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Analysis of Microsoft Client Business Using the Critical-Mass Management Concepts

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Abstract

Microsoft operating system, Windows™, and application software, Microsoft Office™, are the leading products of Microsoft. Microsoft is a major operating system player in the operating systems market. It holds nearly 90% of the market share. In this paper, we apply the management concepts referred as the critical-mass concepts (Choi et al., 2007) for Microsoft Windows™ client business to examine whether the Microsoft client-business has locked-in on its customer base and has acquired increasing financial returns, which prove the acquisition of the critical mass in the operating system market. The findings and conclusions of this study are based on data including Microsoft market shares, number of Microsoft Windows™-based personal computers, and the revenues from Microsoft's client business. We test the critical mass concepts through two components, namely lock-in effect and increasing returns. The study reveals that Microsoft client-business lost an opportunity to acquire the critical mass and it currently faces threats of losing its customer base to Linux and Apple's Mac operating systems.

Keywords
Microsoft management, operating systems, Microsoft versus Apple, critical mass management.

Introduction

Microsoft Corporation was founded by Bill Gates and Paul Allen in 1975. Microsoft client operating system trademarked as Windows™ and application software trademarked as Office™ are the leading products of Microsoft. The Windows™ operating-system product-line comes under Microsoft's "client business" division. Microsoft is a major operating system player in the operating systems market. It has captured nearly 90% of the worldwide market share. In this paper, we examine Microsoft's client business using the framework of the critical mass defined by Choi et al. (2007). We analyze if Microsoft has achieved the lock-in effect and

increasing returns, both of which are explained in the following paragraph. The study also verifies if the critical mass concepts could be applied to the operating systems sector.

In the business environment, the critical mass is the size of the business at which the business or its market has a fundamental change in its operations (Investor Worlds, 2009). The critical mass is the minimum level of an activity which makes the activity self-sustaining (Schelling, 1978). Increasing returns is an indicator of a company reaching towards the critical mass. The other indicator for the critical mass is that the customers lock-in with a company. Lock-in for either customers or vendors is defined as the situation where a customer is dependent on a vendor for products and services and (s)he is unable to use another vendor without a significant switching cost. Switching costs place a financial constraint on the customers who intends to switch brands or suppliers. Therefore, the industry with significant switching cost generally has customer loyalty. Customer lock-in adds significant value to a company's strategy (Joachim, 2004) and thus gaining the critical mass a momentous achievement for a company.

The Critical-Mass Concepts Details

The management concept of critical mass originates from nuclear physics where it is used to denote the minimum amount of nuclear material required for a self-sustaining nuclear fusion reaction to occur (Oliver et al. 1985). In the business domain, the critical mass is a specific phase beyond which an organization has increasing returns and is capable of sustaining its position in the market with little effort.

Choi et al. (2007) define the critical mass-based strategy as "frameworks for analyzing industry competition subject to increasing rather than diminishing returns. These frameworks are dynamic in nature, and believe in positive and negative feedback mechanisms especially in terms of social networks, which reinforce either existing competitive success or failure in industries". One of the important components mentioned in this definition is increasing return. This definition takes a different approach towards the critical mass compared to the conventional approach, since Choi et al. (2007) includes factors such as social networks and interactions between companies in an industry. Critical-mass business strategy is more applicable to knowledge, and information based industries, and in high technology industries such as pharmaceuticals, aerospace, and computers, as opposed to the conventional strategies, which are more applicable to traditional, manufacturing industries, especially in industries where the initial R&D spending is not high. The detailed comparison of conventional and the critical-mass strategies is provided in Appendix 1. Choi et al. (2007) believe that a firm's strategy must consider social communication and networking effect beyond technological factors of product development. There must be an integrated approach of marketing and technology strategies, which considers the effects of social networking of customers and the companies in an industry. The social network is a result of huge client base.

We applied the critical mass based business-framework defined by Choi et al. (2007) for the Microsoft's client business segment. Specifically, in this paper, we first examine if the critical mass concepts are applicable to operating market sector and then we examine whether Microsoft Windows ™ client business has customers locked-in and has increasing returns.

Microsoft Business-Analysis

Microsoft is considered as a major operating system player in the operating system market for personal computers (PCs). Steve Ballmer, the CEO of Microsoft believes that there are two major competitors for Microsoft, namely the open source software and the advertising-supported software (Wharton, 2007). According to Ballmer, the present threat to Microsoft is not from other companies, but from the business models followed by the two trends. These trends are represented by Linux, which is freely available open source and the software from Google™ that are monetized through advertisement (Wharton, 2007). However, our study reveals that in addition to open source Linux, Microsoft faces a strong competition and risk of being locked-out of a customer base by Apple.

Brief History of Operating System Market

In 1976, Digital Research Incorporated (DRI) sold a popular operating system, known as CP/M, to be used on the machines based on Intel's 8-bit 8080 processor. In 1980, Microsoft paid $100,000 for the rights to a CP/M derivative or clone software referred as "Disk Operating System" (DOS). After minor modifications to DOS, Microsoft referred to this updated operating system as MS-DOS. In 1981, IBM entered into the PC market and it chose Intel's new 16-bit 8088 chip as the CPU. IBM also decided to endorse Microsoft's MS-DOS as the operating system for their PCs. IBM's partnership with Microsoft did not last for long. In the meantime, IBM and DRI continued developing their own operating systems. Under the terms of the dissolution, IBM continued to develop MS-DOS, and consequently its own variant, PC-DOS, which IBM loaded on PCs bearing the IBM nameplate. In exchange, IBM paid royalty to Microsoft for a predetermined number of units (Baseman, et al., 1995). Later, Microsoft's Windows™ turned out to be a major player in the operating system product category, which captured majority of the market. One of the major competitors for Microsoft, right from Microsoft's inception, is Apple Inc. Apple developed Macintosh Operating System, which is referred as Mac OS or Mac for short by the industry. Due to its cost, compatibility and organization leadership issues, Apple was not successful in capturing the market share initially. However, in the recent days with its flexible operating system products, Mac is posing as a major threat to Microsoft operating system products' market share. We analyze the competition in section 4.

Challenges for Microsoft

The feature referred as *Spaces* in Mac OS™ provides flexibility of switching between Mac OS™ and Windows™, that is, flexibility in terms of platform-independent hardware or software. In

addition to this flexibility, the software development kit for iPhone™ and other innovative features offered with Mac OS™ has made customers prefer Mac OS™ to Windows™ (Morgenthaler, 2008). The customer would like to buy a product, which would be compatible with the existing hardware or software. This feature will help the company to create customer value and results in shift over of customer base from its competitors. The acceptance level of Mac OS™ is growing; meanwhile the acceptance level of Windows™ is on the downward trends, since Mac OS™ provides effective and efficient solution in place of many hard-to-use features in Windows™ (Morgenthaler, 2008). Microsoft is not focusing on its core business; it needs to focus on making secure, reliable and user-friendly operating system products and also has to redefine its strategy for developing operating system products and the business model (McCracken, 2008). The critical study conducted by Baseman, et al. (1995) evaluated the Microsoft operating system product pricing strategies. The study identified pricing strategies of Microsoft that aimed at maintaining monopoly in the market. The decreasing market share of Microsoft could be because of its lack of technological edge in today's technology-driven industry (Hahn and Passell, 2008). Hahn and Passell, (2008) also found that the present cloud in IT prefers Google™ to Microsoft. Microsoft has also been under scrutiny by customers for its security of its products. Jaikumar (2008) stresses that there is a need to change the perception of customers about the security feature of Microsoft operating system products. Secured application has become the major concern for customers of MS operating system product (Jaikumar, 2008).

The literature review showed that Microsoft operating system product line is on the verge of decline and its business model and product features need to be aligned with the present technology-driven business environment. Customer momentum has started to prefer non-Windows™ operating system. Microsoft has a reason to be concerned about slowly losing its customer base.

