy, and Spain.

Sectors: sample firms sectors—mainly in manufacturing and services. Type of firms—very large firms. Sample firms: Greece, 132 firms; Spain, 98 firms; Italy, 150 firms; total = 380 firms; for the period 2007–2015

(a) *Firms' Descriptive statistics*

Type of firms—very large firms

Table 1 presents the sample firms sectors—mainly in manufacturing and services.

Table 2 presents the sample's firms' descriptives statistics.

The average of 9 years was intentionally chosen to avoid including misleading information about the volumes of total assets, current assets, and working capital and the procedures delivered by them in the analysis to be made.

3. Empirical Results: DEA

The nonparametric approach DEA is mainly applied to estimate efficiencies with the use of the following parameters:

(a) *DEA Analysis*

Outputs

- Output1—Sales account
- Output2—Net income account

Inputs

- Input1—Gearing (leverage), financial ratio
- Input2—Equity capital
- Input3—Net fixed assets

We take the following orientation—CRS output and VRS output orientations—and we run the DEA model for firms from selected countries.

(b) *Results of DEA*

The mean values per year for the whole sample (i.e., all countries' firms) are depicted in Table 3.

Mean Values of DEA Scores per Country

DEA Scores

Tables 4, 5, and 6 show that the companies in the Italian sample have the highest average values for CRS output per year (%) and VRS output per year (%) during the audit period, while the sampled companies from Greece have the lowest scores in all DEA analysis options. The year 2011 shows the sharpest decline in efficiency

Table 1 Sample firms sectors—mainly in manufacturing and services

1.	Trade of gas through mains (very large companies)
2.	Activities of holding companies (very large companies)
3.	Construction of other civil engineering projects (very large companies)
4.	Postal activities under universal service obligation (very large companies)
5.	Passenger air transport (very large companies)
6.	Wholesale of clothing and footwear (very large companies)
7.	Production of electricity (very large companies)
8.	Manufacture of air and spacecraft and related machinery (very large companies)
9.	Construction of residential and nonresidential buildings (very large companies)
10.	Retail sale in nonspecialized stores with food, beverages, or tobacco predominating (very large companies)
11.	Wholesale of electrical household appliances (very large companies)
12.	Manufacture of refined petroleum products (very large companies)
13.	Wholesale of metals and metal ores (very large companies)
14.	Collection of nonhazardous waste (very large companies)
15.	Operation of dairies and cheese making (very large companies)
16.	Restaurants and mobile food service activities (very large companies)
17.	Water collection, treatment, and supply (very large companies)
18.	Manufacture of cement (very large companies)
19.	Gambling and betting activities (very large companies)
20.	Building of ships and floating structures (very large companies)
21.	Engineering activities and related technical consultancy (very large companies)
22.	Private security activities (very large companies)
23.	Wired telecommunications activities (very large companies)
24.	Accounting, bookkeeping, and auditing activities; tax consultancy (very large companies)
25.	Retail sale of clothing in specialized stores (very large companies)
26.	Service activities incidental to air transportation (very large companies)
27.	Distribution of electricity (very large companies)
28.	Development of building projects (very large companies)
29.	Other information technology and computer service activities (very large companies)
30.	Construction of railways and underground railways (very large companies)
31.	Manufacture of machinery for metallurgy (very large companies)
32.	Freight transport by road (very large companies)
33.	Wholesale of computers, computer peripheral equipment, and software (very large companies)
34.	Transmission of electricity (very large companies)
35.	Manufacture of other parts and accessories for motor vehicles (very large companies)
36.	Construction of utility projects for electricity and telecommunications (very large companies)
37.	Computer programming activities (very large companies)
38.	Hotels and similar accommodation (very large companies)
39.	Business and other management consultancy activities (very large companies)
40.	Manufacture of beverages (very large companies)
41.	Other business support service activities not elsewhere classified (very large companies)

Table 2 Firms' descriptives

	Total assets—average values	Current assets—average values	Working capital—average values
2015	2.083.389,39€	683.528,42€	129.467,78€
2014	2.175.872,59€	718.413,81€	142.457,96€
2013	2.262.989,32€	737.912,38€	148.833,14€
2012	2.272.748,99€	726.935,51€	163.046,13€
2011	2.306.798,55€	736.580,63€	163.164,40€
2010	2.077.650,65€	675.500,92€	177.180,30€
2009	2.006.586,63€	701.979,12€	168.195,37€
2008	1.866.506,67€	643.491,97€	133.899,40€
2007	1.644.196,60€	533.034,96€	145.069,18€

