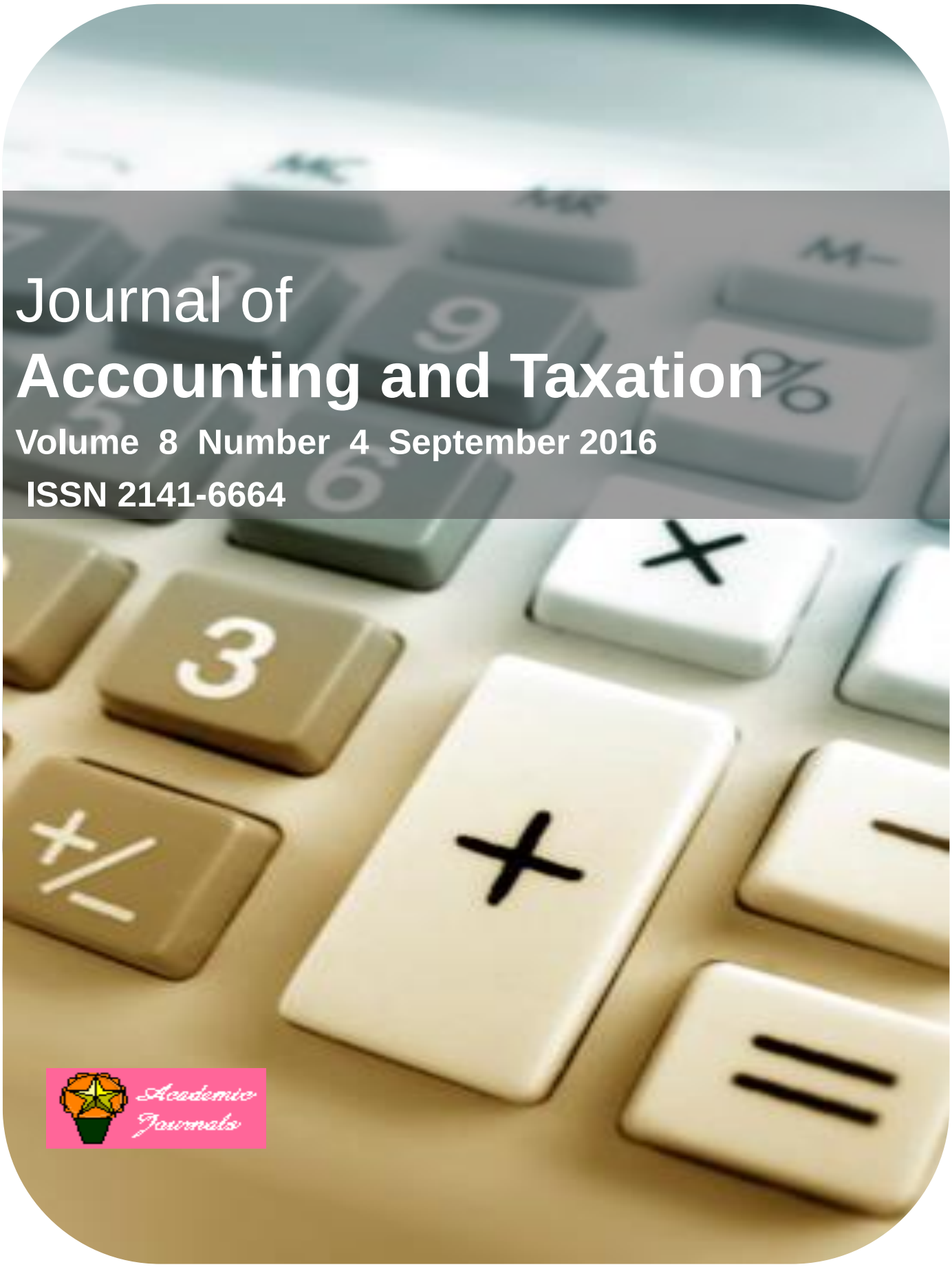

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Table of Contents: Volume 8 Number 4 September 2016

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Full Length Research Paper

R&D activity and operating performance of small and medium-sized enterprises (SMEs): The case of a small open economy

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The study investigates the impact of R&D activity on operational performance of small- and Medium-sized Enterprises (SMEs). Prior studies have indicated that R&D activity improves market performance of large listed companies in advanced economies. We extend the research objective on the operational performance of SMEs in the small open Greek economy in which SMEs are normally not listed companies operating in a "bank-driven" financial system. The empirical results highlight the positive role of R&D investment in the performance improvement of SMEs, especially in the increase of operating cash flows and gross profit margins. Furthermore, the results indicate that the performance impact of R&D activity is moderated by the life cycle and firm size, but it does not depend on the technological intensity of the industry. Overall, the findings suggest that R&D activity may be a positive factor in the enhancement of operational performance of SMEs.

Key words: Financial accounting, R&D, operating performance.

INTRODUCTION

In recent decades companies have increased considerable R&D activity. The specific activity may influence their value and performance since it provides a firm with specific know-how which may strengthen its efficiency (Oliveira et al., 2010; Lev, 2001). Financial-accounting research primarily strives to answer whether R&D investment improves future firm performance (Wang et al., 2016; Cazavan-Jeny et al., 2011; Ciftsi and Cready, 2011; Ehie and Olibe, 2010;; Anagnostopoulou and Levis, 2008; Karjalainen, 2008; Eberhart et al., 2004; Shortridge, 2004; Bae and Noe, 2001; Chan et al., 2001; Sougiannis, 1994). Nevertheless, the vast majority of these studies concentrate in market performance of large listed companies in advanced economies such as the U.S. and the U.K. economy.

The study extends the research objective on

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manufacturing small- and Medium-sized Enterprises (SMEs) in Greece and sheds light in some interesting new insights of operational performance since the Greek financial system is “bank- driven” and almost all SMEs are not listed companies. In bank-based financial systems, the relationship between R&D investment and the level of future profitability may increase (Karjalainen, 2008).