Microsoft Business-Data

Microsoft is one of the major players in operating system product category. In 2006, Microsoft announced major revamp of its business units. The business units were re-organized as the following.

- Client (Windows™ desktop operating system)
- Server and Tools (server products and services)
- Online Business Services (the Microsoft Network, also known as MSN)
- Microsoft Business Division (Microsoft Office™ and Microsoft Dynamics)
- Entertainment and Devices Division (Xbox, Zune)

For the fiscal year 2008 Microsoft had global annual revenue of $60.42 billion and nearly 90,000 employees in 105 countries. Overall, the revenue grew by 18% for the fiscal year 2008. However, the minimum growth was in the client segment. Table 1 indicates the revenue growth for all of Microsoft's business units.

Table 1: Microsoft Revenue Growth in 2008[1]

Business	**Revenue Growth(FY'08)**
Client	13%
Server and Tools	18%
Online Business Services	32%
Microsoft Business Division	15%
Entertainment and Devices Division	34%

Table 2 captures Microsoft's operating system market-share trend against the two major competitors for the period of 2005 to 2008.

Table 2: Operating System Market Share in Percent of Total Industry Share[2]

	Month	**Windows™**	**Mac™**	**Linux**
2005	January – June	96.15%	3.45%	0.3%
	July – December	95.75	3.83	0.31
2006	January - June	95.18	4.35	0.36
	July – December	94.57	4.94	0.41
2007	January - June	93.21	6.24	0.41
	July – December	92.59	6.58	0.52
2008	January - June	91.39	7.61	0.67
	July – December	90.12	8.43	0.84

[1] **Source:** Microsoft Annual Report 2008
[2] **Source:** http://marketshare.hitslink.com/report.aspx

Microsoft has lost 6% of the market share between January 2005 (96.15%) and December 2008 (90.12%) while Apple's Mac, one of the major competitors for Microsoft, gained 5% of the market during the same period.

Findings and Discussion

In the conventional market-concepts, successful products or firms eventually run into limitations in their success within the market, eventually creating stability in the market when returns start to diminish. However, the critical mass concepts (Choi et al., 2007), emphasize on increasing returns. That is, the concepts state that the successful products or firms that are ahead tend to gain further competitive advantage whereas unsuccessful products or firms suffer further losses and competitive disadvantage. Using the critical mass concepts (Choi et al., 2007) we analyze Microsoft client business. In the following subsections, first, we verify if the critical mass concepts can apply to the operating system sector of the industry, followed by the findings of our study.

The operating system products are following the critical mass concepts.

Per Choi et al. (2007), the products or firm that has higher increase in market share gain further competitive advantage. Unsuccessful products or firms suffer further losses and lose competitive disadvantage.

The market share trend for the operating systems, as shown in Table 2, indicates that increasing returns are dynamic and self-reinforcing for Mac OS™. These three companies dominate the operating system market share. This is a zero-sum game where a loss for a company is the gain for another player since the total of operating systems market share of these three major players is close to 100%. Table 2 illustrates that the percent change from year-to-year has positive effect on Mac OS™ and Linux and these products are gaining momentum. However, Microsoft's Windows™ operating system has negative growth, which suffers increasing losses and is losing its competitive advantage. The critical mass concept of increasing returns with positive or negative reinforce feedback loop is apparent from this data.

When/Why Microsoft client business failed to possess lock-In.

In this section, we analyze revenue from Microsoft's client business and number of Microsoft's Windows™-based PC to examine the missed opportunity for the Microsoft operating systems business unit to have lock-in on customers in the recent years.

A steady or increasing client base is one of the important factors that could help an organization reach critical mass. Lock-in effect is an important stage in the critical mass concept. Although Microsoft client business reached a significant mass in the client business, Microsoft failed to posses lock-in on the present business environment. We used revenue from Microsoft's

client business and number of Windows™ PCs to measure the customer lock-in. Table 3 depicts the variation in revenues generated through the client business segment. The data illustrates that Microsoft's client-business segment did not achieve lock-in since the numbers show decline among its variation, specifically, in 2002.

Table 3: Microsoft Revenue from Client Business[3]

Year	Revenue	% Increase
1998	$6,280	
1999	$8,500	26.12
2000	$9,380	9.38
2002	$9,360	-0.21
2003	$10,394	9.95
2004	$11,546	9.98
2005	$12,042	4.12
2006	$13,089	8.00
2007	$14,972	12.58
2008	$16,870	11.25

The Table 4 indicates the number of PCs sold worldwide with Windows™ operating system installed on them. The Table implies that at nascent stage of operating system market (years 1998-2000), there was exponential growth in terms of value and units of Microsoft Windows™ operating system. The enormous IT downtrend between 2001 and August 2006 was a cause of concern for Microsoft. If Microsoft had customer lock-in, it would have resisted the enormous downtrend to some extent despite the IT downturn and the bursting of the IT bubble. To further verify if the revenue loss for the year 2002 could be treated as an outlier, let us compare the Microsoft business with its competitors such as Apple's Mac™ and open source

Linux. As show in Table 2, during years 2005 to 2008, Microsoft's competitors gained the percent of operating system market share. Flexibility of features offered by the competitor Apple as discussed in the previous section and scalability to hardware platforms offered by Linux (Kotlan, 2008) could be the reasons for Microsoft's loss to its competitors and the lost opportunity to gain the lock-in effect.

Table 4: Windows/MS-DOS-Based PC Sales[4]

Year	Worldwide Units (in Millions)	Percent Growth	Worldwide Value (in billions)	Percent Growth
1981-1985	5.7		$16.9	
1986-1990	60.3	957.89%	181	971.01%
1991-1995	172	185.24	447	146.96
1996-2000	444	158.14	1,010	125.95
2001-8/2006	855	92.57	1,440	42.57

Table 4 illustrates that the growth of Windows™-based PCs is on a downward trend in terms of both number of units and the value. The decrease in the growth had a multiplier effect, since the competitors could leverage the market growth. For example, Apple's iMacs (both G4 and G5) released in 2002 and 2004 respectively did create awareness of Apple Computers (Datta, 2005). 70% of iMacs were purchased by previous Mackintosh users. 12% of Windows users bought iMacs (Datta, 2005). 18% of new computer users purchased iMacs (Datta, 2005).

The market-share data, revenue from Microsoft's client business, and number of Windows™-based PC illustrated that Microsoft operating system failed to possess a lock-in despite its significant business till 2000. One of the significant factors of the lock-in concept is the switching cost. Recently Apple released Mac Mini™, a low priced Macintosh computer at a cost of $499. It has the hardware compatibility with other brands. This compatibility has resulted in low switching cost for customers. When a company achieves lock-in effect, other companies are locked-out. Although the process of lockout takes many years and is complicated, Microsoft faces a risk of being locked-out by rival companies. In the following section, we analyze how other companies could take advantage of Microsoft's missed opportunity.

Other companies have technological/quality advantage since Microsoft did not reach the critical mass.

In the conventional market concepts, investments in quality and technology are highly correlated with market success. The higher-quality products are frequently guaranteed to lead to competitive advantage. However, in the critical mass concepts (Choi et al., 2007), higher quality and technology alone do not guarantee market success, if other firms have already reached, the critical mass and locked-in on a customer base. Since Microsoft failed to lock-in on its customer base, other companies such as Apple and Linux may have an opportunity to leverage their technical advantage especially when Apple and Linux have gained the market momentum as shown in Table 2.

The literature review and the recent (2009 first quarter) first-ever massive lay off plan indicate that Microsoft is losing its competitive advantage. Although Microsoft has enormous market share, the corporation is slowly losing its market share to its competitors. With the development of platform-independent applications, Microsoft's competitors can take over the market share from Microsoft. As mentioned in the above section, nearly 12% of the customers who purchased Windows™ previously purchased iMacs (Datta, 2005) and with the recent development of Mac-Mini, Microsoft faces additional challenges since Mac-Mini is designed with multiplatform hardware compatibility. Microsoft is vulnerable to its competitors' success and in turn, their success could hurt Microsoft's revenues (Klein, 2001).

