INTER-RELATIONSHIP BETWEEN PROFITABILITY, GROWTH AND SIZE: CASE OF TURKEY

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<table>
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<th>Keywords</th>
<th>ABSTRACT</th>
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<tbody>
<tr>
<td>Profitability, Growth, Size, Multiple structural breaks, Bootstrap causality</td>
<td>This study aims to analyze inter-relationship between firm profitability, growth and size by using quarterly data of Turkish manufacturing industry consisting of Borsa Istanbul (BIST) listed manufacturing firms covering 1991.Q2-2014.Q4. In the study, to test the stationarity of series and the co-integration relationship between them, unit root test of Carrion-i-Silvestre et. al. (2009) and co-integration test of Maki (2012) are used, respectively. Co-integration coefficients are estimated by means of Stock and Watson (1993)’s dynamic ordinary least squares (DOLS) method. Finally, causal relationships between the series are tested by Hacker and Hatemi-J (2012) bootstrap causality test. Structural break dates estimated point out dramatic turning points in Turkish economy. Maki (2012) test results show that the series are co-integrated in the long-run. Long-run parameters estimated by DOLS method posit a significantly negative relationship between profitability and size. Causality test results indicate the existence of one-way causality from size to profitability.</td>
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JEL Classification
C22,C58,L25,O47

1. INTRODUCTION

The inter-relationship between firm profitability, growth and size has attracted massive research interest among academic researchers and industry practitioners for several decades (Goddard et. al., 2006; Brännback et. al., 2009). However, related empirical findings show inconsistency (See Coad, 2007, 2009; Davidsson et. al., 2009; Steffens et. al., 2009). The explanation of this inconsistency can be that though it is generally presumed that profitability and growth (and consequently, size) influence each other, they may not be necessarily connected. Therefore the impact and direction of the inter-relationship between them remain ambiguous. Greiner (1972) tries to explain this ambiguity with several arguments. According to him, excessive and/or rapid growth may contribute to a breakdown of informal relationships established over time in firms causing increases in formality in relationships, profitability may be negatively affected. However, excessive and/or rapid growth may also result in greater profitability as an outcome of increased motivation among employees expecting additional gains in future due to this growth. Beyond these managerial explanations, the ambiguity may also be related with
econometric issues. Due to endogeneity, it is difficult to capture a clear causality and direction between profitability, growth and size. Moreover, incorporation of profitability and growth time lags into the econometric models complicates the endogenous relationship between them due to unknown influences of different time lags.

This study aims to shed light on the inter-relationship between firm profitability, growth and size intentionally focusing on econometric issues, rather than managerial implications. Throughout this aim, advanced econometric methods are performed to estimate the mentioned inter-relationship on a sample of Turkish manufacturing industry (consisting of Borsa Istanbul (BIST) listed manufacturing firms) for the period of 1991.Q2-2014Q4. In the following section of the study, literature review is presented. Then methodology and empirical results are given. Finally, in the Conclusion, findings are discussed, limitations of the study and suggestions for further studies are presented.

2. LITERATURE REVIEW

There exist a very comprehensive literature on the inter-relationship between profitability, growth and size. However, while the majority of studies focus on dual relationships between these variables such as profitability-growth, profitability-size or growth-size in a limited framework; a few of them attempt to undertake the entire relationship in depth. Empirically considering both profitability-growth and profitability-size inter-relationships with their causalities, this study is one of the latter. As it is widely assumed that profitability and growth are inter-related, the literature should be discussed from two different perspectives such as (1) the effect of growth on profitability, and (2) the effect of profitability on growth. Concerning the first perspective, there exists several theories claiming that growth positively affects profitability such as Kaldor-Verdoorn Law suggested by Verdoorn (1949) and Kaldor (1966). According to this law, (firm) growth increases the productivity of a firm and this increase triggers sales' growth and consequently profitability. However, this notion conflicts with the theory of diseconomies of scale, an economic concept in which economies of scale -sustaining that larger firms with relatively high growth rates may benefit from cost advantages due to their economies of scale and in turn enhanced profitability- no longer function. Beyond these theories, related empirical studies also indicate similar inconsistent findings. While findings from studies of Capon et. al. (1990), Chandler and Jansen (1992), Mendelson (2000), Cowling (2004), Serrasquerio et. al. (2007), Asimakopoulous et. al. (2009), Serrasquerio (2009) and Jan and Park (2011) indicate positive effect of growth on profitability; Reid (1995)'s, Roper (1999)'s, Gschwandtner (2005)'s and Nakano and Kim (2011)'s findings are opposite to them.