The study proposes that the innovation activity of SMEs should be financially rewarded in the subsequent years. In particular, R&D activity may lead to an internal improvement of operational performance via lower production costs and cost of sales. This is attributed *inter alia* to changes in production process chains, methods of operation management, management control systems and production values (Daveport, 2000; Tsamenyi et al., 2001). Lower cost of sales may contribute to a higher gross profit margin (Anagnostopoulou and Levis, 2008), and probably to lower prices thus leading to increased customer satisfaction. Moreover, R&D activity can produce benefits in increased output or new products to gain new sales and market shares (Anagnostopoulou and Levis, 2008; Roper, 1997; Shortridge, 2004). Thus, an extension of the market share and a reduction of cost of sales would improve performance in terms of accounting profitability and cash flows.

Utilizing a unique panel dataset, the study investigates whether innovations produce operational benefits for SMEs. The dataset comprises accounting information of 108 SMEs located in several industries for the period 2002 to 2007 immediately after the entry of Greece into the Euro-zone (in 2001) where many SMEs have increased R&D activity to face the intensified international competition. As SMEs we adopt the definition by European Commission as those firms with labor force between 10 and 250 persons. The study measures operating performance (dependent variable) using operational cash flows, sales growth, gross-profit margin, and net earning margin. The independent variables are R & D expenses, type of industry, life cycle of firm, firm size, liquidity ratio, debt ratio, and real assets. The empirical analysis indicates significant operational performance differences caused by variation in R&D activity of SMEs.

LITERATURE REVIEW

Hypotheses development

Technological capability can be identified as one of the major factor for the enhancement of firm performance (Radas and Bozic, 2009). However, innovation is very expensive for SMEs, given their constraints in terms of internal resources such as technology, finance, marketing and human resources (Kumar and Subrahmanya, 2010; Sawers et al., 2008). Consequently, the benefits from innovation should clearly outweigh its costs and risks. Otherwise R&D investment is not beneficial and may lead to a slow erosion of the firm’s capital base (Boer, 2005). Generally, R&D activity by nature is subject to high uncertainty and information asymmetry (Moehlre and Walter, 2008). If R&D investments have a successful economic outcome, this will be reflected in operating performance growth. In general, firms that invest heavily in R&D investments are more likely to be profitable and successful. There is strong empirical evidence from the US (Ciftsi and Cready, 2011; Sougiannis, 1994), UK (Anagnostopoulou and Levis, 2008) and EU markets (Cazavan-Jeny et al., 2011) that R&D intensity is positively related to the future level of operating performance. Also, these studies take into account possible interactions of R&D with firm size, technological intensity level of the industry and the life cycle of firm. In the following the main hypotheses of the study are developed.

Role of R&D investment on operational performance

Studies suggest that a large part of the value created by a firm comes from investments in intangible assets (Ehie and Olibe, 2010; Lev, 2001). This is because companies create more value from branding their products and services and less for their tangible assets. So, firms increasingly look to develop an innovation activity that will differentiate them from other firms (Lev, 2001). R&D investment in intangible assets may contribute to the value added (Tsang et al., 2008) and the long-term sales growth (Anagnostopoulou and Levis, 2008; Bae and Noh, 2001; Chan et al., 2001; Chan et al., 2003). Moreover, such an investment may work as a barrier to entry for competitors, (Bae and Noh, 2001). Furthermore, R&D investment is characterized by inherent non-rival use and scalability (Hand, 2003; Lev, 2001) and economies of network (Lev, 2001) may contribute to the reduction of production costs. Overall, the uniqueness of intangibles created by R&D activity can enable firms to differentiate their structure, strengthen their unique capabilities and finally to sustain a competitive advantage (Lev, 2001).

Especially for SMEs, innovation activity could be an important tool for their survival as the external cooperation and strategic alliances with multinational enterprises is normally seldom. Taking into account the earlier mentioned considerations, R&D activity could be generally attractive to shareholders in anticipation of better financial performance. Specifically, this activity may be relevant to the understanding of a business firm’s earning prospects and future cash flows (King and Henry, 1999) since it presents a crucial instrument for competitiveness achievement associated with excellent performance (Cakar and Ertürk, 2010) that could outweigh the relative high innovation costs. In the most recent paper for R&D investments by Wang et al. (2016),

the authors empirically tested the relationship between expensed R&D expenditure and accounting performance using a sample of 5170 Chinese listed companies for the period 2007 to 2014. The results showed that the expensed R&D increases the accounting performance of firms. Therefore, we propose the following hypothesis:

H1: In a small open economy, R & D investment is likely to have a positive effect on operating performance of SMEs

Effect of R&D investment in operational performance according to technological level of industry

Technological opportunities vary across industries (Tsang et al., 2008). Consequently, industrial environment may moderate the impact of R&D investment on operating performance. Evidence supports this argument. Specifically, Chan et al. (2003) and Anagnostopoulou and Levis (2008) suggested that persistence growth in sales and gross income only exists in an R&D-intensive sector.

In addition, Morbey (1988) observed that a threshold R&D funding level must be achieved in order for R&D investment to contribute to future sales growth. Also, Tsang et al. (2008) concluded that value-added generated by R&D is greater in high-tech industries than in low-tech. Moreover, Gustavsson et al. (1999) and Kafouros (2005) found that the impact of R&D investment on competitiveness and productivity is significant for high-tech industries, but it is low for the traditional manufacturing sector.