Microsoft's client-business failure to lock-in customers comes at a time when there are instances of product failure like Vista operating system. The products such as Apple Mac OS™ or Linux are gaining market share since the companies are releasing high quality, flexible operating system. To make the situation worse for Microsoft, Windows Vista, the latest version of Microsoft operating system was significantly outperformed by Mac OS™ (Welch, 2007). As conceptualized in the critical mass concepts, the products with high quality and better technology are gaining the market share although Microsoft's client business has major market share.

Summary

Microsoft has been one of the dominant players in the operating system market since its conception. However, in the recent years, this dominance is declining. Using the management strategy based on the critical mass concepts (Choi et al., 2007), which states that the successful products or firms that are ahead tend to gain further competitive advantage whereas unsuccessful products or firms suffer further losses and competitive disadvantage, we examined Microsoft's client business. Specifically, we examined whether Microsoft client business has locked-in on its customer base and analyzed the increasing returns phenomenon that is part of the critical mass concepts. We presented the data showing Microsoft's decline in the operating market dominance and Microsoft's lost opportunity to acquire critical mass. In a conventional market concept,

successful products or firms eventually run into limitations in their success within the market, eventually creating stability in the market when returns start to diminish. However, the critical mass concepts emphasize on increasing returns. Our study revealed that Microsoft's client business does not have the customer lock-in. On the contrary, Microsoft faces a significant risk of losing its operating system customer-base to the companies such as Apple, which has recently launched products of higher quality and technology, and to the open source software Linux.

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Appendix 1: Comparison of Conventional and The critical mass Concepts (Source: Choi et al., 2007)

Conventional management strategy	Critical mass management
• Diminishing returns, successful products or firms eventually run into limitations in their success within the market, eventually creating a stability in the market	• Increasing returns, successful products or firms that are ahe tend to gain further competitive advantage; unsuccess products or firms suffer further losses and competit disadvanta
• Predictable equilibrium, with market shares being relatively evenly distributed among several firms; profits may then become a key element of competitive strategy	• Unpredictability and instability, with market shares and total market being potentially dominated by one or cert coalition of firms; client base and market share strategy n become cruc
• More applicable to traditional, manufacturing industries, especially in industries where the initial R&D spending is not high relative to variable, unit costs, making it easier to optimize firm strategy	• More applicable to knowledge, information based industri and in high technology industries such as pharmaceutica aerospace, computers, where the initial R&D spending is v high relative to variable, unit co
• Firm strategy is static, with independent strategies for different situations and changes; industry and market conditions are analyzed with history playing only a minor role in future firm strategy	• Firm strategy is dynamic, and path dependent, with posit and negative feedback mechanisms; this reinforces past fi strategies as a driver of successful future strate
• Investments in quality and technology will be highly correlated with market success; higher quality products will often be guaranteed to lead to competitive advantage	• Higher quality and technology alone do not guarantee mar success, if other firms have already reached, "critical ma and locked-in the market, i.e. VHS vs Betamax; Microsoft Ap
• Consumer demand in markets is relatively separated from supplier strategies in industries, with industry conditions being the main driver of a firm's competitive strategy	• Demand in markets and strategies in industries beco closely linked as "critical mass" is developed by technolo standards as well as social network effects in consur dema

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Oil Price, Energy Use, and Tunisian Economic Growth: A Multivariate Cointegration Analysis with Multiple Structural Changes

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Abstract

The objective of this study is to examine the effect of energy use and oil price shock on output growth in Tunisia. This paper examines the major determinants of GDP growth in Tunisia using quarterly time series data spanning from 1960 to 2005. The Tunisian economy has been subject to a multitude of structural changes and regime shifts during the sample period. Thus, the VAR model is first analyzed. Taking into account the resulting endogenously determined structural breaks in multivariate case; the cointegration approach is then employed to determine the long-run drivers of economic growth. This cointegration technique accommodates predetermined potential structural breaks that could undermine the existence long-run relationship between GDP growth, energy use and oil price. Empirical estimates present different cointegrating directions and different causal relationship in each regime. Hence, our results reject the neoclassical assumption that energy is neutral to growth. Finally, we conclude that energy use and oil price, are a limiting factors to output growth in Tunisia.

Key words
Cointegration, structural changes, oil price, energy use, economic growth,
J.E.L classification: C32, C39, E30, Q43.

Introduction

A development in the global economy posing a great challenge to policy makers across countries is the increasing spate of fluctuations in oil prices. The oil price oscillating between $17 and $26 at different times in 2002, $53 per barrel in October 2004, hovered around $136 per barrel in June 2008. In fact, the price of oil has witnessed profound fluctuations since 1974. Persistent oil shocks could have severe macroeconomic implications, thus inducing challenges for policy making - fiscal or monetary in both the oil exporting and oil importing countries over the past three decades (Kim and Loughani, 1992; Tatom, 1988; Mork, 1994; Hooker, 1996; Caruth,

Hooker and Oswald, 1996; Daniel, 1997; Hamilton, 1996; and Cashin et al 2000). Some of these studies suggest rising oil prices reduced output and increased inflation in the 1970s and early 1980s and falling oil prices boosted output and lowered inflation particularly, in the U.S in the mid-to late 1980s.

The transmission mechanisms through which oil prices have impact on economic growth include both supply and demand channels. The supply side effects are related to the fact that crude oil is a basic input to production, and consequently an increase in oil price leads to a rise in production costs that induces firms to lower output. Oil prices changes also entail demand-side effects on consumption and investment. Consumption is affected indirectly through its positive relation with disposable income. Oil price rises reduces the consumers spending power. Investment may also be affected if the oil price shock encourages producers to substitute less energy intensive capital for more energy-intensive capital. The magnitude of this effect is in turn stronger the more the shock is perceived to be long-lasting. For this reason, the theoretical literature has been of a general equilibrium nature, with different authors assigning different weights to the supply and demand channels.

Thus, the ongoing debate among energy economists about the relationship between energy use and output growth led to the emergence of two opposite views. One point of view suggests that energy is the prime source of value because other factors of production such as labor and capital cannot do without energy. According to this argument, energy use is expected to be a limiting factor to economic growth or its proxies such as employment. The other point of view suggests that energy is neutral to growth. This is what became to be known in the literature as the neutrality hypothesis". The main reason for the neutral impact of energy on growth is that the cost of energy is very small as a proportion of GDP and, thus, it is not likely to have a significant impact on output growth. It has been also argued that the possible impact of energy use on growth will depend on the structure of the economy and the stage of economic growth of the country concerned. As the economy grows its production structure is likely to shift towards services, which are not energy intensive activities. (Solow (1978), Brendt (1980), Denison (1985) and Cheng (1995)).

Most of the empirical studies carried out have focused on the oil importing economies, particularly the developed economies. Few studies exist yet on the effect of oil price shock on key macroeconomic variables for an oil exporting country**.** Also**,** other empirical literature on the subject investigated the relationship between energy use and output growth by testing for the existence and direction of causality between the two variables in either a bivariate or a multivariate context. However, this literature produced conflicting results and, there is no consensus judgment neither on the existence nor on the direction of causality between energy use and output growth.

The objective of this paper is double. Firstly, to go out of the predefined framework (executive) of the cointegration theory: the rank of cointegration space cannot overtake (n-1), to study the cases where the number of the cointegration vectors can overtake n-1. That is, study of cointegration theory in a cointegrated system when a structural break occurs and affects the long run parameters. Secondly, to go out of the predefined framework of study of the causal relationship between energy use, oil price and output growth, to study the long run relationships between variables under investigation in the multiple structural changes cases.