Table 3 Average of CRS and VRS output values per year (%)

Years	Average of CRS output values per year (%)	Average of VRS output values per year (%)
2007	30.29	37.05
2008	28.62	35.98
2009	25.63	31.87
2010	23.24	31.25
2011	23.38	31.77
2012	24.68	32.56
2013	24.22	32.83
2014	23.15	31.86
2015	27.19	35.89
Average	*25.60*	*33.45*

Table 4 Average of crs and vrs output values per year (%) for Spain

Years	Average of CRS output values per year (%)	Average of VRS output values per year (%)
2007	32.84	44.55
2008	28.18	39.71
2009	24.52	35.39
2010	19.83	29.96
2011	19.84	29.25
2012	23.13	32.39
2013	21.26	34.25
2014	20.69	30.92
2015	24.27	35.62
Average	*23.84*	*34.67*

Table 5 Average of CRS and VRS output values per year (%) for Italy

Years	Average of CRS output values per year (%)	Average of VRS output values per year (%)
2007	35.11	41.92
2008	32.32	39.75
2009	32.30	37.71
2010	30.44	40.12
2011	31.49	42.46
2012	29.70	40.94
2013	29.47	38.73
2014	26.47	37.78
2015	34.52	42.93
Average	*31.31*	*40.26*

Table 6 Average of CRS and VRS output values per year (%) for Greece

Years	Average of CRS output values per year (%)	Average of VRS output values per year (%)
2007	22.91	25.93
2008	24.74	28.92
2009	18.86	22.63
2010	17.59	22.14
2011	16.80	21.49
2012	20.11	23.16
2013	20.45	25.06
2014	21.19	25.82
2015	21.01	28.08
Average	*20.41*	*24.80*

for companies in Spain and Greece, while these data are collected 1 year later, in 2012, for Italy, although the crisis period continues for all companies in the sample in the following years.

4 Econometric Results

We use econometric analysis in order to relate the taxes to the profitability indices, and the costs and the debts of a corporation can be referred.

In case of determining a relationship between debts ratio to the assets and profits as well as asset return, a correct decision over granting various types of financial facilities to the studied companies can be made.

In particular, in this part of the study, we run the following regression models, i.e., Options 1–4. We have as follows:

Option 1

$$\text{ROA BEFORETAXi} = \text{a1} + \text{a2 COLLECTIONPERIODi} + \text{a3 LOGTAX} + \text{a4 VRSOUTPUTi}$$

$$+\text{a5LOGDEPRAMORTi} + \text{a6LOGDEBTORSi} + \text{a7 LOGINTERPAIDi} + \text{a8 LOGWORK}-$$

$$\text{INGCAPITALi} + \text{a9 LOGENTERPRISEVALUEi} + \text{a10 LOGPROVISIONSi} + \varepsilon\text{i}$$

For each firm $i (i = 1, 2, 3, \ldots, 380)$, for 9 consecutive years, e.g., 2007–2015 we run Option 1.

Because cross-section random has a probability of 0.000, we reject the null hypothesis (H0) that the model follows the random effects method, and we accept the alternative, i.e., the H1 that the model follows the fixed effects method (Table 7).

We run the fixed effects method with the use of White test to reduce heteroskedasticity of the model (Table 8).

We run four options of the econometric models as follows:

We use White cross-section standard errors and covariance (d.f. corrected) and estimated coefficient covariance matrix which is of a reduced rank. We found positive relation of the ROA with the variables of taxation, efficiency (VRSOUTPUT) and enterprise value (at 1% significance level), and negative relation with depreciation and amortization firms' accounts (at 1% significance level).