From the second perspective, some prior studies like Alchian (1950)'s theoretical article, financing constraints-based hypotheses, and pecking order theory firstly suggested by Donaldson (1961), then modified and popularized by Myers (1984) and Myers and Majluf (1984) have placed emphasis on the positive effect of profitability on growth. In contrast, some theories have been put forth opposing this effect such as the managerial growth maximization hypothesis under market competition (Mueller, 1972). This theory asserts that firm’s primary managerial objective is growth maximization -rather than profit maximization-, and this objective may sometimes cause decreases in profit rates as a
result of competitive relationship between profitability and growth. In the scope of empirical studies, inconsistent research findings are also seen. Robson and Bennett (2000), Cox et. al. (2002), Liu and Hsu (2006), Coad (2007) and Bottazzi et. al. (2008) express that profitability affects firm growth positively. However, an opposite effect has been observed in studies of Capon et. al. (1990), Markman and Gartner (2002) and Coad (2010).

Firm size as a proxy of firm’s resources is one of the other main determinants of profitability due to theory of economics of scale positing that for bigger firms, manufacturing costs are relatively low compared to the smaller ones. According to this theory, the relationship between profitability and size is expected to be positive. However, opposite of economies of scale, i.e. diseconomies of scale theory predicts that efficiency lessens in firms expanding beyond their optimum scales as a result of several diseconomies including poor communication, co-ordination, x-inefficiency, low motivation and agency problems. In such circumstances, the expected direction of the relationship may turn out to negative. Theoretical and empirical evidence concerning the relationship between profitability and size has also attracted massive interest. While in the pioneering studies of McConnell (1946), Alexander (1949), Haines (1970) and Shepherd (1972), a weak or negative relationship or none at all have been obtained; Hall and Weiss (1967), and Gale (1972) have found positive relationship between profitability and size. Following them, mixed empirical results have been obtained from mainly cross-sectional and time series studies. Briefly concluding that larger firms have tendency to have higher rates of profitability, and therefore supporting the theory of economies of scale; Fiegenbaum and Karnani (1991), Gschwandtner (2005), Özgübaş et. al. (2006), Wu (2006), Jonsson (2007), Akbaş and Karaduman (2012), Mule et. al. (2015) find that size has significantly positive effect on profitability. On the contrary, findings of Amato and Burson (2007), Becker-Blease et. al. (2010) and Khatap et. al. (2011) indicate statistically negative relationship between profitability and size.

3. DATA, VARIABLES and THE MODEL

The data of the study covers 1991.Q2-2014.Q4 for the manufacturing industry (consisting of Borsa İstanbul (BIST) listed manufacturing firms) in Turkey. As mentioned before, the primary aim of the study is to analyze possible relationship between profitability and growth. Additionally, size -as an alternative possible determinant of profitability- is also undertaken in order to check the robustness of the profitability-growth relationship and to enhance the empirical analysis. Therefore, three key variables are included in two different models: profitability as dependent variable in both models, and growth and size as independent variables in each model. These three variables can be measured in different ways due to the aim and context of the studies involved. For instance, while many researchers such as Amato and Wilder (1985), Roquebert et. al. (1996), McGahan and Porter (1997), Glancey (1998), Mauri and Michael (1998), Claver et. al. (2002), Fitzsimmons et. al. (2005), Asimakopoulos et. al. (2009), Davidson et. al. (2009), Narware (2010), Vijaykumar and Devi (2011), Delmar et. al. (2013), and Li and Wang (2014) have used return on assets (ROA); some such as Hall and Weiss (1967), Ebaid (2009), Ferati and Ejupi (2012), Velnampy and Niresh (2012), and Bokhari and Khan (2013)
have used return on equity (ROE) as profitability variable. Here, it can be emphasized that ROE has mostly been used in studies related with (especially in financial) service industries. Additionally, less often than ROA and ROE, some other profitability variables such as return on sales (ROS) (see, for instance, Fitzsimmons et. al., 2005; Jang and Park, 2011; Vijayakumar and Devi, 2011), and earnings before interest and taxes (EBIT) (see, for instance, Kwoka and Ravenscraft, 1986; Brännback et. al., 2009; Fareed et. al., 2014) have also been used in related studies. In this study, the most generally employed profitability variable; i.e., return on assets is used as the dependent variable, as it gives a quick indication of the capital intensity and assets utilization depending on the industry, and overcomes variations based on size in terms of total profits. Besides, use of ROA rather than ROE and any other profitability variables shows consistency with the data.

