The Impact of Intellectual Capital on Firms' Performance: Evidence from Saudi Arabia

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Abstract

The purpose of this study is to empirically investigate the relationship between intellectual capital (IC) measured by the value-added intellectual coefficient (VAIC) and firms' performance (FP) in the Saudi context. Data are drawn from a sample of 25 Saudi firms listed on the Saudi Stock Exchange (Tadawul) for the period 2015-2018. Using the VAIC model, the multiple linear regression models were constructed to examine the relationship between intellectual capital (IC) and firms' performance (measured in terms of financial and market performance). The findings indicate that there is a positive association between overall intellectual capital efficiency as well as each of its three components (human capital efficiency, structural capital efficiency, capital employed efficiency) and the firms' financial performance. Additionally, there is a positive association between human capital efficiency (HCE), structural capital efficiency (SCE), and the firms' market performance. Overall, the findings suggest that human capital efficiency (HCE) has a significant and positive impact on firms' financial and market performance in Saudi Arabia. The VAIC method may be a useful tool for managers and investors in their decision process. This is the first study about the impact of intellectual capital on firms' performance in four industry groups in Saudi Arabia using the VAIC model.

Keywords: intellectual capital, firms' performance, VAIC, Saudi context

1. Introduction

The world moved from the production era, in which the physical assets of organizations: lands, buildings, etc., were a sole source of value creation to the knowledge era based on the idea that knowledge, instead of a physical asset, is the main driver of economic growth (Seetharaman, Helmi Bin Zaini Sooria & Saravanan, 2002). The information revolution, the digital world, and knowledge in the current era have made intellectual capital an important source of wealth creation alongside physical assets. Intellectual capital (IC) is a resource that provides a competitive advantage (Bayraktaroglu, Calisir & Baskak, 2019; Chen, Cheng& Hwang, 2005), which means it also has a positive impact on firms' performance for that firms need methodologies to identify and measure IC (Bayraktaroglu et al., 2019).

Given the intangible nature of IC, there is a difficulty in measuring it (Chang & Hsieh, 2011). The traditional accounting model remains focused on physical and financial assets and ignores most IC assets. Additionally, the International Accounting Standards/International Financial Reporting Standards (IAS/IFRS) did not contribute to redefining many of the concepts, principles, and valuation methods of IC assets. The relative lack of IC accounting recognition and its increasing role in the value creation process means that the financial statements have lost some of their value to users (Zéghal & Maaloul, 2010). Many researchers have made significant contributions to solving the problem of classification and measurement of IC (Dzenopoljac, Yaacoub, Elkanj & Bontis, 2017).

The Value-Added Intellectual Coefficient (VAIC) model, developed by Pulic (1998), is one of the most used methods of the efficiency measurement for three components: physical capital, human capital, and structural capital within a firm. Many studies used the VAIC model (Bayraktaroglu et al., 2019; Maditinos, Chatzoudes, Tsairidis, & Theriou, 2011; Nadeem, Gan& Nguyen, 2017) to measure intellectual capital (IC). Evidence from these studies indicates that there is a relationship between IC and FP.

Previous IC and FP studies have been conducted on firms in the United Kingdom, Greece, South Africa, Turkey, and Taiwan, etc. However, within the Saudi Arabian context, studies related to this subject are very few and are not in line with its importance at the global level as well as, in particular, the local level. The economy of Saudi Arabia is one of the top twenty economies in the world (Group of Twenty - G20). It is dependent on oil because it has the second-largest proven petroleum reserves, and it is the largest exporter of petroleum in the world. In 2016 the Saudi Government announced its Saudi Vision 2030 to reduce the country's dependency on oil and to diversify its economic resources (“Economy of Saudi Arabia,”2020). The importance of (IC) in Saudi Arabia is increasing because it represents the cornerstone for achieving the 2030 vision, and one of its goals was to raise the social capital index issued by the World Bank from 26th place in 2016 to ten by 2030 (“Vision 2030,” 2016).

The main objective of the present study is to examine the relationship between intellectual capital measured by the value-added intellectual coefficient (VAIC) and the firms’ performance of 25 Saudi firms listed on the Saudi Stock Exchange (Tadawul), from four industry groups: telecommunication services (four companies), diversified financials (four companies), banks (11 banks), and health-care equipment and Svc (six companies). All four industry groups are knowledge-based, are important to the Saudi economy, and belong to the service sector. The services sector contributed 48.5 % to the Saudi gross domestic product (GDP) for the year 2018, as it is the highest ever in history, and it is expected to record rapid growth during the coming years in light of the huge tourism and entertainment projects announced within Vision 2030 (Abdullah, 2019).

The data required to measure the intellectual capital components (VAIC) as it was defined by Pulic (1998) were obtained from the firm's annual financial reports for four years during the period 2015 - 2018.

One main hypothesis and three derived sub-hypotheses were developed to, first, test the relationship between the intellectual capital (VAIC) in terms of all its components and FP, and second, the impact of each of the three components of IC on FP.

The objective of this study is to, first, empirically test the relationship between IC and FP in the context of the Saudi economy. Second, we compare our findings with previous relevant studies and identify the convergent and divergent aspects of our study compared with previous studies.

The remaining sections of this study are organized as follows: Section 2 provides highlights on the relevance of IC and the necessity for its measurement in the knowledge economy in general, and in the Saudi context in particular. Section 3 describes the relationship between IC and FP by referring to the relevant literature review. Section 4 describes the conceptual model and hypotheses development. Section 5 provides the research methodology. Section 6 provides empirical evidence of the impact of IC on FP in the Saudi context. Section 7 is for the results discussion. Finally, Section8 summarizes and concludes the study.

2. Relevance of IC and Necessity for Measurement

Intellectual capital represents a competitive advantage for contemporary organizations so decision-makers are in urgent need of information regarding its components, the cost of these components, and the returns each component generates. The process of measuring and disclosing IC is a challenge for accountants, and the need arose to find accounting standards to measure it (Zerzar,2015).

This section will present the importance of IC in the knowledge economy and the necessity to measure it as well as a set of concepts and definitions and the most important methods of measurement:

2.1 Relevance of IC in The Knowledge Economy

There is a major shift from material sources to knowledge, from hardware to software, so that expansion and growth are based on knowledge. This new “production factor” has replaced energy to some extent and natural sources because it aims to replace routine work and finally physical capital (Pulic,1998).

The knowledge economy is the use of knowledge to create goods and services. Qualified and highly skilled human resources, or human capital, are the most valuable asset in a knowledge-based economy.

According to the resource-based view of the firm, the firm’s ownership of strategic tangible and intangible assets leads to achieving a sustainable advantage and increased profit (Riahi-Belkaoui, 2003). This topic is important for two reasons: 1) given the growing importance of the professional services industry and the many new and knowledge-based companies that have been launched recently (Bontis,1998) and 2) the characteristics of this topic, such as: multidisciplinary, a new source of knowledge that generates competitive advantages and valuation for companies and professionals, and potential for an abnormal rate of return for investors (Reina & Ensslin, 2011).

These are intellectual assets that companies do not trade it, and the value of its elements cannot be inferred from normal market transactions, such as the value of traditional tangible assets (Bontis, 1998). In a knowledge-based economy, the companies increase shareholders' value to the maximum from intellectual resources more than physical or financial resources(Chang & Hsieh, 2011).

There is a consensus that organizational capabilities are based on knowledge management because they are the source of organizational sustainability and competitive advantage(Chang & Hsieh, 2011). The United Nations estimates that knowledge economies now account for 7% of global GDP and grow at 10% annually. It is worth noting that 50% of productivity growth in the European Union is a direct result of the use and production of information and communications technology (Dahman, 2017).

In Saudi Arabia, The Council of Economic and Development Affairs has set 13 executive programs to achieve the 96 strategic goals of the Kingdom of Saudi Arabia's 2030 vision. One of these programs is The Human Capital Development program, which aims to improve the outputs of the education and training system in all its stages from early education to continuous education and training to reach global levels through education, qualification, and training programs that keep pace with the developments of the times and its requirements ("Human Capital Development Program Saudi Vision 2030," 2016).

2.2 Definitions of IC

According to The International Accounting Standards Board (IASB;1998) is defined an intangible asset as: "an identifiable non-monetary asset without physical substance". Such an asset is identifiable when it is separable, or when it arises from contractual or other legal rights. Examples of intangible assets include computer software, licenses, trademarks, and patents. Under Standard 1 issued by the IASB (1997), intangible assets are separately recognized on the balance sheet. To manage and measure a specific phenomenon, it must first be clearly defined. Additionally, IC is a conceptually clear research topic but represents significant diversity when it comes to developing an accurate definition (Dzenopoljac et al., 2017).