In that case, we study the relationships between oil prices, energy use, and economic growth. Then, we can view, if energy use and oil price are a limiting factors or neutral to Tunisian economic growth, we analyze the effects of oil price and energy use on economic growth in Tunisia. In order to apprehend these relationships, various papers have considered the usual cointegration framework Jones and Leiby (1996) and Brown and Yücel (2002)). These studies generally put forward an inverse relationship between variables[5] (Hamilton (1983), Burbidge and Harrison (1984), Gisser and Goodwin (1986)). However, by themid-1980s, the estimate linear relationship between oil prices and GDP began to lose significance: the declines in oil prices occurred over the second half of the 1980s where found to have smaller positive effects on economic activity than predicted by usual linear models. At the same time, evidence of asymmetries in the link between the two variables has been established in some papers (see Mork (1989), Mory (1993), Olsen and Mysen (1994), Ferderer (1996), Brown and Yücel (2002)).

[5] Oil price energy use and output growth

The empirical findings from the analysis of the relationship between energy use and output growth show that output, capital, labor, and energy share two common stochastic trends. In particular, output and energy are found to be moving together towards a stable long-run equilibrium relationship that is consistent with causality running in both directions (see Yu and Jin (1992) Stern (1993,2000) Masish and Masih (1996) and Yang (2000)).

The paper is organized as follows. Section 2 presents the review of the literature that how oil use may have an impact on economic growth and whether oil price shocks affect economic activities. Section 3 briefly presents the econometric framework, we explains first structural breaks estimation beased on Zhongjun Qu and Pierre Perron (2007) (ZP) approach, second cointegration analysis in the presence of pre-determined structural breaks using the Saikkonen and Lutkephol (2002) and Johansen and al(2001) cointegration test, and the Quintos (1995) and Johansen (1993) VECM estimation approach.. Section 4 is devoted to an empirical analysis of the link between oil prices, oil use and economic growth in the long run in Tunisia. Section 5 concludes the paper.

Review of Literature

Oil prices may have an impact on economic activity through various transmission channels. First, there is the classic supply-side effect according to which rising oil prices are indicative of the reduced availability of a basic input to production, leading to a reduction of potential output (Barro (1984), Brown and Yücel (1999), Abel and Bernanke (2001)). Consequently, there is a rise in cost production, and the growth of output and productivity are slowed. Second, an increase of oil prices deteriorates terms of trade for oil importing countries (Dohner (1981)). Thus, there is a wealth transfer from oil-importing countries to oil-exporting ones, leading to a fall of the purchasing power of firms and households in oil-importing countries. Third, according to the real balance effect (Pierce and Enzler (1974) and Mork (1994)), an increase in oil prices would lead to increase money demand. Due to the failure of monetary authorities to meet growing money demand with increased supply, there is a rise of interest rates and a retard in economic growth (for a detailed discussion on the impact of monetary policy, see Brown and Yücel (2002)). Fourth, a rise in oil prices generates inflation. The latter can be accompanied by indirect effects, called second round effects, given rise to price-wages loops. Five, an oil price increase may have

a negative effect on consumption, investment and stock prices. Consumption is affected through its positive relation with disposable income, and investment by increasing firms' costs. Six, if the oil price increase is long-lasting, it can give rise to a change in the production structure and have an impact on unemployment. Indeed, a rise in oil prices diminishes the rentability of sectors that are oil-intensive and can incite firms to adopt and construct new production methods that are less intensive in oil inputs. This change generates capital and labor reallocations across sectors that can affect unemployment in the long run (Loungani (1986)). For all these reasons, oil prices can affect economic activity.

From an empirical viewpoint, studies generally consider a linear cointégration framework to analyze the link between oil prices and GDP (Brown and Yücel (2002) for a recent survey). However, as was previously mentioned, economic activity tends to react asymmetrically to oil price shocks: an increase in oil prices seems to retard aggregate economic activity by more than a fall in oil prices stimulates it. In order to apprehend this fact, it seems necessary to go further than the usual cointegration concept which is rather restrictive. Let us now describe a general framework – asymmetric cointegration – devoted to account for these asymmetries.

Recent empirical studies have used cointegration and Granger-causality analysis to investigate the relationship between oil price and output growth. Mignon and Lardic(2005) used co-integration analysis to test the long-run relationship between oil price and economic activity in USA, Europe and Euro area. They found that no standards co-integrating relationship exists between these variables.

Joutz and al (2006) examined the long run relationship between oil prices, fiscal policy, and economic growth in Venezuela. They employed a multivariate VAR, they found two long-run relations relating: 1) the government budget constraint between government revenues and government consumption and 2) oil, prices, economic growth, and investment in a neoclassical framework. Also they found there are oil price volatility effects and asymmetry effects in the short-run, but not the long-run. There is an indirect relationship between the government budget constraint and economic growth through investment. The later is positively related to improvements in the country's fiscal position. Olomola and Adejumo (2006) examine the effect

of oil price shock on output, inflation, the real exchange rate and the money supply in Nigeria using quarterly data from 1970 to 2003. The VAR method was employed to analyze the data. The findings were contrary to previous empirical findings in other countries; oil price shock does not affect output and inflation in Nigeria. However, oil price shocks do significantly influence the real exchange rates. The implication is that a high real oil price may give rise to wealth effect that appreciates the real exchange rate.

In the other hand, recently, most of the empirical literature on the subject investigated the relationship between energy use and output growth by testing for the existence and direction of causality between the two variables in either a bivariate or a multivariate context. However, this literature produced conflicting results and, there is no consensus judgment neither on the existence nor on the direction of causality between energy use and output growth. Stern (2000) extends his analysis on the US economy by introducing cointegration analysis of the relationship between energy and GDP. He found again that using total energy use does not seem to be Granger causing GDP. However, using quality weighting index of energy is found to be Granger causing GDP. His cointegration results show that energy can not be excluded from the cointegration space. In 3 of the 5 models estimated he found unidirectional causality between energy use and GDP where causality runs from energy use to GDP. In the other two models he found a bi-directional causal relationship between energy use and GDP. Stern results suggest that energy is considered to be a significant explanatory factor that explains GDP in USA. Cheng (1995) used bivariate analysis and found no causality between energy use and GNP in USA in either direction. Using multivariate analysis he also found no causal relationship between energy use and GNP.

Ghali and El_Sakka (2004), test for the existence and direction of causality between output growth and energy use in Canada. Using the Johansen cointegration technique, the empirical findings indicate that the long-run movements of output, labor, capital and energy use in Canada are related by two cointegrating vectors. Then using a VEC specification, the short-run dynamics of the variables indicate that Granger-causality is running in both directions between output growth and energy use. Hence, an important policy implication of the analysis is that energy can be considered as a limiting factor to output growth in Canada.

Methodology

The model formulation

To investigate the relationship between oil price, energy use and economic growth, we propose a framework based on the conventional neo-classical one-sector aggregate production technology where we treat capital, labor, energy use, and oil price as separate inputs.

That is:

$Y_t = f(K_t, L_t, EU_t, OP_t)$ (1)

Where Y is a real GDP; K is the capital stock; L is the level of employment; EU is the total energy use, OP is World oil price, and where the subscript t denotes the time period.

We follow the endogenous growth theory and consider instead, human capital (the number of employed workforce) rather than the total labor force in our empirical models. The following modified model in logarithm form is used to examine the long run relationship between nexus in developing economy like Tunisia:

$$Ln(Y_t) = \beta_0 + \beta_1 Ln(K_t) + \beta_2 Ln(L_t) + \beta_3 Ln(EU_t) + \beta_4 Ln(OP_t) + \varepsilon_t$$

We use in our following empirical study a VAR model :

$$Y_t = A_1 Y_{t-1} + \dots + A_p Y_{t-p} + U_t, \quad t = 1, \dots, T$$

Where Y is a vector of the variables under investigation: real GDP(y), capital stock (K); level of employment (L) ; total energy use (EU), world oil price (OP) et U is the Gaussian error vector.