A potential explanation for the earlier mentioned arguments may be that the R&D-intensive sectors are characterized by rapidly changing technology and market conditions (Tsang et al., 2008). SMEs operating in such sectors need to possess fast-responding capabilities in order to produce new goods, to identify suitable markets, and to benefit from external spillovers on time. Otherwise, they have relatively limited survival chances. Moreover, the dynamics of high-tech industries normally constitute a large knowledge pool that may enable SMEs to more effectively exploit the performance gains created by their investment in R&D. Thus, we test the following hypothesis:

H2: In a small open economy, R & D investment is likely to have a more positive effect on operating performance of SMEs in high-tech industries than in low-tech industries

Effect of R&D investment in operational performance according to life cycle of firm

The impact of R&D activity on operational performance may also depend on its internal organization process. This aspect has not been investigated sufficiently in the accounting-financial literature. Evolution of enterprises takes place through a succession of stages (Porter, 1980). As companies grow they change their structures and strategies, strengthen their ability to absorb and utilize innovation outcomes. Many stages of business life cycle are not connected to each other in a deterministic way, since organizations do not always move in a linear progression through the different stages. However, one could easily distinguish relatively new SMEs from relatively mature SMEs. Early in the life cycle a firm is in a growth phase with rapid sales growth and expansion of activities and products. This phase involves investments in assets for the purpose of future expansion (Anandarajan et al., 2010). New SMEs are relatively characterized by inexperience, and insufficient technological capabilities. Mature enterprises, in turn, have a greater organizational size, a more diversified product service range and more effective and developed management control and innovation systems relative to new firms (Davila, 2005). If they were able to avoid bureaucracy and stagnation (the final stage of life cycle that is characterized by declining firm profitability and lower rate of product innovation) it would be expected that relatively mature SMEs will be benefit most from the R&D spending. Thus, we hypothesize that:

H3: In a small open economy, R&D investment is likely to have a more positive effect on operating performance of relatively mature SMEs than relatively new SMEs

Effect of R&D investment in operational performance according to firm size

R&D scale effects have received significant attention in the financial accounting literature. However, empirical evidence on the relation between firm size and R&D doesn't present a clear picture and the association is not straightforward. Hence, while there is some evidence that larger firms enjoy multiple R&D project spillover advantages (Ciftsi and Cready, 2011), it is also empirically evident that smaller firms account for a disproportionately large number of innovations relative to their size (Cohen and Klepper, 1996). In the case of this study, SMEs in general, are constrained in terms of resources such as innovation capacity, finance, marketing and human resources. However, innovative capabilities of medium-sized companies may be superior as compared to those of small-sized. Medium-sized enterprises have a relatively satisfactory pool of innovation capabilities that provides them better scope for effective exploitation of resources. Thus, medium-sized enterprises appear to be able to exhibit better innovative and economic performance as compared to small-sized that may have some advantages in terms of flexibility. Thus, we hypothesize that:

Table 1. Structure of the sample.

Number of firms	108 SMEs
Number of observations	540 observations for the period 2002-2007
Type of industry (IND):	30 SMEs in low-tech industries; 78 SMEs in high-tech industries
Age of enterprise (CYCLE):	44 new SMEs
	64 mature SMEs
Firm size (SIZE):	46 small-sized SMEs; 62 medium-sized SMEs

H4: In a small open economy, R&D investment is likely to have a more positive effect on operating performance of medium-sized SMEs than small-sized SMEs

METHODOLOGY

Data

We identified SMEs in the Hellastat database that contains a wide range of financial and other business information for all kind of companies in Greece. The selection criterion for SMEs was the maximum ceiling for staff head count according to the definition of the European Commission that is 10 to 50 employees for small- and 50 to 250 for medium-sized enterprises. From a total population of 1.234 manufacturing SMEs, 108 (9%) of them presented an innovation activity during the investigation period indicating the serious difficulties of many SMEs to develop a successful innovation activity. From the 108 SMEs (Table 1), 46 (43%) of them were small-sized and 62 (57%) were medium-sized. Moreover, 30 (28%) operated in low-technology industries and 78 (72%) in high-technology industries (NACE Classification, 4-digit level). In addition, 44 (41%) were relatively new, established from 1990 and afterwards and 64 (59%) were relatively mature SMEs established before 1990. For purpose of this study, the R&D expense was taken from the income statement in order to ensure comparability of the study with previous work that relied on R&D expenses of income statement (Anagnostopoulou and Levis, 2008). Also, although the Greek GAAP allows the conditional capitalization of development costs, the dominant practice in Greece is for R&D expenses to be immediately expensed given the benefit of up front tax deductibility and the potential difficulties of explaining the write-off unproductive R&D projects (Boer, 2005). Overall, the total data sample is a balanced panel with 540 firm-year observations for the period 2002 to 2007 (Table 1).

Measurement of variables

We examine the relationship between R&D intensity (independent variable) and operational performance (dependent variable). Four alternative operational based performance measures (OPM) are employed as dependent variables: Operational cash flows (OCF), sales growth (GROWTH), gross profit margin (GPM) and net earnings margin (NEM). Operational cash flows measured as a percentage of total sales (Bae and Noh, 2001) indicate the ability of a firm to convert intangible benefits into monetary terms. Sales growth computed as the three-year net sales growth (Bae and Noh, 2001) is a measure of firm growth, indicating customer satisfaction via brands, new products etc. Gross profit margin measured as the share of profit margin in sales (Anagnostopoulou and Levis, 2008) indicates less cost of sales through better production methods, new operation systems, productivity improvement etc. Finally, net earnings margin measured as the share of net earnings in sale (Sougiannis, 1994) indicates good profitability.