Given the intangible nature of knowledge, various concepts have been proposed in academia, and each attempt to captures a specific phenomenon. As a result, IC is an ideological process are not just an intangible asset. It is a type of movement from owning the knowledge and having the skills to using it (Chang & Hsieh, 2011). Bontis (1998) defined IC as "the pursuit of effective use of knowledge as opposed to information" (p.67). According to (Maditinos et al., 2011) IC can be defined as the gap observed between the market value and the book value. Additionally, Seetharaman et al. (2002) argued that IC is the difference between the firm's market value and the cost of replacing its assets.

Based on the definitions presented, we can define IC as the knowledge that is used to create value for the organization to obtain a competitive advantage.

The most frequently used classification of literature focuses on two or three elements (Dzenopoljac et al., 2017). Pulic (1998) identified two basic components for IC; human capital and structural capital. (Bontis ,1998; Chang &Hsieh, 2011; Ferreira & Martinez, 2011; Roos, Bainbridge, & Jacobsen, 2001) identified three basic components for IC; human capital (HC), structural (organizational) capital (SC), and customer (relational) capital (CC). The basic components are almost identical, with terminology differences between definitions (Inkinen, 2015). The HC "represents the knowledge acquired from individual employee's skills, experience, and expertise" (Ferreira & Martinez,2011, p.252). It includes competence and skills and the individual agility of employees (Roos et al., 2001).

Additionally, SC "represents all non- human stocks of codified knowledge in an organization" (Ferreira & Martinez,2011, p.252). It includes operations, systems, structures, brands, intellectual properties, and other intangible properties owned by the company that are not visible on its balance sheet (Roos et al., 2001). Finally, CC is "considered a market-based asset that is obtained through an affiliation with a brand" (Ferreira & Martinez,2011, p.252). It represents all valuable relationships with customers, suppliers, and other relevant stakeholders (Roos et al., 2001).

2.3 Some Methods and Models for the Measurement of IC

Academia has drawn attention to the role of knowledge in business development (Chang & Hsieh, 2011), and there is a large number of publications on this topic as well as a wide variety of methods (Osinski, Selig, Matos, & Roman, 2017). To effectively and efficiently manage IC, it is necessary to properly identify, understand, and measure its components, which poses a great challenge for academics and practitioners (Dzenopoljac et al., 2017). Many tools have been proposed in studies, but the reliability of the tool is still largely dependent on industry characteristics and the objectivity of the information (Chang & Hsieh, 2011).

These tools can be separated into two groups: The first group, determines each component of IC in monetary terms, such as the calculated intangible value (CIV), Tobin's Q, and VAIC, developed by Pulic (1998).

They determine the economic value of a firm's intangible assets and compares a firm's performance with its competitors(Bayraktaroglu et al., 2019).

The second group determines the IC without assigning a monetary value to it, such as Balanced Scorecard and Skandia Navigator (Bayraktaroglu et al., 2019; Dzenopoljac et al., 2017). They monitor what kind of IC elements a firm has, and what type of effects it has(Bayraktaroglu et al., 2019). The (VAIC) model, developed by Pulic (1998), is one of the most widely used monetary measures of IC efficiency because this model measures the value added (VA) by any business along with the individual contributions of each asset class of human capital (HC), structural capital (SC), and capital employed (CE) in value creation-unlike other valuation-based measurements that cannot measure the value of a company's IC assets (Bayraktaroglu et al., 2019; Maditinos et al., 2011; Nadeem et al., 2017).

VAIC has received attention from academics and in practice, because it provides a model for peer researchers to build upon (Chang & Hsieh, 2011). Its simplicity, data availability (Bayraktaroglu et al., 2019; Dzenopoljac et al., 2017; Maditinos et al., 2011; Nawaz & Haniffa, 2017), subjectivity, reliability, and comparability make it an ideal measure (Bayraktaroglu et al., 2019; Chang & Hsieh, 2011; Maditinos et al., 2011; Smriti & Das, 2018). It can be used by stakeholders to gain insight into the intangible assets of the firm (Smriti & Das, 2018).

3. The Relationship Between IC and FP: A Literature Review

When examining the main elements of the IC and their impact on FP, many studies indicate a strong and positive relationship, based on how each IC component is measured (Dzenopoljac et al., 2017). In the literature, there are various studies, which have been conducted in diverse industries (banking/finance, IT, high technology, service, manufacturing, etc.) and countries (India, Australia, Greece, Taiwan, etc.) to examine the relationship between IC and FP by using the VAIC model.

There are many indicators often used in the VAIC model to measure FP, including three financial performance indicators: return on assets (ROA), return on equity (ROE) for profitability and assets turnover (ATO) for productivity, and one market performance indicator—market to book ratio (MB) (Bayraktaroglu et al., 2019).

3.1 The Pros of a Positive Relationship between IC and FP

Riahi-Belkaoui (2003) investigated the relationship between IC and FP using 81 United States (US) multinational firms. The results revealed that intangible assets in general and IC in particular are a sustainable source for creating superior wealth. Chen et al. (2005) examined the relationship between IC and market value and the financial performance of Taiwanese firms listed on the Taiwan Stock Exchange (TSE) for the period from 1992 - 2002. The results indicate a positive relationship between IC and firms' market value and financial performance. Also, investors place a high value on firms with better IC efficiency.

(Zéghal & Maaloul, 2010) tested the impact of IC on the firm's economic, financial, and stock market performance of 300 United Kingdom (UK) companies for the year 2005. The findings show that the IC of companies has a positive impact on economic and financial performance and also indicates that capital employed was a major determinant of financial and stock market performance. (Chu, Chan, & Wu, 2011) investigated the relationship between companies' IC and their financial performance for all the constituent companies of the Hang Seng Index of the Hong Kong Stock Exchange for the years 2001 – 2009. The results indicate that the companies' IC was positively associated with their financial performance. Al-Qulaiti (2013) examined the relationship between the components of IC and FP for a sample of 50 firms listed on the Egypt Stock Exchange in three sectors, and the study covers the period from 2007-2011. The results indicate a positive relationship between the components of IC and FP.

Al-Musali and Ismail (2014) conducted a study on all of the commercial banks listed on the Saudi Stock Exchange (Tadawul) —11 commercial banks — for 2008 - 2010. They argued that the main resources of banks are intellectual and intangible and play the most important role in the value creation process, so it is important to explore the relationship between IC and bank performance. The results revealed that the IC performance of Saudi banks is low and HCE is positively associated with bank financial performance indicators (measured by ROA and ROE) and CEE is positively associated with bank financial performance indicators (ROE) while SCE has a nonsignificant association with financial performance indicators.

In his review of empirical IC research, Inkinen (2015) focused on analyzing 54 experimental research papers to determine whether IC systematically affects FP. First, the main results show that IC mainly impacts FP through combinations and interactions between the IC dimensions. Second, IC influences FP through mediation (a variable that explains the relationship between the independent variable and the dependent variable, which is FP). Third, there is evidence of a strong relationship between the IC dimensions and the firm's innovation performance.

Dzenopoljac et al. (2017) used a sample of 100 publicly traded Arab companies to assess the impact of IC components on the company's earnings, profitability, efficiency, and market performance for the period between 2011-2015. The results showed that earnings and profitability were significantly affected by structural and physical capital. Efficiency was determined primarily by physical capital. The performance of the market has been mainly affected by HC.

Nadeem et al. (2017) used a sample of all publicly listed firms on the Australian stock exchange for a period from 2005 - 2014. This study showed that IC efficiency is positively significant with FP, as measured by ROA and ROE.

Nawaz and Haniffa (2017) examined the effect of IC on the FP of 64 Islamic financial institutions in 18 different geographical regions and categorized the data into three main groups, namely, Asia, Europe, and the Middle-East for the period from (2007 to 2011). The results showed a significant positive relationship between VAIC and FP (measured by ROA) and a significant positive relationship between FP and CEE and HCE; however, there was no significant relationship with SCE.

Smriti and Das (2018) examined the relationship between IC and FP for a sample of 2,500 Indian companies in 15 industries for the period from (2001 to 2016). Their findings revealed that HC has a major impact on firm productivity (measured by ATO). Additionally, SCE and CEE have an important role in the firm's sales growth (SG) and market value (measured by Tobin's Q).