The data are collected from the WDI CD-ROM, and the International Financial Statistics (IFS).

We start our empirical analysis by unit root test and break dates estimation based on the Zhongjun Qu and Pierre Perron (2007) approach, which take into account the existence of potential multiple structural breaks in multivariate regressions. Then we discus the results of cointegration analysis in the presence of pre-determined structural breaks. First we test for cointégration using Saikkonen and Lütkepohl (2000a) and Johansen and al (2001) procedures. Second we estimate the VEC model using the Quintos (1995) and Johansen (1993) approach

Structural Break dates determination

ZP provide a comprehensive treatment of issues related to estimation, inference and computation with multiple structural changes occurring at unknown dates in linear multivariate regression models that include VAR,

ZP consider testing for structural changes. Their setup is quite general in that they shall consider tests that allow for changes in the coefficients of the conditional mean or in the variance of the error term or both. Also, they allow only a subset of coefficients to change across regimes, hence partial structural break and block partial structural break models are permitted. They first consider using a likelihood ratio test for the null hypothesis of no change in any of the coefficients versus an alternative hypothesis with a pre-specified number of changes, say m.

Test of l versus l+1 breaks

It is often the case that we do not know the number of changes in the system, and a statistical procedure to determine it is needed. For this purpose, information criteria such as those proposed by Liu, Wu and Zidek (1997) and Bai (2000) are possible. But as argued by Perron (1997), these perform rather poorly, especially in models involving lagged dependent variables. Hence, it is useful to have a complementary test-based procedure. Following Bai and Perron (1998), ZP consider a sequential testing procedure based on the estimates of the break dates obtained from a global maximization of the likelihood function.

Consider a model with *l* breaks, with estimated break dates denoted by $(\hat{T}_1, \ldots, \hat{T}_l)$, which are obtained by a global maximization of the likelihood function. The procedure to test the null hypothesis of *l* breaks versus the alternative hypothesis of $l + 1$ breaks is to perform a one break

test for each of the (l + 1) segments defined by the partition $(\hat{T}_1, ..., \hat{T}_l)$ and to assess whether the maximum of the tests is significant. More precisely, the test is defined by

$$supSEQ_T = \left(l + \frac{1}{1}\right) = \max_{1 \le j \le l+1} \sup_{\tau \in \Lambda_{j,\varepsilon}} [lr_T(\hat{T}_1], ... \hat{T}_{j-1}, \tau, \hat{T}_j, ..., \hat{T}_l) - lr_T(\hat{T}_1, ..., \hat{T}_l)$$

Where

$$\Lambda_{j,\varepsilon} = \{\tau : \hat{T}_{j-1} + (\hat{T}_j - \hat{T}_{j-1})\varepsilon \le \tau \le \hat{T}_j - (\hat{T}_j - \hat{T}_{j-1})\varepsilon\}$$

Note that this is different from a purely sequential procedure since for each value of l the estimates of the break dates are re-estimated to get those that correspond to the global maximizers of the likelihood function.

Double maximum tests

As in Bai and Perron (1998), Zhongjun Qu and Pierre Perron (2007) also consider a test of the null hypothesis of no break versus the alternative hypothesis of some unknown number of breaks between (1) and some upper bound M. These are called double maximum tests since they are based on the maximum of the (possibly weighted) individual tests for the null of no break versus m breaks (m = 1, ..., M). These are particularly useful to determine whether some structural change is present since a sequential testing procedure can be unreliable for particular forms of multiple changes (Bai and Perron, 2004). More precisely, the test and its limiting distribution are given by

$$Dmax\ LR_T(M) = \max_{1 \le m \le M} a_m \sup LR_T(m, p_b, n_{b0}, \varepsilon)$$

$$\Rightarrow \max_{1\le m\le M} a_m \sup_{(\lambda_2,\ldots,\lambda_m)\in\Lambda_\varepsilon} \sum_{j=1}^{m} LR_j(\lambda, p_b, n_b^*)$$

With $LR_j(\lambda, p_b, n_b^*)$ as defined in Theorem 5 (Zhongjun Qu and Pierre Perron (2005)) they consider an equally weighted version defined by $a_m = 1$, denoted UD max LR_T (M), and a second version that applies weights to the individuals tests such that the marginal p-values are equal across values of m, denoted W D max LR_T (M). More precisely, $a_1 = 1$ and for $m > 1$, $\boldsymbol{a_m = c(\alpha, 1)/c(\alpha, m)}$ where $c(\alpha, m)$ is the asymptotic critical value of the test $\boldsymbol{sup\ LR_T\ (m, p_b, n_{bd}, n_{bo}, \varepsilon)}$ at significance level α.

In practice, ZP suggest to use the following procedure to determine the number of structural breaks. First, use either UD max LR_T (M) or W D max LR_T (M) to test whether at least one break is present. If the test rejects, then apply the test SEQT ($l + 1|l$) sequentially, for l = 1, 2,..., until the test fails to reject the null hypothesis of no additional structural break.

Cointegration Analysis with Structural breaks

Cointegration test with structural breaks

As had been noted as far back as 1989 by Perron, ignoring the issue of potential structural breaks can render invalid the statistical results not only of unit root tests but of cointegration tests as well. Kunitomo (1996) explains that in the presence of a structural change, traditional cointegration tests, which do not allow for this, may produce "spurious cointegration". In the present research, therefore, considering the effects of potential structural breaks is very important, especially because the World economy has been faced with structural breaks like revolution and war in addition to some policy changes.

Saikkonen and Lütkepohl (2000a, b, c) and Johansen and al (2001) have proposed a test for cointegration analysis that allows for possible shifts in the mean of the data-generating process. Because many standard types of data generating processes exhibit breaks caused by exogenous events that have occurred during the observation period, they suggest that it is necessary to take into account the level shift in the series for proper inference regarding the cointegrating rank of the system.

SL and Johansen argued that "structural breaks can distort standard inference procedures substantially and, hence, it is necessary to make appropriate adjustment if structural shifts are known to have occurred or are suspected" (2000b: 451). The Saikkonen and Lütkepohl (SL) test investigates the consequences of structural breaks in a system context based on the multiple equation frameworks of Johansen-Jeslius, while earlier approaches like Gregory-Hansen (1996) considered structural break in a single equation framework and others did not consider the potential for structural breaks at all.

According to Saikkonen and Lütkepohl (2000b) and Lütkepohl and Wolters (2003), an observed n-dimensional time series $y_t = (y_{1t},\ldots,y_{nt})$, y_t is the vector of observed variables (t=1,…, T) which are generated by the following process:

$$y_t = \mu_0 + \mu_1 t + \gamma_1 d_{1t} + \gamma_2 d_{2t} + \gamma_3 d_{3t} + \delta Dt_{0t} + \delta_1 Du_{1t} + x_t$$

Where DT_{0t} and DU_{1t} are impulse and shift dummies, respectively, and account for the existence of structural breaks. DT_{0t} is equal to one, when $t=T_0$, and equal to zero otherwise. Step (shift) dummy (DU_{1t}) is equal to one when ($t>T_1$), and is equal to zero otherwise. The parameters

$\gamma(i = 1,2,'), \mu_0, \quad \mu_1 1$, and δ are associated with the deterministic terms. The seasonal dummy variables d_{1t} ,d_{2t} and d_{3t} are not relevant to this research since our data are yearly. According to SL (2000b), the term *xt* is an unobservable error process that is assumed to have a VAR (p) representation as follows:

$$x_t = A_1 x_{t-1} + \cdots + A_p x_{t-p} + \varepsilon_t \quad t = 1,2$$

By subtracting xt-1 from both sides of the above equation and rearranging the terms, the usual error correction form of the above equation is given by:

$$\Delta x_t = \Pi x_{t-1} + \sum_{j=1}^{p-1} \Gamma_j \Delta x_{t-j} + u_t$$

This equation specifies the cointegration properties of the system. In this equation, *ut* is a vector white noise process; $x_t = y_t - D_t$ and D_t are the estimated deterministic trends. The rank of Π is the cointegrating rank of x_t and hence of y_t (SL, 2000b). The possible options in the SL procedure, as in Johansen, are three: a constant, a linear trend term, or a linear trend orthogonal to the cointegration relations. In this methodology, **t**he critical values depend on the kind of the above-mentioned deterministic trend that included in the model. More interestingly, in SL, the critical values remain valid even if dummy variables are included in the model, while in the Johansen test; the critical values are available only if there is no shift dummy variable in the model. The SL approach can be adopted with any number of (linearly independent) dummies in the model. It is also possible to exclude the trend term from the model; that is, μ=0 maybe assumed *a priori*. In this methodology, as in Johansen's, the model selection criteria (SBC, AIC, and HQ) are available for making the decision on the VAR order. In the following section, we have applied SL tests for the cointegration rank of a system in the presence of structural breaks.