As in most of related studies (Delmar, 1997; Weinzimmer et. al., 1998; Coad, 2007; Short et. al., 2009; Serrasquerio, 2009; Bottazzi et. al., 2010; Jang and Park, 2011), the growth variable focused on this study is sales' growth. It is relatively easy to obtain sales' growth data from financial statements. As an important indicator reflecting both short-term and long-term changes in sales capacity of the industry, sales' growth is also favored by entrepreneurs themselves (Barkham et. al., 1996). The study by Shepherd and Wiklund (2009) delving into the relationships between various growth variables such as growth in (1) sales, (2) employees, (3) profit, (4) assets, and (5) equity indicates that in many situations sales' growth is the most appropriate variable for growth.

Size is the other independent variable of the model. There are several size variables used by researchers in their studies such as total assets (see, for instance, Friend and Lang, 1988; Anderson and Makhija, 1999; Frank and Goyal, 2003; Dalbor et. al., 2004; Deesomsak, 2004; Padrón et. al., 2005; Zeitun and Tian, 2007; Saliha and Abdessatar, 2011; Doğan, 2013), total sales (see, for instance, Titman and Wessels, 1988; Rajan and Zingales, 1995; Wiwattanakantang, 1999; Booth et. al., 2001; Huang and Song, 2006; Serrasquerio and Nunes, 2008), and number of employees (see, for instance, Bonaccurso, 1992; Archarungroj and Hoshino, 1998; Jonsson, 2007). In this study, size variable is represented by total assets due to the fact that it is the most appropriate variable to epitomize the size of activities. It is measured as the natural logarithm of total assets with the aim of controlling a possible non-linearity in the data, and the consequent problem of heteroscedasticity (Sogorb and Lopez, 2003). Definitions and calculations about the variables of the study are summarized in Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Calculation</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profitability (Return On Assets)</td>
<td>Net Income / Total Assets</td>
<td>ROA</td>
</tr>
<tr>
<td>Growth (Sales' Growth)</td>
<td>[\frac{\text{Sales}<em>t - \text{Sales}</em>{t-1}}{\text{Sales}_{t-1}}]</td>
<td>GROWTH</td>
</tr>
<tr>
<td>Size (Natural Logarithm of Total Assets)</td>
<td>ln(Total Assets)</td>
<td>lnSIZE</td>
</tr>
</tbody>
</table>

The regression equations in order test possible relationships between profitability and growth, and between profitability and size are as given as given below:
\[ \text{ROA}_t = \beta_0 + \beta_1 \text{GROWTH}_t + \epsilon_t \quad (\text{Model 1}) \]
\[ \text{ROA}_t = \beta_0 + \beta_1 \ln \text{SIZE}_t + \epsilon_t \quad (\text{Model 2}) \]

In the model, profitability, growth and size variables are denoted by ROA, GROWTH and lnSIZE, respectively.

4. METHODOLOGY and EMPIRICAL FINDINGS

This study tries to find out the inter-relationship between profitability, growth and size via various empirical analyses including (1) multiple structural breaks unit root test of Carrioni-i-Silvestre et al. (2009), (2) multiple structural breaks co-integration test of Maki (2012), (3) dynamic ordinary least squares (DOLS) method developed by Stock and Watson (1993) and (4) bootstrap causality test developed by Hacker and Hatemi-J (2012), respectively.

4.1. Multiple Structural Breaks Unit Root Test of Carrion-i-Silvestre et. al. (2009)

The results derived from traditional unit root tests may sometimes be misleading when major events like economic crises, wars, catastrophes, etc. have influence on the data analyzed, as these events have tendency to create structural breaks in the series. In these cases, unit root tests allowing for the presence of multiple structural breaks should be referred. The multiple structural breaks unit root test developed by Carrioni-i-Silvestre et. al. (2009: 1786) is one of them allowing for the presence of multiple breaks affecting the individual effects and time trend under the endogenous structural break assumptions; and also offers improvements over commonly methods in even small samples (as the one in this study). In this study, this unit root test is employed because of its superiority to other similar tests, especially about the total number of presence of multiple breaks (maximum up to five).

Carrioni-i-Silvestre et. al. (2009: 1786) see their study as an extension of Kim and Perron (2009)’s work by (1) allowing for an arbitrary number of changes in both the level and slope of the trend function; (2) adopting the so-called quasi-generalized least squares (quasi-GLS) detrending method advocated by Elliot et. al. (1996); and (3) considering the class of M-tests introduced in Stock (1999) and analyzed in Ng and Perron (2001).