However, some studies added other elements to IC to expand and modify the VAIC methodology. Bayraktaroglu et al. (2019) examined the relationship between IC and FP for a sample of 400 manufacturing firms listed on the Istanbul Stock Exchange for the period from (2003 to 2013). They added customer capital (CC) efficiency and innovation capital to the VAIC model. The results reveal that innovation capital has a moderating role in SC's impact on firm profitability and that IC components have a moderating role on the relationship between CEE and profitability.

3.2 The Cons of a Positive Relationship between IC and FP

Chang and Hsieh (2011) added innovation capital to the VAIC model to investigate the efficiency of IC and its performance on all the publicly listed semiconductor companies on the Taiwan Stock Exchange— based on data from 367 companies for the period from (2000 to 2008). They concluded that a company's IC has a negative impact on its financial and market performance, but the association between innovation capital and companies' operating, financial, and market performance is significant.

3.3 The Neutral Effect of IC on FP

Firer and Williams (2003) tested the relationship between IC and FP for a sample of 75 publicly traded firms from South African and belonging to four sectors. The empirical results failed to find any relationship between the IC and the dependent variables (profitability, productivity, and market value). This means that South African firms mostly depend on their tangible resources despite efforts to increase the nation's IC base. Maditinos et al. (2011) examined the impact of IC on firms' market value and financial performance for a sample that consisted of 96 Greek companies belonging to four economic sectors for a period from 2006 to 2008. The empirical results failed to support any relationship between the value-added efficiency components and the dependent variables (profitability, growth, and market value) except for having a significant relationship between HCE and FP (measured by ROE).

According to the aforementioned literature, which was conducted to examine the relationship between IC and FP, there is some evidence of a relationship between IC components and FP but there are differences regarding the nature of this relationship (Bayraktaroglu et al., 2019). This difference may be for several reasons: 1) variation in economic and political conditions between countries; 2) some studies have been conducted during the years of the global financial crisis; and 3) the use of multiple indicators to measure FP.

4. Conceptual Model and Hypotheses Development

4.1 Conceptual Model

The conceptual model developed for this study is based on previews methodologies (Maditinos et al., 2011; Nawaz & Haniffa, 2017; Pulic,1998,2004) and investigates the relationship between IC and FP. The resource-based view of the strategy claims that performance differences arise because successful companies have valuable resources that others do not (Roos et al., 2001). The VAIC methodology defines IC as the total of human capital and structural capital. It includes three components; human capital efficiency (HCE), structural capital efficiency (SCE), and capital employed efficiency (CEE). In the previous section, we discussed a set of empirical research using the VAIC methodology and the results were mixed.

The design of the conceptual model of the relationship between IC and FP may be developed as follows:

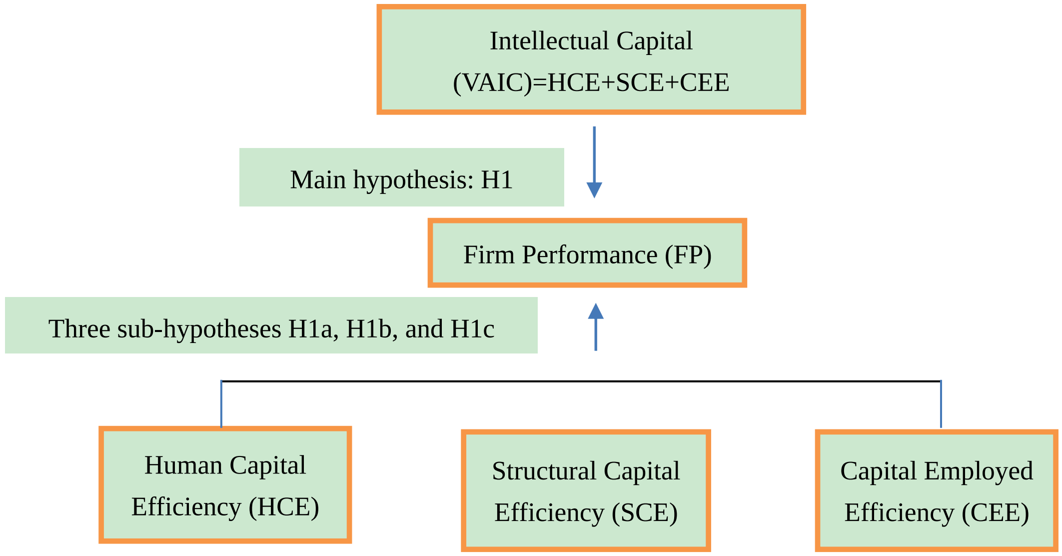

Figure 1. The conceptual model of the study

4.2 Hypotheses Development

The hypotheses developed in this study arise from the literature review related to our subject. The main hypothesis assumes that there is a positive relationship between overall intellectual capital efficiency and firm performance.

From this main hypothesis, three sub-hypotheses related to the impact of each component of Intellectual Capital are derived and would be tested.

H1a: There is a positive relationship between human capital efficiency and firm performance.

H1b: There is a positive relationship between structural capital efficiency and firm performance.

H1c: There is a positive relationship between capital employed efficiency and firm performance.

5. Research Methodology

5.1 Definition and Measurement of Variables

The variables used in our conceptual model can be classified into three categories: independent, dependent, and control variables.

5.1.1 Independent Variables

VAIC is the measurement of the independent variables in this study using the definition of Pulic (1998). It measures the value added (VA) by any business along with the individual contributions of each asset class of human capital (HC), structural capital (SC), and capital employed (CE) in value creation to assist management and other interested parties in effectively monitoring and evaluating the efficiency of VA. The present study includes four independent variables: HCE (human capital efficiency), SCE (structural capital efficiency), CEE (capital employed efficiency), and VAIC (the composite sum of the three separate indicators).

In the first phase, to compute efficiency levels, the value created by the company (VA) must be calculated. The VA is the difference between the output and input (Pulic,2004, p.64). Additionally, OUT is "total sales," and IN is the "cost of bought-in materials, components, and services" except the labor expenses are treated as a resource because of the important role of employees in the VA(Pulic,2004).

VA= OUT – IN

Value added can be calculated from the company accounts as follows:

VA = OP + HC + D + A

where: OP = operating; HC = employee costs; D = depreciation; and A = amortization (Pulic,2004).

In the second phase: we calculate (CE, HC, and SC) as they were defined by Pulic (2004).

CE is a book value of the net assets of the company = total assets – intangible assets

HC includes the total salaries and wages for the company = total investment of employees (salary, wages, etc.)

SC is the difference between VA and human capital =VA-HC

This means there is an inverse relationship between human capital and structural capital in creating value for the company. (Pulic,2004).

Finally, we compute VAIC and its three components (CEE, HCE, and SCE).

HCE is the ratio of VA to human capital (HC) =VA/HC

SCE is the ratio of Structural Capital (SC) to VA =SC/VA

CEE is the ratio of VA to Capital Employed (CE) =VA/CE

VAIC=CEE+ HCE +SCE

There are several main reasons for the use of the VAIC model in this study:1) simplicity and availability of data; 2) objectivity, and reliability because the data are usually audited by a professional accountants ; and 3) comparability— in addition to its use by interested parties to effectively monitor and gain insight into the intangible assets of the company (Al-Qulaiti,2013; Bayraktaroglu et al., 2019; Chang & Hsieh, 2011; Firer & Williams, 2003; Maditinos et al., 2011; Pulic 1998, 2004; Smriti & Das, 2018).

5.1.2 Dependent Variables

The present study includes two financial performance indicators and one market performance indicator as to the dependent variables.

The financial performance is measured using two indicators: Return on Assets (ROA) and Return on Equity (ROE). Return on assets is an indicator that measures the company's profitability relative to its total assets. Return on equity is an indicator that measures the company's efficiency in generating profits from each unit of shareholders' equity (Chen et al.,2005; Firer & Williams, 2003; Maditinos et al., 2011; Nawaz &Haniffa, 2017).

The market performance is measured using Tobin's Q which is the ratio of the market value of a company's assets to the replacement value of those assets. The market value of assets can be estimated as the sum of the market value of the company's equity and book values of its debt and the replacement value can be considered as equal to the book value of the total assets. It measures the wealth generated by a company for its shareholders (Bayraktaroglu et al., 2019; Smriti & Das, 2018).

5.1.3 Control Variables

This study includes two control variables (the firm's size and the firm's activity) because the sample consists of firms from different industry groups.

-The firm's size is measured by the natural log of the total assets (Al-Qulaiti, 2013; Goebel, 2015)

-The firm's activity consists of the nominal variable representing four industry groups within the service sector (Firer & Williams, 2003; Goebel,2015).

5.2 Econometric Models

Six multiple regressions would be used to test the developed hypotheses of the study.