Estimation of the cointegration relationships

The Johansen's procedure apply the likelihood maximum (LM) on VAR model assuming that errors is *iid*.

$$Y_t = A_1 Y_{t-1} + ... + A_k Y_{t-k} + U_t, \qquad t = 1,..., T$$

Where Y_t is an n-vector of I(1) variables.

We can rewrite Y_t as follow :

$$\Delta Y_t = B_1 Y_{t-1} + B_2 \Delta Y_{t-1} + \ldots + B_k \Delta Y_{t-k+1} + U_t$$

Where $B_1 = -I + \sum_{i=1}^{k} A_i$ and $B_j = -\sum_{i=j}^{k} A_i$ with j= 2,…, k.

The variables $\Delta Y_t, \ldots, \Delta Y_{t-k+1}$ are all I(0) but Y_{t-1} is I(1), in order that this equation be consistent, β_1 should not be a full rank. Let its rank r and let write

$$B_1 = \alpha\beta'$$

Where α is an n×r matrix and β' is an r×n. Then, ▯ EMBED Equation.3 ▯▯▯ are the cointegrated variables, β' is the matrix of coefficients of the cointegrating vectors and α has²the interpretation of the matrix of error correction terms.

Since our interest α and β' we eliminate ▯ EMBED Equation.3 ▯▯▯ first. To do this we proceed at follow. Regress ▯ EMBED Equation.3 ▯▯▯ on ▯ EMBED Equation.3 ▯▯▯ . Get the residuals. Call them ▯ EMBED Equation.3 ▯▯▯ ▯ EMBED Equation.3 ▯▯▯ . regress on these same variables. Get the residuals. Call them ▯ EMBED Equation.3 ▯▯▯ . Now, our regression equation is reduced to

$$R_{0t} = \alpha\beta' R_{1t} + u_t$$

This is a multivariate regression problem. Define

$$\begin{bmatrix} S_{00} & S_{01} \\ S_{10} & S_{11} \end{bmatrix}$$

As the matrix of sums of squares and sums of products of ▯ EMBED Equation.3 ▯▯▯ and ▯ EMBED Equation.3 ▯▯▯ . Johansen (1991) shows that the asymptotic variance of

 EMBED Equation.3 is EMBED Equation.3 the asymptotic variance of EMBED Equation.3 is EMBED Equation.3 and the asymptotic covariance matrix of EMBED Equation.3 and EMBED Equation.3 is EMBED Equation.3 where EMBED Equation.3 are the population counterparts of $S_{00}, S_{01} etS_{11}$

We shall maximize the likelihood function with respect to α holding β constant and then maximize with respect to β in the second step. We get

$$\hat{\alpha}' = (\beta' S_{11} \beta)^{-1} \beta' S_{10}$$

Note that $\hat{\alpha}'$ is an r*n matrix and the conditional maximum of the likelihood function is given by :

$$[L(\beta)]^{-2/T} = \left|S_{00} - S_{01}\beta(\beta' S_{11}\beta)^{-1}\beta' S_{10}\right|$$

Maximization of the likelihood function with respect to β implies minimization of the determinant with respect to β. We will minimize

$$\frac{\left|\beta' S_{11}\beta - \beta' S_{10} S_{00}^{-1} S_{01}\beta\right| . \left|S_{00}\right|}{\left|\beta' S_{11}\beta\right|}$$

But

$$\min_{X} \frac{\left|X'(A_1 - A_2)X\right|}{\left|X' A_1 X\right|}$$

is given by the maximum characteristic root of the equation $|A_1 - \lambda A_2| = 0$. Thus, substituting $A_1 = S_{11}$ and $A_2 = S_{10} S_{00}^{-1} S_{01}$ we get the maximum of the likelihood function by solving the eigenvalue problem

$$\left|S_{10} S_{00}^{-1} S_{01} - \lambda I\right| = 0$$

Or finding the eigenvalue of $\left|S_{11}^{-1}S_{10}S_{00}^{-1}S_{01} - \lambda I\right| = 0$ (1)

But the roots of this equation are the r canonical correlations between R_{1t} and R_{0t}. If the eigenvalues of A are λ_i, the eigenvalues of $(I - A)$ are $(1-\lambda_i)$. Hence if λ_i are the canonical correlations given by solving equation (1), then $(1-\lambda_i)$ are the eigenvaluees of $\left(I - S_{11}^{-1}S_{10}S_{00}^{-1}S_{01}\right)$.

The value of the determinant of the matrix is equal to the product of its eigenvalues, we have

$$\prod_{i=1}^{n}(1-\lambda_i) = \left|I - S_{11}^{-1}S_{10}S_{00}^{-1}S_{01}\right| = \frac{\left|S_{11} - S_{10}S_{00}^{-1}\right|}{\left|S_{11}\right|}$$

Hence

$$L_{\max}^{-2/T} = \left|S_{00}\right|.\prod_{i=1}^{n}(1-\lambda_i)$$

Johansen propose two statistics to determine the cointegration rank

$$\lambda_{trace} = -T\sum_{i=r+1}^{n}\ln(1-\hat{\lambda}_i)$$

$$\lambda_{\max} = -T\ln(1-\hat{\lambda}_{r+1})$$

In structural changes cases we follow the approach of Johansen (1993) and Quintos (1995).

The two procedures start from the equation:

$$R_{0t} = \alpha\beta' R_{1t} + u_t$$

We can rewrite this equation as follow:

$$R_{0t} = \Pi R_{1t} + u_t$$

Quintos separates the sample into different periods assuming the break dates known. For instance, let there be one break date and let Π and ($\Pi_1 1, \Pi_1 2$) be the parameters for the whole sample and the split samples. The hypothesis is

$$H_0 = Rang(\Pi_1) = Rang(\Pi_2) = Rang(\Pi)$$

Empirically, we estimate the model in the two regimes and show the cointegration rank in each regime.

Empirical Results

Data and Variables Definitions

Data used in the analysis are quarterly time series on real GDP, capital, labor, energy use and oil price, and that for Tunisia during the period 1960- 2005. The variables' notations and definitions are as follows.

Variable	*Definition*
Y	Real Gross Domestic Product(GDP)
K	Capital stock
L	Total employment
EU	Total Energie Use
OP	World Oil Price

All variables are transformed into their natural logarithm so that their first differences approximate their growth rates.

We investigate the stationarity status of the variables using the augmented Dickey-Fuller (ADF), the Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests for unit roots. In each case the lag-length is chosen using the Akaike Information Criteria (AIC) and Schwarz Criteria (SC) after testing for first and higher order serial correlation in the residuals.