In their model, \( y_t \) is the stochastic process generated according to:

\[ y_t = d_t + u_t \quad (1) \]
\[ u_t = a u_{t-1} + \nu_t, \quad t = 0, ..., T \quad (2) \]

where \( \{u_t\} \) is an unobserved mean-zero process. It is assumed that \( u_0 = 0 \). The disturbance term \( \nu_t \) is defined by \( \nu_t = \sum_{i=0}^\infty \gamma_i \eta_{t-i} \) with \( \sum_{i=0}^\infty |\gamma_i| < \infty \) and \( \{\eta_t\} \) a martingale difference sequence adopted to the filtration \( \mathcal{F}_t = \sigma \cdot \text{field}\{\eta_i; i \geq 0\} \). The short-run and long-run variance are defined as \( \sigma^2 = \sigma^2 \gamma (1)^2 \) and \( \sigma^2_\eta = \lim_{T \to \infty} T^{-1} \sum_{t=1}^T E(\eta_t^2) \), respectively.
Carrioni-i-Silvestre et al. (2009) have developed five test statistics. The first one is based on the analyses of Elliot et al. (1996) and Perron and Rodriguez (2003). Here the feasible point optimal statistic is given by:

\[ P_t^{GLS}(\lambda^0) = \frac{S(\bar{z}_t^*,\lambda^0) - \bar{\alpha}S(1,\lambda^0)\sqrt{2}}{s^2(\lambda^0)} \tag{3} \]

where \( s^2(\lambda^0) \) is an estimate of the spectral density at frequency zero of \( \nu_t \). Following Perron and Ng (1998) and Ng and Perron (2001), Carrioni-i-Silvestre et al. (2009) use an autoregressive estimate defined by:

\[ s(\lambda^0)^2 = \frac{s_{0k}^2}{(1 - \sum_{j=1}^{k} \hat{\beta}_j)^2} \tag{4} \]

where \( s_{0k}^2 = (T - k)^{-1} \sum_{t=k+1}^{T} \hat{e}_t \hat{e}_k \) and \( \hat{e}_t \) obtained from the ordinary least squares (OLS) regression:

\[ \Delta \tilde{y}_t = b_0 \tilde{y}_{t-1} + \sum_{j=1}^{k} b_j \Delta \tilde{y}_{t-j} + \epsilon_{t,k} \tag{5} \]

with \( \tilde{y}_t = y_t - \Psi z_t(\lambda^0) \) where \( \Psi \) minimizes the objective function.

The order of autoregression \( k \) is selected using the modified information criteria suggested by Ng and Perron (2001) and with the modification proposed by Perron and Qu (2007).

The three \( M \)-class of tests allowing for multiple structural breaks used by Carrioni-i-Silvestre et al. (2009) are defined by Equations 6-8 as given below. These tests have been analyzed previously in Ng and Perron (2001).

\[ MZ_t^{GLS}(\lambda^0) = (T^{-1} - s(\lambda^0)^2) \left( 2T^{-2} \sum_{t=1}^{T} \tilde{y}_{t-1}^2 \right)^{-1} \tag{6} \]

\[ MSB^{GLS}(\lambda^0) = \left( s(\lambda^0)^{-2}T^{-2} \sum_{t=1}^{T} \tilde{y}_{t-1}^2 \right)^{\frac{1}{2}} \tag{7} \]

\[ MZ_t^{GLS}(\lambda^0) = (T^{-1} \tilde{y}_{t-1}^2 - s(\lambda^0)^2) \left( 4s(\lambda^0)^2T^{-2} \sum_{t=1}^{T} \tilde{y}_{t-1}^2 \right)^{-\frac{1}{2}} \tag{8} \]

with \( \tilde{y}_t = y_t - \Psi z_t(\lambda^0) \), where \( \Psi \) minimizes the objective function given in the footnote 1 and \( s(\lambda^0)^2 \) is defined in Equation (4).

Following Ng and Perron (2001), the fifth statistic in Carrioni-i-Silvestre et al. (2009) is a modified feasible point optimal test defined by:

---

1 The so-called GLS detrended unit root test statistics are based on the use of the quasi-differenced variables \( y_t^\circ \) and \( z_t^\circ (\lambda^0) \) defined by \( y_t^\circ = y_t \), \( z_t^\circ (\lambda^0) = z_t(\lambda^0) \), and \( y_t^\circ = (1 - \alpha \Delta) y_t \), \( z_t^\circ (\lambda^0) = (1 - \alpha \Delta) z_t(\lambda^0) \) for \( t = 2, \ldots, T \) with \( \alpha = 1 + \epsilon/T \) where \( \epsilon \) is a noncentrality parameter. Once the data have been transformed, the parameters \( \Psi \), associated with the deterministic components, can be estimated by minimizing the following objective function: \( S' (\Psi, \bar{\alpha}, \lambda^0) = \sum_{t=1}^{T} (y_t^\circ - \Psi z_t^\circ (\lambda^0))^2 \). The minimum of this function is denoted by \( S(\bar{\alpha}, \lambda^0) \) (Carrioni-i-Silvestre et al., 2009: 1758-1759).
$MP_{I}^{GLS}(\chi^{0}) = \frac{[c^{-2}T^{-2}\sum_{i=1}^{T} y_{i-1}^{2} + (1-c)T^{-1}y_{1}^{2}]}{s(\chi^{0})^{2}}$ (9)

In Carrion-i-Silvestre et. al. (2009), asymptotic critical values are obtained by using the bootstrap. The null hypothesis of a unit root is rejected in case of calculated test statistics being smaller than critical values. In this situation, it can be said that series is stationary under the presence of structural break. Results of unit root test of Carrion-i-Silvestre et. al. (2009) are given in Table 2.

Table 2.: Results of Unit Root Test of Carrion-i-Silvestre et. al. (2009)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Critical Values</th>
<th>Break Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$p_{I}^{GLS}$</td>
<td>$MZ_{I}^{GLS}$</td>
</tr>
<tr>
<td>ROA</td>
<td>13.236 (8.869)</td>
<td>-33.102 (-46.219)</td>
</tr>
<tr>
<td>InSIZE</td>
<td>24.236 (9.250)</td>
<td>-21.739 (-47.749)</td>
</tr>
<tr>
<td>GROWTH</td>
<td>13.039 (9.169)</td>
<td>-36.538 (-46.490)</td>
</tr>
<tr>
<td>△ROA</td>
<td>2.358*** (5.543)</td>
<td>-38.138** (-17.325)</td>
</tr>
<tr>
<td>△InSIZE</td>
<td>2.141*** (5.543)</td>
<td>-44.517*** (-17.325)</td>
</tr>
<tr>
<td>△GROWTH</td>
<td>2.804*** (5.543)</td>
<td>-40.055** (-17.325)</td>
</tr>
</tbody>
</table>

Note: Figures in parenthesis are critical values obtained by using the bootstrap at significance level of 5%. *** and ** denote stationarity at significance level of 5%; and the first difference, respectively.

According to the empirical results, the null hypotheses of a unit root test is accepted as calculated test statistics at level are bigger than critical values. Test results also indicate that series are stationary at their first differences and integrated of order one, I(1).

As seen in Table 2, structural break dates estimated by the unit root test of Carrion-i-Silvestre et. al. (2009) point out dramatic turning points in Turkish economy. These break dates are to be discussed in the Conclusion part of the study.

4.2. Multiple Structural Breaks Co-integration Test of Maki (2012)

Among co-integration tests considering structural breaks, tests suggested by Zivot and Andrews (1992); Gregory and Hansen (1996), and Westerlund and Edgerton (2007) allow only one structural break. However, Gregory and Hansen (1996) criticizes that in case of referring such tests, breaks may cause spurious unit root behavior in the co-integrating relationship. So, multiple (at least more than one) structural breaks should be processed in co-integration tests. In this context, tests developed by Carrion-i-Silvestre and Sanso (2006) and Hatemi-J (2008) allow two structural breaks. Additionally, Maki (2012) proposes a test performing better than its ancestors when the co-integration relationship has more than three (maximum up to five) breaks or persistent Markov switching shifts. Therefore in this study, Maki (2012) co-integration test is used. Maki (2012) tries to identify the long-run relationships between series with four different regression models in as given below:

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\[ y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \beta x_t + \mu_t \]  \hspace{1cm} (10)

\[ y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \beta x_t + \sum_{i=1}^{k} \gamma_i t D_{i,t} + \mu_t \]  \hspace{1cm} (11)

\[ y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \beta x_t + \sum_{i=1}^{k} \beta_i x_i D_{i,t} + \mu_t \]  \hspace{1cm} (12)

\[ y_t = \mu + \sum_{i=1}^{k} \mu_i D_{i,t} + \beta x_t + \sum_{i=1}^{k} \gamma_i t D_{i,t} + \beta_i x_i D_{i,t} + u_t \]  \hspace{1cm} (13)