The independent variables employed in the study are R&D intensity (RDI), industry type (IND), life cycle of the firm (CYCLE), firm size (SIZE), debt (DEBT), liquidity (LIQ) ratio and real assets (RA). The main variable of interest is the R&D intensity measured as the share of R&D expenses to sales (Anagnostopoulou and Levis, 2008; Bae and Noh, 2001; Chan et al., 2001; Ehie and Olibe, 2010), until the year immediately previous to the final year of the time period the dependent variable covers. For instance, when we assess operating growth from year t to t+1, we take R&D intensity as of year t. For the industry type high R&D intensity is distinguished from low intensity with a dummy variable taking the value of one if the industry is classified as high technology and 0 otherwise (Tsang et al., 2008). The creation of the variable is based on evidence concerning the European industry classification (Hallet, 2000). For the life cycle of the firm the logarithm of the year of establishment is used. Firm size is measured as a natural logarithm of the number of employees (Anagnostopoulou and Levis, 2008; Ehie and Olibe, 2010). Debt ratio is a proxy for credit risk computed as the share of total liabilities in total assets (Ehie and Olibe, 2010) to test variation in firm performance due to differences in capital structure. Liquidity ratio is a proxy for liquidity risk measured as the current ratio (that is, current assets to short-term liabilities) investigating possible variation in firm performance due to differences in liquidity. Finally, the variable real (tangible) assets measure the natural logarithm of the sum of three components: net book values of property, plant and equipment, the book value of inventories and the book value of recorded investments in unconsolidated subsidiaries (Sougiannis, 1994; Karjalainen, 2008).

Model

The following regression is run with ordinary least squares (OLS) using panel data for the whole sample for the period 2002 to 2007. Panel data can provide more information on variability and efficiency as compared to conventional cross sectional and time series data sets. It worth pointing that the results are robust to the addition of time period effects and fixed/random effect estimation, with no qualitative change in the direction of results. The estimations of the above OLS panel data model are corrected for heteroscedasticity by using the White's Heteroscedasticity-Consistent Standard Errors and Covariance method. In addition, the stationarity of the panel is tested through the employed Fisher unit-root test, with the null hypothesis of non-stationarity to be rejected at the 1% level for the dependent and independent variables. Also, a basis F test is run for joint parameter insignificance, with the null hypothesis that coefficients are jointly

Table 2. Descriptive statistics of the regression variables.

Variable	OCF	Growth	GPM	NEM	RDI	Cycle	Size	Debt	LIQ	RA
Mean	0.073	0.119	0.335	0.056	0.026	26	82	0.683	1.506	7.736.000
SD	0.113	0.192	0.211	0.108	0.037	11	54	0.384	0.642	6.716.000
Max.	0.312	0.600	0.906	0.361	0.139	64	220	1.993	3.164	49.091.000
Min.	-0.138	-0.200	0.096	-0.095	0.001	9	10	0.239	0.692	461.000

OCF is the share of cash flows to sales, Growth *is* the three-year net sales growth, GPM is the share of profit margin in sales, NEM is the share of profits in sales, RDI *is the* share of R&D expenses to sales, Cycle is the years of operation, SIZE is the number of employees, Debt is the share of total liabilities in total assets, LIQ is the share of short-term assets to short-term liabilities, RA is the amount of tangible assets in Euro.

insignificant at the 1% level to be rejected. Thus, the earlier mentioned tests ensure the robustness of the employed OLS panel data model. Moreover, because extremes in the values of the dependent and independent variables might distort the true picture of the relationship between these variables, before running the regression, the dependent and independent variables are winsorized at 5% in both tails:

$$OPM = \beta_0 + \beta_1(\mathrm{RDI}) + \beta_2 \mathrm{IND} + \beta_3 \mathrm{CYCLE} + \beta_4 \mathrm{SIZE} + \beta_5 \mathrm{DEBT} + \beta_6 \mathrm{LIQ} + \beta_7 RA + \mathrm{e}_{it} \quad (1)$$

Where:

OPM: Four alternative Operational Performance Measures: 1) Operational cash flows – OCF- 2) Growth in sales – GROWTH- 3) gross profit margin – GPM- 4) net earnings margin – NEM
RDI: R&D intensity
IND: Industry type (High or Low technology)
CYCLE: Life cycle of the firm
SIZE: Firm size
DEBT: Leverage
LIQ: Liquidity
RA: Real assets

RESULTS

Descriptive statistics and correlation analysis

Table 2 presents some descriptive statistics (mean, standard deviation, and min and max) for all dependent and independent variables. We only exclude the dummy variable IND. The average SME of the sample had 82 employees, age of 26 years, a satisfactory liquidity of 1.5, and a relative high debt ratio at the level of 68%. Its three-year net sales growth rate was almost 12%, the GPM 33.5%, and the NEM 5.6%. The share of R & D expenses to sales was 2.6% (Table 2). Table 3 reveals that the estimated correlation coefficients between the independent variables were usually smaller than 20%. Only in three cases, the coefficient was relatively high but lower than 70%. A relatively high correlation coefficient showed the variables of life cycle and size firm (41%), liquidity and debt ratio (-68%) and real assets and size firm (59%). These correlations appeared to be logical. In general, large business size characterizes relatively mature firms, good liquidity is associated with relatively low leverage and real assets are positively connected with firm size. Furthermore, the largest variance inflation factor (VIF) was 1.9, which is much lower than the multicollinearity threshold of 10. Overall, the correlation results indicated that our model did not suffer from multicollinearity problems.

Regression results

Table 4 presents the coefficient estimates and values of t-statistics (in parentheses) that have been measured by running the panel data Equation 1, when the dependent variable OPM equals the OCF or GROWTH or GPM or NEM (Table 4).

According to the results reported on Table 4, the R&D intensity variable appeared positively statistically significant (at 1% significance level) for the Operational Cash Flows and Gross Profit Margin regression. These results provide relatively high support for Hypothesis 1.

In the case of the Growth Sales, the RDI variable was negative and statistically insignificant, while in the Net Profit Margin regression, the RDI variable was positive but not statistically significant. The explanation for the findings is European integration and economic development deteriorated drastically the competitiveness of labor-intensive SMEs in the Greek economy. Many of these enterprises adjusted to the integration process through the restructuring of manufacturing activities and the production of more advanced goods, thanks to investments in technology and human capital that has brought about productivity gains.