5.2.1 Models Testing the Relationship Between the Overall Intellectual Capital Efficiency (VAIC) and FP.

Models,1,2 and 3 were attempts to examine the relationship between (VAIC) and FP measured by two financial performance indicators (ROA, ROE) and the market performance measured by Tobin's Q, respectively. They serve to test the main hypothesis which states that: "There is a positive relationship between overall intellectual capital efficiency and firm performance."

These models are stated as follows:

Model 1: $$ROAit = \beta 0 + \beta 1VAICit+\beta 2\ Sizeit+\beta 3\ Activityit + \epsilon it \quad (1)$$

Model 2: $$ROEit = \beta 0 + \beta 1VAICit+\beta 2\ Sizeit+\beta 3\ Activityit + \epsilon it \quad (2)$$

Model 3: $$Tobin's\ Qit =\beta 0 + \beta 1VAICit+\beta 2\ Sizeit+\beta 3\ Activityit + \epsilon it \quad (3)$$

where:

it: Firm i and year t, ϵit: residuals

5.2.2 Models Testing the Relationship between Components of the VAIC and FP.

The second set of models (4, 5, and 6) serve to test the three sub-hypotheses (*H1a, H1b,* and *H1c).* They serve to examine the relationship between the components of the VAIC (CEE, HCE, and SCE) and FP measured by both financial performance indicators (ROA and ROE), and the market performance indicator (Tobin's Q), respectively.

These models are stated as follows:

$$\text{Model 4: } ROAit = \beta 0 + \beta 1CEEit + \beta 2\ HCEit + \beta 3\ SCEit + \beta 4\ Sizeit + \beta 5Activityit + \epsilon it \quad (4)$$

$$\text{Model 5: } ROEit = \beta 0 + \beta 1CEEit + \beta 2\ HCEit + \beta 3\ SCEit + \beta 4\ Sizeit + \beta 5\ Activityit + \epsilon it \quad (5)$$

$$\text{Model 6: Tobin's } Qit = \beta 0 + \beta 1CEEit + \beta 2HCEit + \beta 3SCEit + \beta 4\ Sizeit + \beta 5\ Activityit + \epsilon it \quad (6)$$

where:

it: Firm i and year t , ϵit: residuals

5.3 Data Collection

To collect the data for testing the hypotheses, we used the convenience sampling method. The firms required for this study were selected from the Saudi Stock Exchange website (Tadawul), as this study was conducted for the Saudi context, and all of the relevant data and variables were available on this website for the period (2015-2018). The sample from the present study includes 25 Saudi firms listed on the Saudi Stock Market (Tadawul) and are from four industry groups: telecommunication services (four companies), diversified financials (four companies), banks (11 banks), health-care equipment and Svc (six companies). The selected data covered a period of four years, 2015 - 2018. The panel data was adopted in this study because we needed observations of multiple phenomena obtained over multiple periods for the same firms. After the exclusion of one observation with a negative VA score, 99 observations belonging to 25 firms operating in four industry groups had been used in the analysis. An observation with a negative VA has been excluded because of the inability of the VAIC model to deal with the negative VA values, because "This would then mean that the company is expending more input resources than its output. The negative sign is carried through in all subsequent indexes, which does not generate meaningful analysis." (Chu et al., 2011, p.252). All four industry groups are knowledge-based and important to the Saudi economy. (Bontis,1998) stated that intellectual assets are important in the professional services industry and the many new and knowledge-based companies.

6. Empirical Evidence of the Impact of IC on FP in the Saudi Context

This section presents the descriptive analysis and the correlation and multiple regression models to test the research hypotheses.

6.1 Descriptive Analysis

6.1.1 Descriptive Statistics

The descriptive statistics, namely, the frequency, mean, standard deviation, median, minimum, and maximum values of all variables are respectively shown in Table (1) and Table (2) (see Appendix A).

Table 1. Descriptive Analysis of Variable "ACTIVITY"

Activity	Frequency	Percentage	Cumulative
1	44	44%	44%
2	16	16%	60%
3	16	16%	76%
4	24	24%	100%
Total	100	100%	

Table 2. Descriptive Statistics of All Variables (String)

Variable	Obs.	Mean	Std. Dev.	Min	Max
VAIC	99	4.588 061	2.513 335	-1.029 383	15.086 88
HCE	99	3.8362 33	2.370 416	0.406 426 4	14.113 19
SCE	99	0.6445 219	0.271 655 4	-1.460 47	0.929 144 3
CEE	99	0.1073 059	0.106 920 5	0.002 231 1	0.422 222 9
ROA	99	0.029 808 2	0.045 205 2	-0.184 988 9	0.189 940 5
ROE	99	0.081 025 1	0.105 401 4	-0.390 739 1	0.276 050 7
Tobin'sQ	99	1.499 903	0.872 533 6	0.773 411	5.004 896
SIZE	99	23.788 1	2.272 388	18.405 16	26.840 02

According to the descriptive analysis results, all variables have positive mean values, which means that the four industry groups have positive performance and positive IC efficiency levels. Table (2) indicates that there is a notably high variance in the values of the standard deviation and minimum and maximum. Regarding the dependent variables, (Tobin's Q) has a high standard deviation of 0.872 533. Additionally, Tobin's Q reflects that the firm's market value is greater than its book value because it has a high mean value of 1.499 903.

As for the independent variables, compared to other efficiency values, (CEE) has a relatively low standard deviation of 0.1069 205. Additionally, it can be seen that the sample firms created more value from (HCE), which has a mean value of 3.836 233 versus SCE (0.644 521 9) and CEE (0.107 305 9).

This suggests that HCE remained the main value driver for firms during the study period, indicating the effective utilization of HC. Also, the sum of the mean values of HCE and SCE is 4.480 754 9, which is more than the mean value of CEE (0.107 305 9), indicating that the firms created more value from the intangible components of VAIC than from the physical and financial components.

It can be seen that the mean of 4.588 061 for VAIC, which indicates that the firm produced an average value of SR 4.588 061 for each one SR employed. It reflects that during the period 2015-2018, the sample was generally efficient in generating value from their IC.

This finding agrees with the prior researches (Al-Qulaiti, 2013; Bayraktaroglu et al., 2019; Chen et al., 2005; Nadeem et al., 2017; Nawaz & Haniffa, 2017; Smriti & Das, 2018; Zéghal & Maaloul, 2010) which indicates that intellectual resources plays an important role and are a significant contributor to creating wealth in the knowledge-based economy.

6.1.2Analysis of Variance:

First, a one-way analysis of variance (ANOVA) was conducted to check if there are significant differences between the means of VAIC in the four industry groups.

Table 3. Analysis of Variance of VAIC Between the Four Industry Groups

Source	SS	Df	MS	F	Prob > F
Between groups	98.501 370 8	3	32.833 790 3	5.99	0.000 9
Within groups	520.550 066	95	5.479 474 38		
Total	619.051 437	98	6.316 851 4		

Table (3) illustrates that there are significant differences between the means of VAIC in the four industry groups at a significant level of 5% (p= 0.000 9). This indicates that the ability of each industrial group to compete depends, to a large extent, on the creation of value through investment in IC.

Second, the one-way ANOVA was conducted on the four industry groups to check if there are significant differences between the means of each component of VAIC (HCE, SCE, and CEE). The results from this test are shown in Tables 4, 5, and 6.

Table 4. Analysis of Variance of HCE Between the Four Industry Groups

Source	SS	Df	MS	F	Prob > F
Between groups	113.610 073	3	37.870 024 2	8.23	0.000 1
Within groups	437.039 276	95	4.600 413 43		
Total	550.649 349	98	5.618 870 9		

Table 5. Analysis of Variance of CEE Between the Four Industry Groups

Source	SS	Df	MS	F	Prob > F
Between groups	.859 853 265	3	.286 617 755	104.53	0.000 0
Within groups	.260 481 743	95	.002 741 913		
Total	1.120 335 01	98	.011 431 99		

Table 6. Analysis of Variance of SCE Between the Four Industry Groups

Source	SS	Df	MS	F	Prob > F
Between groups	.380 244 249	3	.126 748 083	1.76	0.160 6
Within groups	6.851 830 47	95	.072 124 531		
Total	7.232 074 72	98	.073 796 681		

These results in Tables 4 and 5 suggest that there are significant differences between the means of HCE and CEE in the four industry groups at a significant level of (5%) (p= 0.000 1, p=0.000 0), respectively. This means that HC and CE are to play an important role in creating value in the four industry groups. The results in Table 6 suggest that no significant differences exist between the means of SCE in the four industry groups (see Appendix B).