Table 1: Test Results for Unit Roots

Variables	***Y***	***K***	***L***	***EU***	***OP***	***ΔY***	***ΔK***	***ΔL***	***ΔEU***	***ΔOP***
ADF[6]	-1.799	-1.839	-1.596	-0.592	-2.024	-3.705	-3.112	-4.835	-3.442	-12.39
PP[7]	-2.301	-2.592	-2.556	0.141	-2.068	-12.49	-10.48	-23.09	-16.91	-12.33
KPSS[8]	1.591	1.539	1.674	1.660	0.657	0.373	0.453	0.222	0.169	0.055

Table 1 reports the results of testing for unit roots in the level variables as well as in their first difference. In the first half of the table the hypothesis that each variable has a unit root cannot be rejected by three tests. However, after applying the first difference, all tests reject the hypothesis of unit root presence. Since the data appear to be stationary in first differences, no further tests

[6] Critical values for 1%, 5% et 10% are respectively -3,471, -2 ,879 et -2,576

[7] Critical values for 1%, 5% et 10% are respectively -3,468, -2,868 et -2,575

[8] Critical values for 1%, 5% et 10% are respectively 0,739, 0,463 et 0,347

are performed. We, therefore, maintain the hypothesis that each variable is integrated of order one.

Break dates estimation

We use the Zhongjun Qu and Pierre Perron (2007) approach to determine the possible multiple structural breaks in the multivariate cases (VAR model).

Table2: LR test results

Breaks	SupLR	Critical value (10%)	Critical value (5%)
0 versus 1	90.438	13.711	15.662
0 versus 2	108.654	22.588	25.090

Table3: WDmax test results

	Statistic value	Critical value (10%)	Critical value (5%)	Critical value (2,5%)
WDmax (2breaks)	90.438	14.845	16.879	18.772
Seq(L+1/L) : (2/1)	150.164	15.858	17.823	19.409

Table4: Break dates estimation

Break date	Confidence intervals (CI)
The date of the first break is 57^{th} observation (quarter1 of 1974)	CI= [56.000 58.000] à 95% CI= [56.000 58.000] à 90%
The date of the second break is 93^{th} observation (quarter1 of	CI= [92.000 94.000] à 95%

1983)	CI=[92.000 94.000] à 90%

Based on the results reported in Tables 2, 3 and 4, the primary findings of the analysis are as follows. The results of the Zhongjun Qu and Pierre Perron (2007) models indicate that the timing of any structural break (TB) for the multivariate model using the (ZP) approach is also shown in Table 4. The computed break dates correspond closely with the expected dates associated with the effects of the oil boom in 1974, and the effects of dept crises in developing countries in 1983.

Results of Cointegration tests

As explained above, Johansen (2000b) derived the likelihood ratio (LR) test in order to determine the number of cointegrating relations in a system of variables, by allowing for the presence of potential structural breaks. We now apply a maximum likelihood approach for testing and determining the long-run relationship in the model under investigation. As mentioned earlier, in this procedure Johansen assumed that the break point is known a priori. In the last section, we determined the time of the break endogenously by Zhongjun Qu and Pierre Perron (2007) procedure. The empirical result based on this method showed two significant structural breaks in model under investigation, witch are consistent with time of oil shock ,and dept crises in the most of developed countries. Therefore, at this stage we include two dummy variables of regime change in order to take into account the two structural breaks in the system. Following the Johansen procedure we consider three cases: impulse dummy and shift with intercept included; impulse dummy and shift with trend and intercept included; and finally, impulse dummy and shift with a trend statistically independent (orthogonal) to cointegration relation included. The cointegration results in these three cases are presented in tables 5.

The optimal number of lags is determined by AIC and SC, which is more appropriate for the short span of the data. The hypothesis of the long-run relationship among non-stationary variables is tested and the result is reported in table 5. These tables indicates that the hypothesis of no cointegration r=0 is rejected at the10%, 5% and 1% significance level. The existence of one cointegration vectors is not rejected in any of the three cases mentioned above.

Table 5 :Saikkonen and Lutkephol and Johansen and al cointegration test results

Intercept included (C)	Intercept and trend included (C/T)	Trend orthogonal to cointegration relation (C/O)
r0 LR pval 90% 95% 99%	r0 LR pval 90% 95% 99%	r0 LR pval 90% 95% 99%
0 430.57 0.0000 94.41 98.29 105.85	0 488.06 0.0000 107.88 112.90 122.72	0 364.10 0.0000 65.73 69.61 77.29
1 57.71 0.0670 68.53 71.92 78.56	1 72.69 0.0731 79.33 83.69 92.30	1 32.57 0.1857 44.45 47.71 54.23
2 42.20 0.2242 46.56 49.46 55.22	2 51.60 0.1667 54.68 58.38 65.75	2 23.96 0.2087 27.16 29.80 35.21
3 23.16 0.3383 28.42 30.85 35.74	3 24.40 0.5076 33.81 36.81 42.88	3 7.91 0.4821 13.42 15.41 19.62
4 9.76 0.3551 14.12 16.16 20.47	4 10.08 0.5034 16.39 18.53 23.02	

Quintos(1995) and Johansen (1993) estimation approaches results

Empirical results of the First regime (Q1 1960-Q1 1974)

From the β vector we can see that all coefficients of the variables under investigation in the cointegrating vector are significant. But, from α vector we can see that the capital and oil price coefficients in the loading factors vector are insignificant. Then, testing the exclusion of capital

and oil price from the cointegrating relationship yields respectively a likelihood ratio test equal to 3.54 and 2,76, which compared to the 5% critical value of the Khi Squared with 4 degree of freedom enables us to easily accept the null hypothesis. We estimate a vector-error-correction (VEC) model with one cointegrating vector and one common stochastic trend. The cointegrating vector is indicating the direction where a stable, long-run equilibrium relationship exist and, the adjustment coefficients α are indicating the speed of adjustment of each variable to these long run equilibrium states.

Table 6: The β and α Vectors

Variables	B	α
Y	1.000	0.052
		{0.003}
		[2.955]
EU	-4.014	-0.023
	{0.000}	{0.000}
	[-5.463]	[-4.408]
K	-1.451	-0.011
	{0.000}	{0.870}
	[-17.413]	[-0.586]
L	7.535	-0.014
	{0.000}	{0.000}
	[4.498]	[-5.357]
OP	1.7660	-0.011
	{0.000}	{0.9201}

	[12.225]	[-1.439]
Intercept	-11.0848	
	[-6.248]	

{……} and [……] are respectively the P-value and Student t statistics:

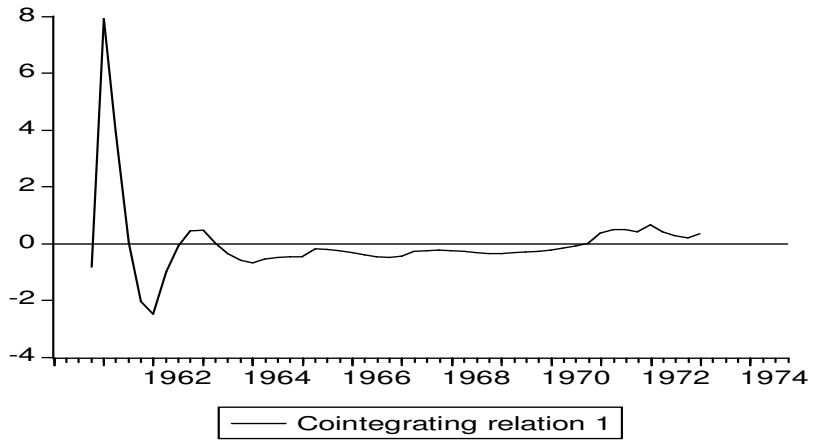

Figure 1: cointegrating relationship of the first regime

Table 7 reports the results of the Granger-causality tests. These results indicate that Granger-causality is running in both directions between, firstly output growth and energy use, second between output growth and oil price, and thirdly between oil price and energy use. Thus, our results for Tunisia indicate that energy and oil price have a causal impact on output growth.