The rationalization of the manufacturing operations reduced substantially the costs of sale and improved economic improvement in terms of cash flows and gross profit margin. At the same time, the incorporation of the Greek economy into the European and global markets was accompanied by an important reduction of protectionism measures. This process was associated with a substantial increase of openness of the domestic manufacturing, leading to an impressive import intensification that depressed local market shares of many domestic enterprises. In this new environment

Table 3. Pearson correlation coefficients of the independent variables.

Variable	RDI	IND	Cycle	SIZE	DEBT	LIQ	RA
RDI	1.000	-	-	-	-	-	-
IND	0.183***	1.000	-	-	-	-	-
CYCLE	-0.026*	0.020*	1.000	-	-	-	-
SIZE	0.168***	0.136***	-0.415**	1.000	-	-	-
DEBT	0.181***	0.161**	0.090**	-0.107**	1.000	-	-
LIQ	-0.088**	0.018	-0.063*	0.116***	-0.684**	1.000	-
RA	0.073**	-0.012	-0.370***	0.599**	-0.109**	0.113***	1.000

RDI *is the* share of R&D expenses to sales, IND is the classification of the industry to low (=0) or high (=1) technology, CYCLE is the logarithm of year of establishment, SIZE is the logarithm of number of employees, DEBT is the share of total liabilities in total assets, LIQ is the share of short-term assets to short-term liabilities, RA is the logarithm of tangible assets. Statistical Significance Index: *** at 1%; ** at 5%; * at 10%.

Table 4. Effect of R&D intensity on operating performance (t-statistic in parentheses).

Dependent variable	OCF	GROWTH	GPM	NEM
Intercept	1.264 (1.772)*	-5.244 (-0.366)	9.633 (1.011)	-0.107 (-0.018)
RDI	0.706 (4.251)***	-0.035 (-0.086)	1.868 (6.441)***	0.0708 (0.378)
IND	-0.043 (4.257)***	0.0313 (1.414)	-0.039 (-2.861)***	-0.0245 (-2.832)***
CYCLE	-3.903 (-1.812)*	1.559 (0.360)	-2.840 (-0.990)	-0.012 (-0.007)
SIZE	-0.032 (-1.529)	-0.010 (-0.231)	0.072 (2.304)**	-0.0208 (-1.050)
DEBT	-0.043 (-2.370)**	0.006 (0.102)	0.301(1.081)	0.195 (1.213)
LIQ	-0.005 (-0.547)	-0.018 (-1.055)	0.056 (4.121)***	0.042 (5.194)***
RA	0.060 (3.055)***	0.036 (0.866)	-0.055 (-1.830)*	0.009 (0.550)
Adjusted R2	0.191	-0.005	0.528	0.376
F - statistic	8.720	0.685	8.518	4.589

OCF is the share of cash flows to sales, GROWTH is the three-year net sales growth, GPM is the share of profit margin in sales, NEM is the share of profits in sales RDI is the share of R&D expenses to sales, IND is the classification of the industry to low (=0) or high (=1) technology, CYCLE is the logarithm of year of establishment, SIZE is the logarithm of number of employees, DEBT is the share of total liabilities in total assets, LIQ is the share of short-term assets to short-term liabilities, RA is the logarithm of tangible assets. Statistical Significance Index: *** at 1%; ** at 5%; * at 10%.

innovative SMEs achieved to defense the existing market positions rather than to acquire new ones. Consequently, the positive impact of R&D investment on sales growth and expansion in that time was relatively limited.

Regarding the effect of the industrial environment on operating performance, the coefficient for SME's in high-tech industries was negative and statistically significant - at 1%- for the OCF, GPM and NEM regression (for Growth sales regression the coefficient is positive but not statistically significant). Though somewhat surprisingly at the first sight, it is to stress that trade liberalization in Greece did not cause significant re-classifications between high- and low-tech industries temporarily. Indeed, the integration process had a beneficial impact on traditional industries such as food and beverages with natural-based assets against of course technologically advanced sectors such as the machine tool industry, transportation etc. Thus domestic SMEs possessed competitive advantages mainly in traditional industries in which they could show a relatively high performance in terms of cash flows and profit margins.

The firm's life cycle variable appeared negatively statistically significant (at 10% significant level) for only the OCF regression (we remind that the life cycle variable is measured inversely). For the GPM and NEM regression the effect was negative but not statistically significant while for the Growth sales regression the impact was positive but insignificant. Overall, innovation activity had a positive impact on the cash flow of relatively mature SMEs. Furthermore, SIZE had a positive impact on GPN (at 5% level), and a negative impact, but statistically insignificant, on the other three operational performance variables. Moreover, DEBT had a negative impact on OCE (5%), LIQ a positive effect on GPM and NEM, and RA a positive effect on OCE (Table 4).

Table 5. Effect of R&D intensity in high-tech industries (t-statistic in parentheses).

Dependent variables	OCF	Growth	GPM	NEM
Intercept	3.264 (2.594)***	-1.267 (-0.055)	-2.926 (-0.227)	-8.819 (-0.633)
RDI	0.630 (2.061)**	-0.028 (-0.069)	1.257 (5.533)***	0.427 (0.798)
CYCLE	-1.004 (-2.632)***	0.348 (0.960)	0.937 (0.241)	2.593 (0.614)
SIZE	-0.122 (-1.807)*	0.017 (0.256)	0.079 (1.834)*	-0.070 (-1.993)**
DEBT	-0.049 (-1.777)*	0.057 (0.533)	0.153(5.902)***	0.154 (3.592)***
LIQ	-0.029 (-1.461)	-0.001 (0.240)	0.006 (1.345)	-0.002 (-0.483)
RA	0.121 (2.386)**	0.028 (0.531)	-0.021(-0.619)*	0.050 (1.880)*
Adjusted R2	0.169	0.004	0.428	0.254
F - statistic	1.424	0.250	4.966	2.309

OCF is the share of cash flows to sales, GROWTH is the three-year net sales growth, GPM is the share of profit margin in sales, NEM is the share of profits in sales RDI is the share of R&D expenses to sales, CYCLE is the logarithm of year of establishment, SIZE is the logarithm of number of employees, DEBT is the share of total liabilities in total assets, LIQ is the share of short-term assets to short-term liabilities, RA is the logarithm of tangible assets. Statistical Significance Index: *** at 1%; ** at 5%; * at 10%.