6.2 Hypotheses Testing: Correlation and Regression Analysis

This research is based on the panel data, which contains observations of multiple phenomena obtained over multiple periods (2015 to 2018) for the same firms (25 companies from four industry groups) to empirically test the relation between IC and FP. There are some mandatory conditions to use multiple regressions based on the panel data.

6.2.1 Hausman Specification Test for a Fixed or Random Effect

Hausman specification tests are conducted for the panel data to check whether models that would be used to test the developed hypotheses were fixed-or random-effect models. When the probability of the test is less than 10%, then the fixed-effect model is most appropriate for the study. The unbiased estimator of this type of model is the “within” estimator.

Table 7. Fixed-Random Effect Test

Model	chi2(3)	Prob>chi2	Effect
1	8.83	0.012 1	Fixed
2	19.11	0.000 1	Fixed
3	32.25	0.000 0	Fixed
4	54.36	0.000 0	Fixed
5	50.64	0.000	Fixed
6	63.77	0.000 0	Fixed

The results of the Hausman specification tests for the six models (in Table 7) show that the fixed-effect model is most appropriate for the study because the probability of the test is less than 10% for all of the models (see Appendix C).

6.2.2 The Impact of Overall Intellectual Capital Efficiency (VAIC) on FP.

Tables 8, 9, and 10 show the results of the multiple linear regressions for models 1, 2, and 3 respectively, to examine the relationship between VAIC and FP as measured by ROA, ROE and Tobin’s Q at the sample level.

Table 8. Result of Multiple Regressions for Model 1 (ROA as a Dependent Variable)

Model 1	$ROA_{it} = \beta0 + \beta1VAIC_{it} + \beta2\ Size_{it} + \beta3\ Activity_{it} + \epsilon_{it}$		
R-squared	0.306 1	Number of obs.	99
ROA	Coef.	P>|z|	
VAIC	0.002 040 4	0.010	
Size	0.000 930 7	0.403	
Activity	0.206 56	0.000	
Constant	-0.233 004 8	0.000	

Table 9. Result of Multiple Regressions for Model 2 (ROE as a Dependent Variable)

Model 2	$ROE_{it} = \beta0 + \beta1VAIC_{it} + \beta2\ Size_{it} + \beta3\ Activity_{it} + \epsilon_{it}$		
R-squared	0.123 5	Number of obs.	99
ROE	Coef.	P>|z|	
VAIC	0.006 557 4	0.043	
Size	0.016 613 1	0.097	
Activity	0.444 493 8	0.000	
Constant	0.845 070 7	0.003	

Table10. Result of Multiple Regressions for Model 3 (Tobin's Q as a Dependent Variable)

Model 3	Tobin's $Q_{it} = \beta0 + \beta1VAIC_{it} + \beta2\ Size_{it} + \epsilon_{it}$		
R-squared	0 .342 9	Number of obs.	99
Tobin's Q	Coef.	P>|z|	
VAIC	0.038 482 2	0.146	
Size	2.187 555	0.000	
Constant	53.714 23	0.000	

As seen in Tables 8, 9, and 10 the R^2 is 0.306 1, 0.123 5, and 0.342 9 for the whole sample, indicating that the models 1, 2, and 3 can explain about 31%,12%, and 34% respectively, of the changes that occur in FP. Also, Tables 8 and 9 indicate that there is a positive and significant relationship between VAIC and the firm's financial performance as measured by ROA and ROE at a significant level (5%). This means that any increase in the value of VAIC leads to the improvement of the financial performance of the firms. Table 10 indicates that there is no relationship between VAIC and the firms' market performance as measured by Tobins'Q.

In regard to the control variables, Tables 8 and 9 show that there is a positive relationship between the firm's activity and the firms' financial performance as measured by ROA and ROE at a significant level (5%).Tables 9 and 10 indicate that there is a positive relationship between the firm's size and the FP measured by ROE and Tobins'Q at a significant level, 10% and 5% respectively (see Appendices D, E, and F).

There is a multicollinearity problem concerning the control variable (activity), thus it is automatically omitted from model 3.

6.2.3 The Impact of the Components of the VAIC (HCE, SCE, and CEE) on FP.

Tables 11, 12, and 13 show the results of the multiple linear regressions for models 4, 5, and 6 when examining the relationships between the components of the VAIC, namely HCE, SCE, and CEE, and the FP measured by ROA, ROE and Tobin's Q respectively.

Table 11. Result of Multiple Regressions for Model 4 (ROA as a Dependent Variable)

Model 4	$ROA_{it}= \beta_0 + \beta_1 CEE_{it}+\beta_2 HCE_{it}+ \beta_3 SCE_{it}+ \beta_4 Size_{it} + \beta_5 Activity_{it} + \epsilon_{it}$		
R-squared	0.400 5	Number of obs.	99
ROA	Coef.	P>|z|	
HCE	0.004 391 9	0.009	
SCE	0.024 556	0.064	
CEE	1.846 252	0.083	
Size	0.067 960 4	0.000	
Activity	1.208 621	0.132	
Constant	2.769 123	0.001	

Table 12. Result of Multiple Regression for Model 5 (ROE as a Dependent Variable)

Model 5	$ROE_{it}= \beta_0 + \beta_1 CEE_{it}+\beta_2 HCE_{it}+ \beta_3 SCE_{it}+ \beta_4 Size_{it}+ \beta_5 Activity_{it} + \epsilon_{it}$		
R-squared	0.279 7	Number of obs.	99
ROE	Coef.	P>|z|	
HCE	0.011 022 2	0.015	
SCE	0.037 666 4	0.291	
CEE	1.603 154	0.576	
Size	0.143 950 5	0.000	
Activity	0.527 268 2	0.807	
Constant	3.857 198	0.076	

Table 13. Result of Multiple Regression for Model 6 (**Tobin's Q** as a Dependent Variable)

Model 6	$Tobin's\ Q_{it}= \beta_0 + \beta_1 CEE_{it}+\beta_2 HCE_{it}+ \beta_3 SCE_{it}+ \beta_4 Size_{it} + \epsilon_{it}$		
R-squared	0.342 8	Number of obs.	99
Tobin's Q	Coef.	P>|z|	
HCE	0.074 014 2	0.018	
SCE	0.340 724 5	0.057	
CEE	0.689 188 1	0.543	
Size	2.133 184	0.000	
Constant	52.382 59	0.000	

The results indicate that the R^2 in a model 4, 5, and 6 is 0.400 5, 0.279 7, and 0.342 8 for the whole sample. This means that the models 4, 5, and 6 can explain about 40%, 28%, and 34% of the changes that occur in FP. The result in Table 11 demonstrates that there is a positive and significant relationship between HCE, SCE, and CEE and the financial performance of firms (ROA).

Moreover, the results depicted in Table 12 indicate there is a positive association between (HCE) only and the firms' performance measured by ROE; however, there is no relationship between SCE, CEE and ROE. According to the results in Table 13, there is a positive and significant relationship between (HCE, SCE) and the market performance of firms measured by (Tobin's Q). In regard to the control variables, Tables11, 12, and 13 show that there is a positive relationship between the firms' size and the firms' performance as measured by ROA, ROE, and Tobin's Q at a significant level (5%) (see Appendices G, H, and I).

There is a multicollinearity problem concerning the control variable (activity), and it is automatically omitted from model 6.

7. Discussion

The results of the models 1 and 2 indicate that VAIC is positively related to firms’ financial performance as measured by ROA and ROE, which means that IC is important for the firms’ competitive advantages and its significant role in value creation.

These findings are consistent with previous studies (Al-Qulaiti, 2013; Chen et al., 2005; Chu et al., 2011; Nadeem et al., 2017; Nawaz & Haniffa, 2017; Zéghal & Maaloul, 2010;). These studies confirmed that the efficiency and ability of intellectual resources to create added value positively affect the financial performance of firms. The results of model 3 failed to find an association between VAIC and firms’ market performance measured by (Tobin’s Q). This finding agrees with the previous studies (Chu et al., 2011; Maditinos et al., 2011). As a result, the main hypothesis H1 is partially confirmed.

Concerning the impact of each component of VAIC (HCE, SCE, and CEE) on a firm’s performance, the results of the model 4 show that there is a positive association when the firm’s performance is measured by ROA, which implies that IC and physical capital have a major impact in creating value for stockholders and other stakeholders. This result corroborates the previous studies conducted by Al-Qulaiti (2013) and Chu et al. (2011).