where \( t = 1, 2, ..., T \), \( y_t \) and \( x_t = (x_{1t}, ..., x_{mt})' \) denote observable 1(1) variables, and \( u_t \) is the equilibrium error. \( y_t \) is a scalar and \( x_t = (x_{1t}, ..., x_{mt})' \) is an \( (m \times 1) \) vector. It is assumed that an \( (n \times 1) \) vector \( z_t \) is generated by \( z_t = (y_t, x_t)' = z_{t-1} + \epsilon_t \), where \( \epsilon_t \) are independent identically distributed with mean zero, definite variance-covariance matrix \( \Sigma \), and \( E[\epsilon_t | \epsilon_1^s] < \infty \) for some \( s > 4 \). \( \mu, \mu_j, \gamma, \beta = (\beta_1, ..., \beta_{im}) \) are true parameters. \( D_{i,t} \) takes as value of 1 if \( t > T_{bi}(i = 1, ..., k) \) and 0 otherwise, where \( k \) is the maximum number of breaks and \( T_{bi} \) denotes the time period of the break.

The first model with level shifts and without trend in which there is a break in the constant term, and the second model (also called as the regime-shifts model) without trend in which there are breaks in both constant term and slope are given in Equations (10) and (11), respectively. The third model given in Equation (12) is the second model with a trend. The fourth and the last model is the comprehensive one with breaks in constant term, slope and trend (Equation 13).

The asymptotic critical values of the tests for the maximum number of breaks (from 1 to 5) approximated by Monte Carlo simulations coded by GAUSS are given in Maki (2012). The null hypothesis of non-existence of co-integration between series is rejected in case of calculated test statistics being smaller than these critical values. In the study, null hypothesis is accepted for the 1st model, while it is rejected for the 2nd one. Therefore, there exists a co-integration relationship between firm profitability and size. The results of multiple structural breaks co-integration test of Maki (2012) are given in Table 3.

As seen in Table 3, calculated test statistics being smaller than critical values point out that alternative hypothesis of existence of co-integration between the series under multiple structural breaks is accepted. Maki (2012) test results show that the series are co-integrated in the long-run. In the next step of the analysis, estimation of long-run parameters are made by using the dynamic ordinary least squares (DOLS) method developed by Stock and Watson (1993). Break dates obtained from co-integration test are also included in the model developed for parameter estimation.
Table 3.: Results of Maki (2012) Co-integration Tests

<table>
<thead>
<tr>
<th>Models</th>
<th>Test Statistics</th>
<th>Critical Values</th>
<th>Break Dates</th>
<th>Existence of Co-integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1%</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>ROA - GROWTH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROA - hSIZE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Critical values are obtained from the Table 1 in Maki (2012)’s study. **, denotes significance level of 5%.

4.3. Estimation of Long-run Parameters

DOLS method of Stock and Watson (1993) is improved on ordinary least squares (OLS) having certain advantages over both it and the maximum likelihood procedures such as coping with small sample and dynamic sources of bias. As a robust single equation approach, DOLS corrects for regressor endogeneity by the inclusion of leads and lags of the first differences of the regressors, and for serially correlated errors by a generalized least squares (GLS) procedure (Esteve and Requena, 2006: 118). Moreover, it has the same asymptotic optimality properties as the Johansen (1991) distribution (Al-Azzam and Hawdon, 1999). Using DOLS estimators requires existence of co-integration between dependent and explanatory series.

The DOLS estimator is obtained from the Equation (14):

\[ y_t = \alpha_0 + \alpha_1 t + \alpha_2 x_t + \sum_{i=q}^{r} \delta_i \Delta x_{i,t} + \epsilon_t \]  

(14)

where \( q \) represent optimum leads and lags, and \( \epsilon_t \) error term, respectively.

The long-run parameters estimated by DOLS method given in Table 4 indicate that the only statistically significant relationship is between profitability and size. Accordingly, size has statistically negative effect on profitability. This empirical result may be discussed in terms of diseconomies of scale.


As co-integration analyses do not provide information on the direction of causality, causality analysis should be undertaken in determining causal relationships between the series. For this purpose, the bootstrap causality test of Hacker and Hatemi-J (2012) is used in this study. In their previous study, Hacker and Hatemi-J (2006) have used the Granger
causality Wald test with a modification for integrated variables suggested in Toda and Yamamoto (1995), concluding that such test is not appropriate to be used with relatively small sample sizes. Therefore, in 2012, they have improved their test by assuming the lag length to be unknown and the one chosen is data-driven; presenting the power and simulation results; and focusing on smaller sample sizes (20-40 observations).