Table 6. Effect of R&D intensity in low-tech industries (t-statistic in parentheses).

Dependent variables	OCF	Growth	GPM	NEM
Intercept	6.739(0.268)	-4.442 (-1.234)	4.068 (1.995)*	1.080 (0.762)
RDI	0.858 (2.467)**	-2.859 (-1.812)*	2.230 (4.483)***	1.226 (0.0946)*
CYCLE	-2.228 (-0.293)	1.357 (1.242)	-1.207 (-1.967)*	-3.291 (-0.771)
SIZE	-0.099 (-2.782)***	-0.024 (-0.327)	0.072 (2.251) **	-0.027 (-0.737)
DEBT	-0.007 (-1.254)	-0.045 (-0.327)	0.065(3.467)***	0.065 (3.703)***
LIQ	0.001 (0.111)	-0.016 (0.594)	-0.011 (-1.030)	-0.018 (1.380)
RA	0.130 (3.376) ***	-0.021 (-0.226)	-0.111(-2.666) ***	0.009 (0.275)
Adjusted R2	0.131	0.033	0.533	0.476
F - statistic	3.602	0.666	2.934	2.361

OCF is the share of cash flows to sales, GROWTH is the three-year net sales growth, GPM is the share of profit margin in sales, NEM is the share of profits in sales RDI is the share of R & D expenses to sales, , Cycle is the logarithm of year of establishment, SIZE is the logarithm of number of employees, DEBT is the share of total liabilities in total assets, LIQ is the share of short-term assets to short-term liabilities, RA is the logarithm of tangible assets. Statistical Significance Index: *** at 1%; ** at 5%; * at 10%.

Subsequently, we present the results concerning the hypotheses H2, H3 and H4. We concentrate in the R&D intensity, the main variable of interest. We did not find any important differentiations as regards the impact of R&D on the performance of SMEs in high- and low-tech industries (compare Tables 5 and 6). In both cases, the impact was clearly positive and concerned the dependent variables OCF and GPM, and secondary the variable NEM in the low-tech industries. Thus, the hypothesis H2 was not confirmed (Tables 5 and 6).

Important differentiations between relatively new and relatively mature SMEs were found (Table 7 and 8). Specifically, the positive effect of R&D intensity on operational performance was much stronger in the case of relatively mature SMEs as compared to new firms, especially in the case of the depended variables OCF, GPM, and NEM. This finding indicates confirmation of the hypothesis H3.

The empirical result concerning the H4 is somewhat surprisingly. The comparison of Table 9 with Table 10 shows that the performance effect of R&D was much stronger in the small- than the medium-sized enterprises. Hence, the hypothesis H4 was not confirmed. A possible explanation is that small-sized companies could be more flexible and less bureaucratic as compared to medium-sized and thus potentially more effective as regards the utilization of innovation outcomes. Furthermore, small-sized firms normally have no access to external technological cooperation with foreign companies as compared to medium-sized enterprises, thus, they are forced to be successful with the internal development of know-how. However, this issue requires further investigation.

The study main findings summarized in Table 11 provide a satisfactory evidence for the positive performance role of R&D activity for the case of Greek

Table 7. Effect of R&D intensity in the new SME's (t-statistic in parentheses).

Dependent variables	OCF	GROWTH	GPM	NEM
Intercept	-0.585 (-1.920) *	0.272 (0.715)	0.306 (1.664)*	-0.099 (-0.693)
RDI	0.876 (1.206)	-1.266 (-1.800)*	1.387 (3.292)***	1.009 (0.830)
IND	-0.021 (-0.774)	0.082 (1.845)*	0.009 (0.456)	0.021 (1.031)
SIZE	-0.186 (-2.398)**	-0.037 (-0.532)	0.018 (0.442)	-0.081 (-1.990)*
DEBT	-0.008 (-0.273)	0.1003 (0.834)	0.148(5.669)***	0.069 (1.291)
LIQ	-0.032 (-1.554)	0.001 (0.360)	0.006 (1.131)	-0.006 (-1.044)
RA	0.151 (2.399) **	-0.028 (-0.444)	-0.028 (-0.822)	0.032 (1.121)
Adjusted R2	0.215	-0.005	0.472	0.125
F - statistic	1.103	1.159	3.363	6.254

OCF is the share of cash flows to sales, GROWTH is the three-year net sales growth, GPM is the share of profit margin in sales, NEM is the share of profits in sales RDI is the share of R & D expenses to sales, IND is the classification of the industry to low (=0) or high (=1) technology, SIZE is the logarithm of number of employees, DEBT is the share of total liabilities in total assets, LIQ is the share of short-term assets to short-term liabilities, RA is the logarithm of tangible assets. Statistical Significance Index: *** at 1%; ** at 5%; * at 10%.

Table 8. Effect of R&D intensity in the mature SME's (t-statistic in parentheses).