The findings of model 5 show that there is a positive association between HCE (only) and FP as measured by ROE. This is in line with the results of (Maditinos et al., 2011) who only found a statistically significant relationship is the one between HCE and (ROE). The explanatory power of models 4 and 5 was higher than that in models 1 and 2. This first implies that, the VAIC components may be a better predictor than the aggregate VAIC in predicting the firm’s financial performance (Chu et al. 2011) and, second, the stakeholders may have emphasized various components of IC differently (Firer & Williams, 2003; Chen et al.,2005; Chu et al., 2011). Additionally, the explanatory power of the ROA models was higher than the ROE models using VAIC and the three components as independent variables because ROA reflects the effectiveness of a firm in utilizing all sources of funding (both debts and shareholders’ equity) while ROE only includes shareholders’ equity (Chu et al., 2011).

The findings of the model 6 show that there is a positive relationship between HCE and SCE and the market performance of firms measured by (Tobin’s Q). This denotes that investors prefer firms that generate a higher return from intellectual resources. It seems that Saudi Arabian investors realize the importance of IC and focus on the human and structural capital of a firm when they estimate its real value. This result is in line with the study of (Bayraktaroglu et al., 2019) who observed a significant relationship between HCE and the market performance of firms. Smriti and Das (2018) also found that SCE had a positive impact on the market performance of firms.

From the aforementioned analysis, H1a is fully supported by the empirical data, while H1b and H1c are partially supported.

The results related to the control variables (in Tables 8, 9, and10) show that there is a positive relationship between the firm’s activity and the firms’ financial performance(ROA, ROE), in addition to there is a positive relationship between the firm’s size and the firms’ financial and market performance (ROE, Tobin’sQ).This indicates that the optimum utilization of available assets leads to lower costs and contributes to improving the firms’ financial and market performance (Al-Qulaiti, 2013).

Overall, it can be observed that HCE, among the components of VAIC, has a great impact on FP. This revealed that the managers of the selected firms in our study focus their attention on IC, especially HC in value generation, more than physical capital.

Our empirical findings contradict the results of Dzenopoljac et al. (2017) who found that profitability was greatly affected by structural and physical capital only, and market performance was negatively affected by HC. This difference may be attributed to several reasons: 1) the different countries and sectors that were included in the sample, which included manufacturing and service sectors; 2) the difference in the period because it covered the years that followed the global financial crisis; and 3) the difference in indicators used to measure FP.

8. Conclusion: Findings, Limitations, and Implications

This research aimed to investigate the association between the IC (on overall), each of its three components HCE, SCE, and CEE and FP (measured in terms of financial and market performance) for 25 Saudi listed firms in four industry groups for the period from 2015 to 2018. The study adopted the VAIC model as a proxy for IC and its components, which were used in previous studies (Bayraktaroglu et al., 2019; Chen et al.,2005; Chu et al., 2011; Dzenopoljac et al., 2017; Firer & Williams, 2003; Maditinos et al.,2011). The empirical findings denote that there is a positive association between VAIC and the firms’ financial performance. This suggests the importance of IC in creating value for stockholders and other stakeholders. Also, there is a significantly positive association between HCE, SCE, and CEE and the firms' financial performance. It is observed that IC components have a predicting power that, for the firms' financial performance, is higher than VAIC overall.

However, findings show that no association exists between VAIC and the firms' market performance while a positive association exists between HCE and SCE and the firms' market performance. This reflects the positive reaction of investors towards firms with a higher efficiency for using intangible resources.

Finally, our results show that HCE has a significantly positive association with a firm's financial and market performance, and it seems to be the most important contributors to economic success in Saudi Arabia.

The results of this research have many practical implications. First, managers can use the VAIC method to efficiently manage IC and compare it with competitors. Second, investors can use the VAIC method to help them make their investment decisions.

This research is subject to limitations and provides a path for future research. First, this study can be expanded to include a longer period of time if the data are available. Second, other control variables might be introduced because the results related to the effect of control variables on dependent variables mixed as well as not important in some cases.

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Appendices

Appendix A: Stata 15 Output of Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
vaic	99	4.588061	2.513335	-1.029383	15.08688
hce	99	3.836233	2.370416	.4064264	14.11319
sce	99	.6445219	.2716554	-1.46047	.9291443
cee	99	.1073059	.1069205	.0022311	.4222229
roa	99	.0298082	.0452052	-.0849889	.1889405
roe	99	.0810251	.1054014	-.3907391	.2760507
size	99	23.7881	2.272388	18.40516	26.84002

. sum tobinsQ

Variable	Obs	Mean	Std. Dev.	Min	Max
tobinsQ	99	1.499903	.8725336	.773411	5.004896

activity	Freq.	Percent	Cum.
1	44	44.00	44.00
2	16	16.00	60.00
3	16	16.00	76.00
4	24	24.00	100.00
Total	100	100.00	

Appendix B: Stata 15 Output of (ANOVA)

. oneway vaic actv

Analysis of Variance

Source	SS	df	MS	F	Prob > F
Between groups	98.5013708	3	32.8337903	5.99	0.0009
Within groups	520.550066	95	5.47947438		
Total	619.051437	98	6.3168514		

Bartlett's test for equal variances: chi2(3) = 87.2505 Prob>chi2 = 0.000

```
. oneway hce actv

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      113.610073      3   37.8700242      8.23     0.0001
 Within groups      437.039276     95   4.60041343
------------------------------------------------------------------------
    Total           550.649349     98    5.6188709

Bartlett's test for equal variances:  chi2(3) =  89.0915  Prob>chi2 = 0.000

. oneway sce actv

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      .380244249      3   .126748083      1.76     0.1606
 Within groups      6.85183047     95   .072124531
------------------------------------------------------------------------
    Total           7.23207472     98   .073796681

Bartlett's test for equal variances:  chi2(3) = 104.3032  Prob>chi2 = 0.000


. oneway cee actv

                        Analysis of Variance
    Source              SS         df      MS            F     Prob > F
------------------------------------------------------------------------
Between groups      .859853265      3   .286617755    104.53     0.0000
 Within groups      .260481743     95   .002741913
------------------------------------------------------------------------
    Total           1.12033501     98    .01143199

Bartlett's test for equal variances:  chi2(3) = 190.1961  Prob>chi2 = 0.000
```