Table 7 Correlated random effects—Hausman test/test cross-section random effects

Test summary	Chi-sq. statistic	Chi-sq. d.f.	Prob.
Cross-section random	99.878440	9	0.0000

Table 8 ROA as the dependent variable and VRS output orientation set for DEA

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	5.776542	7.237436	0.798148	0.4249
COLLECTION_PERIOD	−0.016543	0.013593	−1.217045	0.2238
LOG_TAX (*)	*3.594140*	*0.407739*	*8.814807*	*0.0000*
VRSOUTPUT (*)	*0.070879*	*0.011138*	*6.363975*	*0.0000*
LOG_DEPRAMORT (*)	*−10.74640*	*2.680054*	*−4.009769*	*0.0001*
LOG_DEBTORS	1.703278	2.017213	0.844372	0.3986
LOG_INTERPAID	−1.317873	1.401529	−0.940311	0.3473
LOG_WORKINGCAPITAL	−0.575234	0.666136	−0.863539	0.3880
LOG_ENTERPRISEVALUE (*)	*5.222291*	*0.830273*	*6.289846*	*0.0000*
LOG_PROVISIONS	0.115271	0.419956	0.274484	0.7838

(*) refers to significance at 1%, R-squared = 0.770354, prob. (F-stat) = 0.000000

Option 2

Because cross-section random has a probability of 0.000, we reject the null hypothesis (H0) that the model follows the random effects method, and we accept the alternative, i.e., the H1, that the model follows the fixed effects method (Table 9).

We run in Option 2 the econometric formulation of Model 1, under the fixed effects method with the use of White test to reduce heteroskedasticity of the model. We get the results in Table 10.

We find that the signs remain the same in both models with the use of CRS or VRS output orientation. Also, the results show a positive relation of ROA with taxation, efficiency (CRSOUTPUT) and enterprise value (at 1% significance level), and negative relation with depreciation and amortization firms' accounts (at 1% significance level).

Option 3

In this option, because cross-section random has a probability of 0.000, we reject the null hypothesis (H0) that the model follows the random effects method and we accept the alternative, i.e., the H1 hypothesis, that the model follows the fixed effects method (Table 11).

We also run Model 1 formation with the use of White test to reduce heteroskedasticity (See Table 12).

We find that Option 3 results in a positive relation of solvency with taxation, efficiency (CRS output orientation from DEA) at a1% significance level, and

Table 9 Correlated random effects—Hausman test/test cross-section random effects

Test summary	Chi-sq. statistic	Chi-sq. d.f.	Prob.
Cross-section random	90.640246	9	0.0000

Table 10 ROA as the dependent variable and CRS output orientation set for DEA

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	2.522917	7.442011	0.339010	0.7347
COLLECTION_PERIOD	−0.015425	0.013078	−1.179407	0.2385
LOG_TAX(*)	*3.513639*	*0.448369*	*7.836495*	*0.0000*
CRSOUTPUT(*)	*0.086022*	*0.007530*	*11.42381*	*0.0000*
LOG_DEPRAMORT(*)	*−10.07192*	*2.475968*	*−4.067873*	*0.0001*
LOG_DEBTORS	1.877144	1.846427	1.016636	0.3095
LOG_INTERPAID	−1.132858	1.290667	−0.877731	0.3803
LOG_WORKINGCAPITAL	−0.703548	0.700718	−1.004038	0.3156
LOG_ENTERPRISEVALUE(*)	*5.249635*	*0.866008*	*6.061876*	*0.0000*
LOG_PROVISIONS	0.011614	0.433382	0.026800	0.9786

(*) refers to significance at 1%, R-squared = 0.770354, prob. (F-stat) = 0.000000

Table 11 Correlated random effects—Hausman test/test cross-section random effects/option No3

Test summary	Chi-sq. statistic	Chi-sq. d.f.	Prob.
Cross-section random	84.443644	9	0.0000

Table 12 Solvency ratio as the dependent variable and CRS output orientation set for DEA

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	83.12246	13.72051	6.058264	0.0000
COLLECTION_PERIOD	−0.010725	0.014577	−0.735755	0.4620
LOG_TAX	*2.102207*	*0.590000*	*3.563064*	*0.0004*
CRSOUTPUT	*0.097030*	*0.015760*	*6.156708*	*0.0000*
LOG_DEPRAMORT	1.481268	2.999619	0.493819	0.6215
LOG_DEBTORS	−4.164500	1.809575	−2.301369	0.0215
LOG_INTERPAID	*−7.661831*	*0.941772*	*−8.135548*	*0.0000*
LOG_WORKINGCAPITAL (**)	*1.040409*	*0.532561*	*1.953596*	*0.0510*
LOG_ENTERPRISEVALUE	−1.080738	0.810070	−1.334129	0.1824
LOG_PROVISIONS	*−1.668313*	*0.523974*	*−3.183960*	*0.0015*