Dependent variables	OCF	GROWTH	GPM	NEM
Intercept	-0.410 (-2.298)**	-0.241 (-0.622)	0.560 (2.187)**	0.090 (0.403)
RDI	0.470 (3.127)***	0.289 (0.656)	1.798 (6.825)***	0.814 (2.255)**
IND	-0.056 (-3.363)***	0.035 (0.956)	-0.026 (-1.254)	-0.015 (-0.854)
SIZE	-0.036 (-1.073)	-0.005 (-0.082)	0.109 (2.864)***	-0.042 (-1.307)
DEBT	-0.019 (-2.253)**	-0.048 (-0.470)	0.075(3.198)***	0.098 (5.690)***
LIQ	0.007 (1.092)	0.001 (0.074)	0.001 (0.040)	0.010 (1.852)*
RA	0.087 (2.842) ***	0.055 (0.844)	-0.075 (-1.767*)	-0.006 (-0.166)
Adjusted R2	0.182	0.0122	0.435	0.398
F - statistic	5.754	0.515	4.194	3.623

OCF is the share of cash flows to sales*, GROWTH is* the three-year net sales growth, GPM is the share of profit margin in sales, NEM is the share of profits in sales *RDI is the* share of R & D expenses to sales, IND is the classification of the industry to low (=0) or high (=1) technology, SIZE is the logarithm of number of employees, DEBT is the share of total liabilities in total assets, LIQ is the share of short-term assets to short-term liabilities, RA is the logarithm of tangible assets. Statistical Significance Index: *** at 1%; ** at 5%; * at 10%.

Table 9. Effect of R&D intensity in the small-sized firms (t-statistic in parentheses).

Dependent variables	OCF	Growth	GPM	NEM
Intercept	1.038 (0.535)	-4.589 (-0.149)	2.605 (1.684)*	2.812 (1.990)*
RDI	0.870 (2.815)***	-1.230 (-1.663)*	2.416 (6.224)***	1.569 (2.533)**
IND	-0.064 (-2.887) ***	0.023 (0.582)	-0.002 (-0.124)	0.009 (0.452)
CYCLE	-3.377 (-0.576)	1.288 (0.138)	-7.786 (-1.665)*	-8.633 (-2.019)*
DEBT	-0.012 (-1.697) *	0.111 (0.928)	0.065(3.009)***	0.075 (4.942)***
LIQ	-0.006 (1.098)	-0.003 (-0.378)	-0.015 (-4.086)***	-0.018 (-3.456) ***
RA	0.129 (2.380) **	0.062 (1.113)	-0.018 (-0.522)	0.056 (2.038)*
Adjusted R2	0.156	0.031	0.441	0.423
F - statistic	8.079	0.962	3.112	2.903

OCF is the share of cash flows to sales, GROWTH is the three-year net sales growth, GPM is the share of profit margin in sales, NEM is the share of profits in sales RDI is the share of R & D expenses to sales, IND is the classification of the industry to low (=0) or high (=1) technology, CYCLE is the logarithm of year of establishment, LIQ is the share of short-term assets to short-term liabilities, RA is the logarithm of tangible assets. Statistical Significance Index: *** at 1%; ** at 5%; * at 10%.

Table 10. Effect of R&D intensity in the medium-sized firms (t-statistic in parentheses).

Dependent variables	OCF	GROWTH	GPM	NEM
Intercept	2.243 (1.594)	-5.165 (-0.193)	1.485 (1.105)	-1.036 (-0.621)
RDI	0.250 (1.126)	0.144 (0.295)	1.409 (6.166)***	0.535 (1.019)
IND	-0.010 (-0.463)	0.073 (1.841)*	-0.006 (-0.290)	0.006 (0.429)
CYCLE	-6.851 (-1.608)	1.537 (0.189)	-4.480 (-1.104)	3.064 (0.604)
DEBT	-0.034 (-1.432)	-0.066 (-0.662)	0.139(5.504)***	0.109 (2.883)***
LIQ	-0.045 (-2.922)***	-0.018 (-1.055)	0.012 (6.488)***	0.002 (1.315)
RA	0.0047 (1.547)	0.029 (0.511)	0.011 (0.373)	0.029 (1.184)
Adjusted R2	0.310	0.0138	0.475	0.189
F - statistic	2.418	0.564	4.766	1.301

OCF is the share of cash flows to sales, *GROWTH is* the three-year net sales growth, GPM is the share of profit margin in sales, NEM is the share of profits in sales *RDI is the* share of R & D expenses to sales, IND is the classification of the industry to low (=0) or high (=1) technology, CYCLE is the logarithm of year of establishment, DEBT is the share of total liabilities in total assets, LIQ is the share of short-term assets to short-term liabilities, RA is the logarithm of tangible assets. Statistical Significance Index: *** at 1%; ** at 5%; * at 10%.

Table 11. Summary of findings.

Explanatory variables	Hypotheses	Operational	Degree of support
	[expected sign +/-]	performance	
R & D investment	H1 [+]	OCF	**High support**
	[+]	GROWTH	No support
(RDI)	[+]	GPM	**High support**
	[+]	NEM	No support
Technological level	H2 [+]	OCF	No support
of industry (IND)	[+]	GROWTH	No support
	[+]	GPM	No support
	[+]	NEM	No support
Life cycle of firm	H3 [+]	OCF	**High support**
(CYCLE)	[+]	GROWTH	No support
	[+]	GPM	**High support**
	[+]	NEM	**Weak support**
Firm size	H4 [+]	OCF	No support
(SIZE)	[+]	GROWTH	No support
	[+]	GPM	No support
	[+]	NEM	No support

SMEs. More precisely, we detect that SMEs with high R&D intensity exhibited an excellent performance particularly in the fields of operational cash flows and gross profit margins. These results highly support two out of our four research hypotheses.

Conclusion

Utilizing a unique longitudinal dataset comprising 108 SMEs in the Greek manufacturing for the period 2002 to SMEs in the Greek manufacturing for the period 2002 to 2007, the study tested whether innovations can lead to better economic performance of SMEs. To our best knowledge the paper is one of the first financial-accounting studies which explicitly analyze the impact of R&D activity on the operational performance of SMEs in a small open economy such as that of Greece characterized by a “bank-driven” financial system and not listed SMEs. Operational performance comprised of four indicators such as operational cash flows, sales growth,

gross profit margin, and net earnings margin.