Appendix C: Hausman Test Result for a Fixed-Random Effect

```
. xtreg roa vaic activity size, fe
note: activity omitted because of collinearity

Fixed-effects (within) regression               Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.2842                                         min =          3
     between = 0.0219                                         avg =        4.0
     overall = 0.0295                                         max =          4

                                                F(2,72)           =      14.29
corr(u_i, Xb)  = -0.9580                        Prob > F          =     0.0000

------------------------------------------------------------------------------
         roa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        vaic |   .0083751   .0016071     5.21   0.000     .0051713    .0115788
    activity |          0  (omitted)
        size |  -.0654593   .0166629    -3.93   0.000    -.0986762   -.0322424
       _cons |   1.548535   .3922691     3.95   0.000     .7665613    2.330509
-------------+----------------------------------------------------------------
     sigma_u |  .14999233
     sigma_e |  .01726595
         rho |  .98692246   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(24, 72) = 24.16                     Prob > F = 0.0000

. estimates store fixed


. xtreg roa vaic activity size, re

Random-effects GLS regression                   Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.0842                                         min =          3
     between = 0.3460                                         avg =        4.0
     overall = 0.2960                                         max =          4

                                                Wald chi2(3)      =      18.13
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0004

------------------------------------------------------------------------------
         roa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        vaic |    .003311   .0014146     2.34   0.019     .0005384    .0060835
    activity |   .0291796   .0105103     2.78   0.005     .0085797    .0497795
        size |    .008091   .0056728     1.43   0.154    -.0030275    .0192096
       _cons |  -.2425146   .1530436    -1.58   0.113    -.5424746    .0574454
-------------+----------------------------------------------------------------
     sigma_u |  .03143514
     sigma_e |  .01726595
         rho |  .76823645   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store random


. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
        vaic |    .0083751      .003311        .0050641        .0007627
        size |   -.0654593      .008091       -.0735503        .0156675
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        8.83
                Prob>chi2 =      0.0121
                (V_b-V_B is not positive definite)
```

```
. xtreg roe vaic activity size, fe
note: activity omitted because of collinearity

Fixed-effects (within) regression               Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.1538                                         min =          3
     between = 0.1375                                         avg =        4.0
     overall = 0.0988                                         max =          4

                                                F(2,72)           =       6.54
corr(u_i, Xb)  = -0.9541                        Prob > F          =     0.0025

------------------------------------------------------------------------------
         roe |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        vaic |   .0155245   .0043587     3.56   0.001     .0068356    .0242133
    activity |          0  (omitted)
        size |  -.1143835   .0451915    -2.53   0.014    -.2044711   -.0242959
       _cons |   2.730764   1.063873     2.57   0.012     .6099729    4.851556
-------------+----------------------------------------------------------------
     sigma_u |  .31546545
     sigma_e |  .04682698
         rho |  .97844126   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(24, 72) = 15.63                     Prob > F = 0.0000


. estimates store fixed

. xtreg roe vaic activity size, re

Random-effects GLS regression                   Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.0299                                         min =          3
     between = 0.2757                                         avg =        4.0
     overall = 0.1994                                         max =          4

                                                Wald chi2(3)      =       9.75
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0208

------------------------------------------------------------------------------
         roe |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        vaic |    .005489   .0036252     1.51   0.130    -.0016163    .0125942
    activity |   .0444924   .0267436     1.66   0.096    -.0079242    .0969089
        size |   .0320326   .0144388     2.22   0.027     .0037331    .0603321
       _cons |  -.8062091   .3895243    -2.07   0.038    -1.569663   -.0427556
-------------+----------------------------------------------------------------
     sigma_u |  .08437697
     sigma_e |  .04682698
         rho |  .76452861   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store random

. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
        vaic |    .0155245      .005489        .0100355        .0024199
        size |   -.1143835     .0320326       -.1464161        .0428228
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       19.11
                Prob>chi2 =      0.0001
```

```
. xtreg roa hce sce cee activity size, fe
note: activity omitted because of collinearity

Fixed-effects (within) regression               Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.5240                                         min =          3
     between = 0.0510                                         avg =        4.0
     overall = 0.0645                                         max =          4

                                                F(4,70)           =      19.27
corr(u_i, Xb)  = -0.9677                        Prob > F          =     0.0000

------------------------------------------------------------------------------
         roa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hce |    .005031   .0015813     3.18   0.002     .0018771    .0081848
         sce |   .0388752   .0091146     4.27   0.000     .0206967    .0570536
         cee |   .2481187   .0582724     4.26   0.000      .131898    .3643394
    activity |          0  (omitted)
        size |  -.0721107    .013995    -5.15   0.000    -.1000229   -.0441986
       _cons |   1.674205   .3288316     5.09   0.000     1.018371    2.330039
-------------+----------------------------------------------------------------
     sigma_u |  .17068108
     sigma_e |  .01427934
         rho |  .99304949   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(24, 70) = 22.75                     Prob > F = 0.0000

. estimates store fixed


. xtreg roa hce sce cee activity size, re

Random-effects GLS regression                   Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.3251                                         min =          3
     between = 0.4615                                         avg =        4.0
     overall = 0.4496                                         max =          4

                                                Wald chi2(5)      =      52.36
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0000

------------------------------------------------------------------------------
         roa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hce |   .0000707   .0015291     0.05   0.963    -.0029263    .0030677
         sce |   .0429071   .0104058     4.12   0.000     .0225122     .063302
         cee |   .1723631   .0532033     3.24   0.001     .0680866    .2766397
    activity |   .0146738    .010639     1.38   0.168    -.0061782    .0355258
        size |   .0030849   .0053498     0.58   0.564    -.0074006    .0135704
       _cons |  -.1229799   .1444552    -0.85   0.395     -.406107    .1601471
-------------+----------------------------------------------------------------
     sigma_u |  .02844525
     sigma_e |  .01427934
         rho |  .79872342   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store random


. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
         hce |     .005031     .0000707        .0049603         .000403
         sce |    .0388752     .0429071       -.0040319               .
         cee |    .2481187     .1723631        .0757555        .0237715
        size |   -.0721107     .0030849       -.0751956        .0129321
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       32.25
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

```
. xtreg roe hce sce cee activity size, fe
note: activity omitted because of collinearity

Fixed-effects (within) regression               Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.4524                                         min =          3
     between = 0.1159                                         avg =        4.0
     overall = 0.0730                                         max =          4

                                                F(4,70)           =      14.46
corr(u_i, Xb)  = -0.9728                        Prob > F          =     0.0000

------------------------------------------------------------------------------
         roe |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hce |    .011301   .0042306     2.67   0.009     .0028634    .0197387
         sce |   .0439133   .0243845     1.80   0.076      -.00472    .0925466
         cee |   .9059591   .1558976     5.81   0.000     .5950311    1.216887
    activity |          0  (omitted)
        size |  -.1457611   .0374412    -3.89   0.000    -.2204352    -.071087
       _cons |   3.379533    .879731     3.84   0.000     1.624965    5.134101
-------------+----------------------------------------------------------------
     sigma_u |  .42663406
     sigma_e |  .03820186
         rho |  .99204592   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(24, 70) = 22.68                     Prob > F = 0.0000

. estimates store fixed


. xtreg roe hce sce cee activity size, re

Random-effects GLS regression                   Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.2577                                         min =          3
     between = 0.1101                                         avg =        4.0
     overall = 0.1226                                         max =          4

                                                Wald chi2(5)      =      24.70
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =     0.0002

------------------------------------------------------------------------------
         roe |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hce |   .0010442   .0041991     0.25   0.804    -.0071859    .0092742
         sce |   .0610808   .0286117     2.13   0.033     .0050029    .1171588
         cee |   .4224047   .1456744     2.90   0.004     .1368882    .7079212
    activity |   .0093661   .0289514     0.32   0.746    -.0473776    .0661098
        size |   .0213474   .0145533     1.47   0.142    -.0071766    .0498713
       _cons |  -.5388498   .3929411    -1.37   0.170       -1.309    .2313007
-------------+----------------------------------------------------------------
     sigma_u |   .0750698
     sigma_e |  .03820186
         rho |  .79430422   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. estimates store random

. hausman fixed random

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
         hce |     .011301     .0010442        .0102568        .0005153
         sce |    .0439133     .0610808       -.0171676               .
         cee |    .9059591     .4224047        .4835544        .0555253
        size |   -.1457611     .0213474       -.1671085         .034497
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       54.36
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
```

```
Fixed-effects (within) regression               Number of obs      =         99
Group variable: n                               Number of groups   =         25

R-sq:                                           Obs per group:
     within  = 0.6207                                          min =          3
     between = 0.3845                                          avg =        4.0
     overall = 0.3429                                          max =          4

                                                F(2,72)            =      58.92
corr(u_i, Xb)  = -0.9891                        Prob > F           =     0.0000

------------------------------------------------------------------------------
    tobinsQ |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
       vaic |   .0384822    .026209     1.47   0.146    -.0907289    .0137644
       size |   2.187555     .27174     8.05   0.000    -2.729258   -1.645851
      _cons |   53.71423   6.397148     8.40   0.000     40.96175    66.46671
------------+-----------------------------------------------------------------
    sigma_u |  4.6133514
    sigma_e |  .28157418
        rho |  .9962886   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(24, 72) = 22.44                     Prob > F = 0.0000

. est sto fe

. xtreg tobinsQ vaic size,re

Random-effects GLS regression                   Number of obs      =         99
Group variable: n                               Number of groups   =         25

R-sq:                                           Obs per group:
     within  = 0.3806                                          min =          3
     between = 0.3247                                          avg =        4.0
     overall = 0.3301                                          max =          4

                                                Wald chi2(2)       =      47.70
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =     0.0000

------------------------------------------------------------------------------
    tobinsQ |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
       vaic |   .1235625   .0258945     4.77   0.000    -.1743148   -.0728101
       size |   .2901483   .0703103     4.13   0.000    -.4279539   -.1523426
      _cons |   8.954849   1.663023     5.38   0.000     5.695383    12.21431
------------+-----------------------------------------------------------------
    sigma_u |  .62983111
    sigma_e |  .28157418
        rho |  .83342687   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est sto re

. hausman fe re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |      fe           re          Difference          S.E.
-------------+----------------------------------------------------------------
        vaic |   -.0384822    -.1235625        .0850802        .0040477
        size |   -2.187555    -.2901483       -1.897406        .2624863
------------------------------------------------------------------------------
                          b = consistent under Ho and Ha; obtained from xtreg
           B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       50.64
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)

.
```

III6

```
. xtreg tobinsQ hce sce cee size,fe

Fixed-effects (within) regression               Number of obs      =        99
Group variable: n                               Number of groups   =        25

R-sq:                                           Obs per group:
     within  = 0.6448                                         min =          3
     between = 0.3823                                         avg =        4.0
     overall = 0.3428                                         max =          4

                                                F(4,70)            =     31.77
corr(u_i, Xb)  = -0.9881                        Prob > F           =    0.0000