Table 4: DOLS Estimation Results (Model 2)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>t-statistics</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln SIZE</td>
<td>-0.004***</td>
<td>-1.785</td>
<td>0.078</td>
</tr>
<tr>
<td>D1</td>
<td>-0.047</td>
<td>-0.696</td>
<td>0.488</td>
</tr>
<tr>
<td>D2</td>
<td>0.147</td>
<td>2.397</td>
<td>0.019</td>
</tr>
<tr>
<td>D3</td>
<td>0.015</td>
<td>0.263</td>
<td>0.793</td>
</tr>
<tr>
<td>D4</td>
<td>-0.166</td>
<td>-2.846</td>
<td>0.005</td>
</tr>
<tr>
<td>D5</td>
<td>0.071</td>
<td>0.058</td>
<td>0.226</td>
</tr>
<tr>
<td>C</td>
<td>0.139</td>
<td>2.629</td>
<td>0.010</td>
</tr>
</tbody>
</table>

R²: 0.58  D-W test statistics: 1.013

Note: ***, denotes significance level of 10%.

In the context of Granger causality, Hacker and Hatemi-J (2012) consider the vector autoregressive model of order k, \( VAR(k) \):

\[
\gamma_t = \beta_0 + \beta_1 \gamma_{t-1} + \cdots + \beta_k \gamma_{t-k} + \mu_t
\]  

(15)

where \( \gamma_t, \beta_0, \mu_t \) are vectors with dimensions \( n \times 1 \) and \( \beta_i, i \geq 1 \) is a parameter matrix with \( n \times n \) dimensions. The error vector, \( \mu_t \), has a zero-expected value, assumed to be independent and identically distributed with a non-singular covariance matrix \( \Omega \). The lag length, \( k \), is determined by estimating the \( VAR(k) \) model in Equation (15) for \( k = 0, \ldots, K \), where \( K \) is the maximum lag length considered, and finding that \( k \) which minimizes the information criterion suggested by Hatemi-J (2003; 2008) as an alternative to Schwarz Bayesian Information Criterion (SBC) and Akaike Information Criterion (AIC). Hatemi-J Information Criterion \( (HJC) \) is as below:

\[
HJC = \ln(\text{det}\hat{\Omega}_k) + k \left( \frac{n^2 \ln T + 2n^2 \ln(\ln T)}{2T} \right)
\]  

(16)

where \( \ln \) is the natural logarithm; \( \text{det}\hat{\Omega}_k \) is the determinant of the estimated variance-covariance matrix of the residuals in the \( VAR(k) \) model for lag order \( k \); \( n \) and \( T \) are the number of variables and the sample size (number of observations), respectively.

In case of variables being integrated, standard asymptotical distributions cannot be used to test for restrictions in the \( VAR \) model. To overcome this problem, Toda and Yamamoto (1995) uses an augmented \( VAR(k + d) \) model, where \( d \) denotes integration order of variables. This model can be written compactly as below (Hatemi-J et. al., 2006: 69):
\[ Y = DZ + \delta \quad (17) \]

To test the null hypothesis of non-Granger causality, the modified Wald (MWALD) test statistic is used. This test is as:

\[ MWALD = \left( Q \hat{\beta} \right) \left[ Q \left( (IZ)^{-1} \Theta \Omega_u Q \right)^{-1} Q \hat{\beta} \right] \sim \chi^2_{k} \quad (18) \]

where \( Q \) is an \( k \times n(1+n(k+d)) \) indicator matrix used to identify restrictions implied by the null hypothesis; and \( \Theta \) is the element by all element matrix multiplication operator (the Kronecker product). \( \Omega_u \) is the estimated variance-covariance matrix of residuals in Equation (17) when the restrictions implied by the null hypothesis of non-Granger causality is not imposed and is determined by the formula \( \Omega_u = \left( \delta_u \delta_u' \right) / \left( T - \left( 1 + nk \right) \right) \), where \( 1 + nk \) is the number of parameters.

Under the normal distribution assumption, the Wald test statistics follows a \( \chi^2 \) distribution with \( k \) degrees of freedom asymptotically. However, in cases where sample size is relatively small, the error terms are not normally distributed; and autoregressive conditional heteroscedasticity effects exist, asymptotic critical values of the Wald test are not precise. For the solution of this problem, Hacker and Hatemi-J (2012) suggest a test based on leveraged bootstrap simulations emphasizing that when the lag length choice is endogenized, the suggested test will perform better with more precise results. The null hypothesis non-Granger causality is rejected in case of calculated Wald statistic being higher than the bootstrap critical value. The causality relationships among variables are given in Table 5.