(*), (**) refer to significance at 1 and 85%, respectively, R-squared 0.899396, prob. (F-stat) = 0.000000

Table 13 Correlated random effects—Hausman test/test cross-section random effects/option No4

Test summary	Chi-sq. statistic	Chi-sq. d.f.	Prob.
Cross-section random	77.536557	9	0.0000

Table 14 Solvency ratio as the dependent variable and VRS output orientation set for DEA

Variable	Coefficient	Std. error	*t*-statistic	Prob.
C	86.05583	13.23303	6.503107	0.0000
COLLECTION_PERIOD	−0.012948	0.014457	−0.895631	0.3706
LOG_TAX (*)	*2.281449*	*0.614982*	*3.709782*	*0.0002*
VRSOUTPUT (*)	*0.067166*	*0.016008*	*4.195682*	*0.0000*
LOG_DEPRAMORT	0.659181	3.140555	0.209893	0.8338
LOG_DEBTORS (**)	*−4.266500*	*1.912720*	*−2.230593*	*0.0259*
LOG_INTERPAID (*)	*−7.922536*	*1.016243*	*−7.795908*	*0.0000*
LOG_WORKINGCA PITAL (**)	*1.193687*	*0.497158*	*2.401022*	*0.0165*
LOG_ENTERPRISEVALUE	−0.900786	0.797082	−1.130105	0.2587
LOG_PROVISIONS	−1.611173	0.504215	−3.195407	0.0014

(*), (**) refer to significance at 1 and 85%, respectively, R-squared 0.897181, prob. (F-stat) = 0.000000

working capital of the sample firms (= current assets – current liabilities) at 5% significance level. Also, negative relation of solvency with interest paid and provisions accounts at 1% significance does exist.

Option 4

In this option, we also reject the null hypothesis (H0) that the model follows the random effects method, and we accept the alternative, i.e., the H1 that the model follows the fixed effects method—Hausman test (Table 13).

Now, we run the fixed effects method with the use of White test to reduce heteroskedasticity of the model (Table 14).

Also, the results show a positive relation of solvency with taxation, efficiency (VRS output orientation from DEA) at 1%, and working capital of the sample firms (= current assets – current liabilities) at a 5% significance level for Option 4 settings.

Additionally, we find a negative relation of solvency with interest paid and provisions accounts at 1% significance as well as with debtors at 5% significance level.

Overall, we see a positive relation of ROA with taxation, efficiency (VRSOUTPUT), and enterprise value. Furthermore, there is a negative relation with depreciation and amortization firms' accounts, while a positive relation of solvency with taxation, efficiency (CRS output orientation from DEA), and working capital of the sample firms (= current assets – current liabilities) does exist. Also, negative relation of solvency with interest paid and provisions accounts is found.

5 Conclusions: Considerations

Businesses play an important role in all economies and are the main generators of employment and income as well as the drivers of innovation and growth. They are the engine of growth (Beck & Demirguc-Kunt, 2006; Makridou et al., 2016). The manufacturing sector is a feature of fast-growing economies. Which mechanism and how much tax and efficiency ratios affect the profitability index (ROA) and the solvency ratio are one of the main objectives of this research. Reviewing the efficiency and profitability of European (i.e., Greek, Spanish, and Italian) companies is important because the percentage of companies is declining. In particular, the economic crisis has severely affected Greek companies during the period under review.

Theoretically, there are several variables that can affect the performance of companies, as survival or business success depends mainly on company profitability, market value, and other explanatory variables. However, there is limited evidence on the link between firms' profitability or their solvency ratio and tax level.

Therefore, the present study was initiated to determine the effects of differences in taxation, efficiency, and other explanatory variables in relation to firms' characteristics and activities. It is found that there is a positive effect of the profitability of the companies with their tax obligations. This means that there is a growing tax base in these three countries, mainly coming from very large companies (in terms of total assets) in the manufacturing and services sectors.

Consistent with this concept, this research also finds a positive relationship between firms' profitability and their level of efficiency, indicating that firms are operating profitably in their market. In contrast, efficiency reduces firms' depreciation balances, as their increased profitability makes it easier for them to absorb larger amounts of fixed asset depreciation.

The literature also indicates that studies on the impact of firms' market value on their profitability have made solid claims about a positive relationship between these variables (e.g., Berger and Bonaccorsi di Patti (2006), Becchetti and Sierra (2003),

Shen and Rin (2012), Murillo (2007), Agustinus and Rachmadi (2008), Floros et al. (2014), Fragkiadakis et al. (2016)). In our study, we likewise confirm this positive relationship.