------------------------------------------------------------------------------
     tobinsQ |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hce |   .0740142   .0306046     2.42   0.018     -.135053   -.0129753
         sce |   .3407245   .1764003     1.93   0.057    -.0110949    .6925439
         cee |   .6891881   1.127783     0.61   0.543    -2.938481    1.560105
        size |   2.133184   .2708542     7.88   0.000    -2.673386   -1.592982
       _cons |   52.38259   6.364085     8.23   0.000     39.68982    65.07535
-------------+----------------------------------------------------------------
     sigma_u |  4.4372089
     sigma_e |  .27635712
         rho |  .99613597   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(24, 70) = 21.46                     Prob > F = 0.0000

. est sto fe

. xtreg tobinsQ hce sce cee size,re

Random-effects GLS regression                   Number of obs      =        99
Group variable: n                               Number of groups   =        25

R-sq:                                           Obs per group:
     within  = 0.4288                                         min =          3
     between = 0.2942                                         avg =        4.0
     overall = 0.3113                                         max =          4

                                                Wald chi2(4)       =     54.25
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

------------------------------------------------------------------------------
     tobinsQ |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hce |    .161454   .0315454     5.12   0.000    -.2232818   -.0996261
         sce |   .3519665   .2178488     1.62   0.106    -.0750093    .7789422
         cee |   1.165782   1.061038     1.10   0.272    -3.245379    .9138147
        size |    .316917   .0709011     4.47   0.000    -.4558806   -.1779534
       _cons |    9.54298   1.700047     5.61   0.000     6.210949    12.87501
-------------+----------------------------------------------------------------
     sigma_u |  .60563961
     sigma_e |  .27635712
         rho |  .82766702   (fraction of variance due to u_i)
------------------------------------------------------------------------------

. est sto re

. hausman fe re

                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       fe           re         Difference          S.E.
-------------+----------------------------------------------------------------
         hce |   -.0740142    -.161454        .0874398               .
         sce |    .3407245    .3519665       -.011242                .
         cee |   -.6891881   -1.165782        .4765939         .3822214
        size |   -2.133184    -.316917       -1.816267         .2614097
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       63.77
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)

.
```

Appendix D: Stata 15 Outputs of Multiple Regressions for Model 1

```
Linear regression, correlated panels corrected standard errors (PCSEs)

Group variable:   n                           Number of obs     =         99
Time variable:    t                           Number of groups  =         25
Panels:           correlated (unbalanced)     Obs per group:
Autocorrelation:  no autocorrelation                        min =          3
Sigma computed by casewise selection                        avg =       3.96
                                                            max =          4
Estimated covariances      =       325        R-squared         =     0.3061
Estimated autocorrelations =         0        Wald chi2(3)      =     281.30
Estimated coefficients     =         4        Prob > chi2       =     0.0000

------------------------------------------------------------------------------
             |           Panel-corrected
         roa |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        vaic |   .0020404   .0007933     2.57   0.010     .0004856    .0035952
        size |   .0009307   .0011127     0.84   0.403    -.0012503    .0031116
    activity |     .20656   .0166129    12.43   0.000     .1739993    .2391208
       _cons |  -.2330048   .0286877    -8.12   0.000    -.2892317    -.176778
------------------------------------------------------------------------------
```

Appendix E: Stata 15 Outputs of Multiple Regressions for Model 2

```
. xtreg roe vaic size activity, re

Random-effects GLS regression                 Number of obs     =         99
Group variable: n                             Number of groups  =         25

R-sq:                                         Obs per group:
     within  = 0.2618                                       min =          3
     between = 0.0383                                       avg =        4.0
     overall = 0.0583                                       max =          4

                                              Wald chi2(3)      =      24.63
corr(u_i, X)   = 0 (assumed)                  Prob > chi2       =     0.0000

------------------------------------------------------------------------------
         roe |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        vaic |   .0065574   .0032375     2.03   0.043     .0002121    .0129028
        size |   .0166131   .0099961     1.66   0.097    -.002979     .0362051
    activity |   .4444938   .1083227     4.10   0.000     .2321852    .6568024
       _cons |  -.8450707   .2850244    -2.96   0.003    -1.403708   -.2864331
-------------+----------------------------------------------------------------
     sigma_u |  .09981396
     sigma_e |  .03863737
         rho |  .86968496   (fraction of variance due to u_i)
------------------------------------------------------------------------------

.
```

Appendix F: Stata 15 Outputs of Multiple Regressions for Model 3:

```
Fixed-effects (within) regression               Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.6207                                         min =          3
     between = 0.3845                                         avg =        4.0
     overall = 0.3429                                         max =          4

                                                F(2,72)           =      58.92
corr(u_i, Xb)  = -0.9891                        Prob > F          =     0.0000

------------------------------------------------------------------------------
     tobinsQ |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        vaic |   .0384822    .026209     1.47   0.146    -.0907289    .0137644
        size |   2.187555     .27174     8.05   0.000    -2.729258   -1.645851
       _cons |   53.71423   6.397148     8.40   0.000     40.96175    66.46671
-------------+----------------------------------------------------------------
     sigma_u |  4.6133514
     sigma_e |  .28157418
         rho |   .9962886   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(24, 72) = 22.44                     Prob > F = 0.0000
```

Appendix G: Stata 15 Outputs of Multiple Regressions for Model 4

```
. xtreg roa hce sce cee size activity, fe

Fixed-effects (within) regression               Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.5395                                         min =          3
     between = 0.0656                                         avg =        4.0
     overall = 0.0809                                         max =          4

                                                F(5,69)           =      16.17
corr(u_i, Xb)  = -0.9688                        Prob > F          =     0.0000

------------------------------------------------------------------------------
         roa |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hce |   .0043919   .0016216     2.71   0.009     .0011568    .0076269
         sce |    .024556   .0130253     1.89   0.064    -.0014288    .0505407
         cee |   1.846252   1.049324     1.76   0.083    -.2470916    3.939596
        size |  -.0679604   .0141287    -4.81   0.000    -.0961465   -.0397744
    activity |  -1.208621    .792371    -1.53   0.132    -2.789358    .3721154
       _cons |   2.769123   .7882862     3.51   0.001     1.196536    4.341711
-------------+----------------------------------------------------------------
     sigma_u |  .17265927
     sigma_e |  .01414593
         rho |  .99333228   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(24, 69) = 22.12                     Prob > F = 0.0000
```

Appendix H: Stata 15 Outputs of Multiple Regressions for Model 5

```
. xtreg roe hce sce cee size activity, fe

Fixed-effects (within) regression               Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.4529                                         min =          3
     between = 0.1158                                         avg =        4.0
     overall = 0.0728                                         max =          4

                                                F(5,69)           =      11.42
corr(u_i, Xb)  = -0.9730                        Prob > F          =     0.0000

------------------------------------------------------------------------------
         roe |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hce |   .0110222    .004409     2.50   0.015     .0022265    .0198179
         sce |   .0376664   .0354142     1.06   0.291     -.032983    .1083158
         cee |   1.603154    2.85298     0.56   0.576    -4.088385    7.294694
        size |  -.1439505   .0384142    -3.75   0.000    -.2205848   -.0673162
    activity |  -.5272682   2.154357    -0.24   0.807    -4.825094    3.770557
       _cons |   3.857198   2.143251     1.80   0.076    -.4184715    8.132867
-------------+----------------------------------------------------------------
     sigma_u |  .42844643
     sigma_e |    .038461
         rho |  .99200603   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(24, 69) = 19.21                     Prob > F = 0.0000
```

Appendix I: Stata 15 Outputs of Multiple Regressions for Model 6

```
. xtreg tobinsQ hce sce cee size,fe

Fixed-effects (within) regression               Number of obs     =         99
Group variable: n                               Number of groups  =         25

R-sq:                                           Obs per group:
     within  = 0.6448                                         min =          3
     between = 0.3823                                         avg =        4.0
     overall = 0.3428                                         max =          4

                                                F(4,70)           =      31.77
corr(u_i, Xb)  = -0.9881                        Prob > F          =     0.0000

------------------------------------------------------------------------------
     tobinsQ |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         hce |   .0740142   .0306046     2.42   0.018     -.135053   -.0129753
         sce |   .3407245   .1764003     1.93   0.057    -.0110949    .6925439
         cee |   .6891881   1.127783     0.61   0.543    -2.938481    1.560105
        size |   2.133184   .2708542     7.88   0.000    -2.673386   -1.592982
       _cons |   52.38259   6.364085     8.23   0.000     39.68982    65.07535
-------------+----------------------------------------------------------------
     sigma_u |  4.4372089
     sigma_e |  .27635712
         rho |  .99613597   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(24, 70) = 21.46                     Prob > F = 0.0000
```