**Table 5.: Bootstrap Causality Test of Hacker and Hatemi-J (2012)**

<table>
<thead>
<tr>
<th>The Null Hypothesis</th>
<th>MWALD Statistics</th>
<th>1% Critical Value</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Causality from ROA to GROWTH</td>
<td>1.544</td>
<td>6.939</td>
<td>3.768</td>
<td>2.716</td>
</tr>
<tr>
<td>No Causality from GROWTH to ROA</td>
<td>0.211</td>
<td>6.737</td>
<td>3.947</td>
<td>2.748</td>
</tr>
<tr>
<td>No Causality from ROA to lnSIZE</td>
<td>4.982***</td>
<td>11.164</td>
<td>6.102</td>
<td>4.676</td>
</tr>
<tr>
<td>No Causality from lnSIZE to ROA</td>
<td>0.364</td>
<td>10.431</td>
<td>6.346</td>
<td>4.923</td>
</tr>
</tbody>
</table>

*Note:***, denotes significance level of 10%. The bootstrapping is repeated 10,000 times.*

\(^1\) Toda and Yamamoto (1995)'s augmented VAR\((k+d)\) model is as: \( y_t = \beta_k + \beta_1 y_{t-1} + \ldots + \beta_k y_{t-k} + \mu_t \). Assuming that the initial values are given, the denotations in Hatemi-J et al. (2006) in order to represent the modified Wald statistics are as:

\[ Y := \left( y_1, \ldots, y_n \right) \quad (n \times T) \text{ matrix}, \]

\[ D := \left( \beta_1, \beta_2, \ldots, \beta_{k+d} \right) \quad (n \times 1(1+n(k+d))) \text{ matrix}, \]

\[ Z_t := \begin{bmatrix} y_t \\ \vdots \\ y_{t-1} \\ \vdots \\ y_{t-k+d+1} \end{bmatrix} \quad \left( 1 + n(k+d) \right) \times 1 \text{ matrix, for } t = 1, \ldots, T \]

\[ Z := (Z_1, \ldots, Z_T) \quad \left( 1 + n(k+d) \right) \times T \text{ matrix, and} \]

\[ \delta := (e_1, \ldots, e_T) \quad (n \times T) \text{ matrix.} \]
Bootstrap causality test results indicate the existence of one-way causality from size to profitability variable at significance level of 10% for the manufacturing industry (firms) in Turkey. The result imply that (firm) size statistically affects (firm) growth.

5. CONCLUSION

This study investigates the inter-relationship between firm profitability, growth and size in Turkish manufacturing industry consisting of Borsa Istanbul listed manufacturing firms covering 1991.Q2-2014.Q4. In the study, the stationarity of series are tested by unit root test of Carrioni-i-Silvestre et. al. (2009. The structural break dates estimated by this test point out dramatic turning points in Turkish economy. Last quarter of the year 1993 is seen as the beginning period of Turkey’s currency crisis in 1994. As known, huge public sector borrowing requirements and major policy fallacies in financing the deficit have led to a currency crash in Turkey in 1994. After five years, on August 17th and November 12th, 1999, earthquakes struck the Marmara and Bolu areas of Turkey causing high casualties and significant material damage on property, with severe effects on economy. Following, a new crisis occurred on February 19th, 2001 in the form of a virtual raid on foreign currencies. Finally, along with the world economy, Turkish economy faced with the financial crisis of 2007-08 (also known as Global Credit Crunch or 2008 Financial Crisis) considered by many economists to have been the worst financial crisis since the Great Depression.

Besides, co-integration relationship and co-integration coefficients between profitability, growth and size are tested by means of co-integration test of Maki (2012) and Stock and Watson (1993)'s dynamic ordinary least squares (DOLS) method, respectively. The results of Maki (2012) test indicate a co-integration relationship between firm profitability and size. The long parameters estimated by DOLS method show that the only statistically significant relationship is between firm profitability and size. Accordingly, size has statistically negative effect on profitability indicating that firm profitability decreases due to increase in size. This finding supports to the theory of diseconomies of scale. In diseconomies of scale, long-term average cost of production increases due to increase in the scale of operations beyond a certain level.

Finally, causal relationships between the variables are also tested by Hacker and Hatemi-J (2012) bootstrap causality test. Results of this test indicate only the existence of one-way causality from size to profitability.

This study is subject to some limitations. The findings of the study cannot be generalized to other industries, as the sample consists of only the manufacturing industry. Besides, the profitability, growth and size variables used in the study may be changed with the ones discussed in the 3rd part of the study. So, further studies may investigate the mentioned inter-relationships using other various variables with more enlarged samples consisting of different industries.
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