Moreover, a higher solvency ratio has significant positive effects on corporate taxation, efficiency, and working capital, which in other words indicates a better allocation of resources at the firm level. On the other hand, the results of the econometric analysis show that there is a negative relationship between profitability and the balance of debtor accounts and interest payments on loans and other liabilities. This is an important result that highlights the value of corporate profitability in reducing debt, especially for countries in crisis. Overtaxation also limits the growth opportunities of companies, especially those that meet their tax obligations despite the unfavorable conditions in their countries (e.g., Greece).

This firms' tax policy needs to be improved by national tax authorities, with a focus on gradually reducing the high tax burden of consistent taxpayers so that these businesses can continue to grow their operations. The focus should also be on gradually reducing the tax burden from consistent taxpayers to tax avoiders, so that the former can enjoy a balanced and fair environment and improve their competitiveness and the latter can pay an affordable tax burden in accordance with their respective laws.

This study contributes to the existing literature in two ways: It is one empirical study that highlights the relationship between several firms' focused factors, e.g., ROA, efficiency, taxation, and solvency ratio; also, we apply two commonly accepted methods: data envelopment analysis (DEA) and panel regression.

References

Agustinus, P., & Rachmadi, P. (2008). *Determinants of corporate performance of listed companies in Indonesia, MPRA*. http://mpra.ub.un.muenchen.de/id/eprint/6777

Banker, R., Charnes, A., & Cooper, W. (1984). Some model for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science, 30*, 1078–1092.

Becchetti, L., & Sierra, J. (2003). Bankruptcy risk and productive efficiency in manufacturing firms. *Journal of Banking & Finance, 27*(11), 2099–2120.

Beck, T., & Demirguc-Kunt, A. (2006). Small and medium-size enterprises: Access to finance as a growth constraint. *Journal of Banking & Finance, 30*(11), 2931–2943.

Berger, A. N. & Bonaccorsi di Patti, E. (2006). Capital structure and firm performance: A new approach to testing agency theory and an application to the banking industry. *Journal of Banking & Finance, 30*(4), 1065–1102. Elsevier.

Charnes, A., Cooper, W., & Rhodes, F. (1978). Measuring the efficiency of decision- making units. *European Journal of Operational Research, 2*(4), 429–444.

Charnes, A., Cooper, W., Lewin, A., & Seiford, L. (1994). *Data envelopment analysis: Theory, methodology, and applications*. Kluwer Academic.

Coelli, T. J. (1996). *A guide to DEAP version 2.1: A data envelopment analysis (computer) program*. University of New England; Armidale, CEPA working paper 96/08.

Floros, C., Voulgaris, Z., & Lemonakis, C. (2014). Regional firm performance: The case of Greece. *Procedia Economics and Finance, 14*, 210–219.

Fragkiadakis, G., Doumpos, M., Zopounidis, C., & Germain, C. (2016). Operational and economic efficiency analysis of public hospitals in Greece. *Annals of Operations Research, 247*, 787–806.

Makridou, G., Andriosopoulos, K., Doumpos, M., & Zopounidis, C. (2016). Measuring the efficiency of energy-intensive industries across European countries. *Energy Policy, 88*, 573–583.

Mok, V., Yeung, G., Han, Z., & Li, Z. (2007). Leverage, technical efficiency and profitability: An application of DEA to foreign-invested toy manufacturing firms in China. *Journal of Contemporary China, 16*(51), 259–274.

Murillo, C. (2007). *Asset tangibility and firm performance under external financing: Evidence from product markets*. Retrieved March 20, 2014, from https://doi.org/10.2139/ssrn.971170.

Seiford, L., & Thrall, R. (1990). Recent developments in DEA: The mathematical programming approach to frontier analysis. *Journal of Econometrics, 46*, 7–38.

Shen, G., & Rin, M. (2012). *How does capital structure affect firm performance? Recent evidence from Europe countries*. Retrieved March 12, 2013, from http://edubb.uvt.nl/webapps/blackboard/execute/viewcat-alo?type=course&id=21

Voulgaris, F., & Lemonakis, C. (2014). Creating a business competitiveness index: An application to Greek manufacturing firms. *Journal of Transnational Management, 19*(3), 191–210.