The empirical results highlighted the positive role of R&D investment in the improvement of operational cash flows and gross profit margins. So, the study main hypothesis (H1) was mainly confirmed and this result was also consistent with the outcomes obtained from previous literature (Wang et al., 2016; Cazavan-Jeny et al., 2011; Ehie and Olibe, 2010; Anagnostopoulou and Levis, 2008). In addition, the performance influence of R&D intensity was positive for all SMEs independently of the industry in which they operated. So innovation activity was economically successful even in sectors characterized by an unfavorable industrial environment. The results for the impact of industry on the association of R&D intensity with accounting performance were somewhat different from the findings of Anagnostopoulou and Levis (2008) due to differences in the employed dataset (that is, listed UK companies).

Furthermore, the impact of R&D investment was moderated by the life cycle and firm size. Especially, the findings revealed that the innovation activity of the relatively mature SMEs was more financially rewarded than in the case of the relatively new enterprises. In addition, this policy appeared to be more successful in relative small-sized enterprises thus supporting the argument that smaller firms account for a disproportionally large number of innovations relative to their size. This result stands in line with the findings of Cohen and Klepper (1996).

There are useful implications for financial-accounting managers and policy makers in general. The findings suggest that for firms engaged in R&D, the evidence on an association between R&D intensity measured relative to accounting performance is strong. Thus, managers in order to boost operating cash flows and gross profit margins should promote innovation activity. For future research, there are two areas that can contribute to a more complete understanding about the effect of R&D on accounting performance of SMEs that operating in bank driven financial systems. One possibility would be to study the impact of a major external event such as the recent financial crisis on R&D investment relative to the performance of a firm. Another possibility would be an exploration of the factors affecting the relationship between R&D intensity and performance in other non-listed SME's that operate on similar bank-driven economies such as Portugal, Spain and Italy.

Conflict of Interests

The authors have not declared any conflict of interests.

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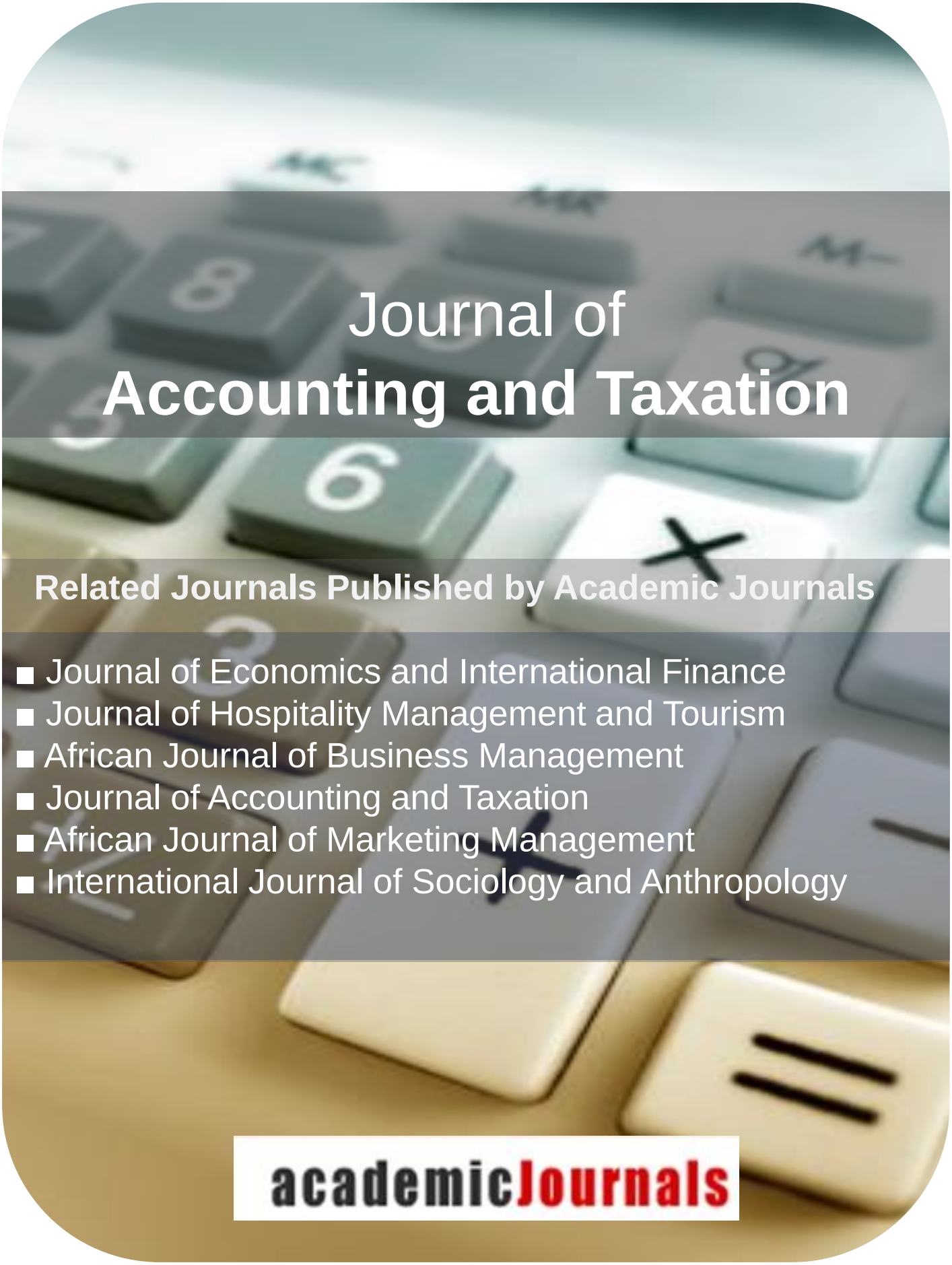

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