Table7 : Test Results for Granger-causality.

Null Hypothesis:	F-Statistic	Probability
OP does not Granger Cause Y	4.95178	0.00245
Y does not Granger Cause OP	40.7326	1.3E-13
EU does not Granger Cause Y	10.8299	4.8E-06
Y does not Granger Cause EU	91.9272	0.00000
EU does not Granger Cause OP	21.6737	1.4E-09
OP does not Granger Cause EU	21.7894	1.3E-09

The Granger-causality tests conducted above indicate only the existence of causality. They do not, however, provide any indication on how important is the causal impact that energy use has on output growth. For example, when there is a shock to oil price, it would also be interesting to know by how much this shock will affect the growth rates of output. In order to provide answers to these questions, we next decompose the variance of the forecast-error of output growth into proportions attributable to innovations in each variable in the system including its. Consider again the vector error-correction model. A change in anyone of the random innovations $\eta_{i,t}$, i=1, 2,… will immediately change the value of the dependent variable and, hence, will also change the future values of the remaining variables in the system through the dynamic structure of the model. Since changes in the random innovations produce changes in the future values of the

variables, it is possible to decompose the total variance of the forecast-error in anyone of them and determine how much of this variance each variable explains. Since our interest focuses on the response of output growth to shocks in the factor inputs, in particular oil price and energy use, we only decompose the forecast-error variance of the output growth variable in response to a one standard deviation innovation in capital, labor, oil price and energy use. Since the innovations are not necessarily totally uncorrelated, the residual terms are orthogonalized using a Choleski decomposition in order to obtain a diagonal covariance matrix of the resulting innovations and, therefore, isolate the effects of each variable on the other.

Table 8 and figure 2 report the results of the variance decomposition of output growth in Tunisia within a twenty period horizon. As can be seen in the table, the four factor inputs together explain about 40% of the future changes in output growth in Tunisia. The remaining 60% are due to changes in output growth itself. Looking at the separate effects of factor inputs, energy use have the highest effect on output growth followed by human capital and physical capital then oil price.

These results contradict the assumption on the neutrality of energy and clearly illustrate how important could be the effect of energy use and oil price on the future growth of output.

Table8 : Results of Variance Decomposition

Period	D(Y)	D(K)	D(L)	D(EU)	D(OP)
2	94.03070	0.050330	0.160691	3.726484	2.031795
4	84.45430	0.083029	3.269808	8.033084	4.159779
6	73.94236	0.528700	8.319008	11.88775	5.322178
8	66.55364	4.309641	11.04902	12.54885	5.538849
10	62.84139	8.400824	11.08845	12.01733	5.652007
12	62.32311	8.849383	10.87282	11.80563	6.149052

14	61.50162	8.531018	11.32396	12.09104	6.552354
16	60.60398	8.688550	11.79875	12.25466	6.654054
18	60.02955	9.280007	11.84266	12.19436	6.653422
20	59.98608	9.436239	11.73907	12.12124	6.717376

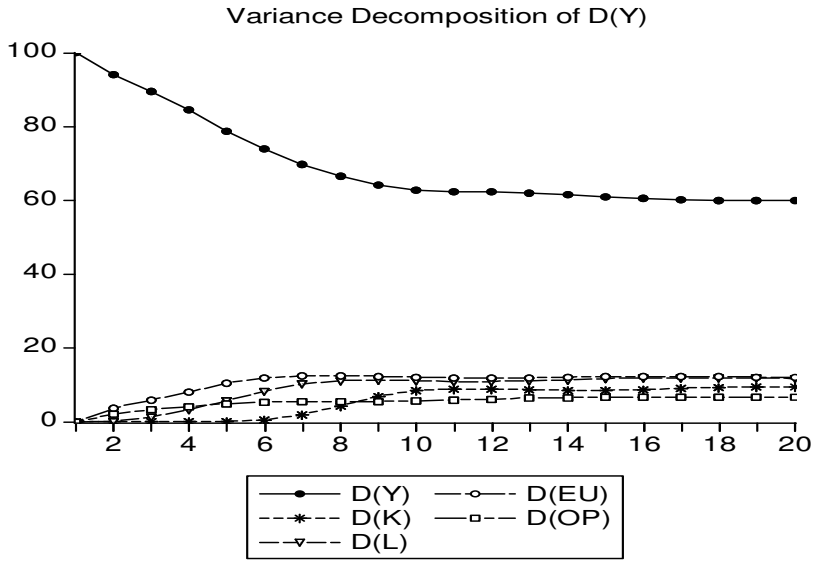

figure 2. the response of output growth to a one standard deviation innovation in inputs

Empirical results of the second regime (Q2 1974-Q11983)

In this second regime, from the β and α vectors we can see that the coefficient on oil price in the loading factors vector is insignificant. Testing the exclusion of oil price from the cointegrating relationship yields a likelihood ratio test respectively equal to 2.54, which compared to the 5% above critical value enables us to easily accept the null hypothesis

Table 9: The β and α Vectors

Variables	β_1	α_1
Y	1.000	0.140
		{0.000}
		[9.682]
EU	-3.530	0.051
	{0.000}	{0.000}
	[-33.483]	[6.063]
K	-2.588	0.071
	{0.000}	{0.000}
	[-41.965]	[6.336]
L	1.5268	0.004
	{0.000}	{0.000}
	[16.430]	[7.542]
OP	-1.676	0.203
	{0.000}	{0.523}
	[-30.663]	[0.639]
Intercept	-14.3851	
	{0.000}	
	[-13.566]	

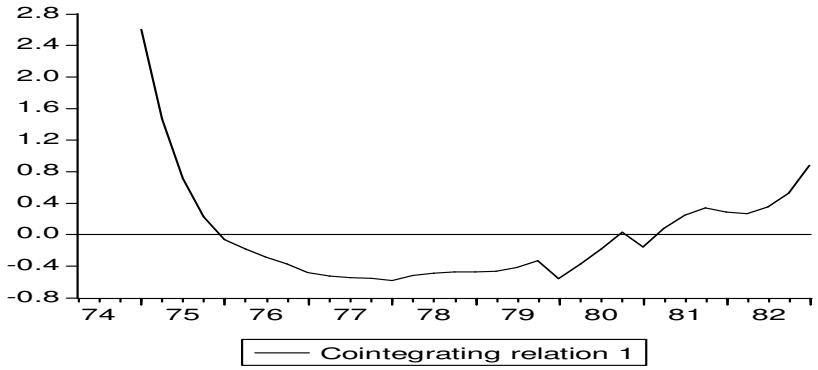

Figure 3: Cointegration relationship of the second regime

Table 10 reports the results of the Granger-causality tests. The results of these tests indicate that Granger-causality is running in both directions between, firstly output growth and energy use and second between output growth and oil price. But, the Granger-causality is running in only one direction between oil price and energy use (oil price causes energy use). Thus, in this period, our results for Tunisia also indicate that energy and oil price have a causal impact on output growth

Table10 : Test Results for Granger-causality.

Null Hypothesis:	F-Statistic	Probability
EU does not Granger Cause Y	0.25105	0.00604
Y does not Granger Cause EU	4.71307	0.00633
OP does not Granger Cause Y	2.86934	0.04592
Y does not Granger Cause OP	4.38438	0.00883
OP does not Granger Cause EU	3.73936	0.01741

EU does not Granger Cause OP	1.57499	0.21457

Table 11 and figure 4 report the results of variance decomposition. Looking at the separate effects of factor inputs, capital has the highest effect on output growth followed by energy use then oil price and finally labor. About 48,8% of future changes in output growth are due to changes in capital, 24,29% due to energy use, 5,38% due to oil price, and 4,54 to labor. In this period the output growth explain itself changes only about 16,9%. The remaining 83% is due to the inputs.

Table11: Results of Variance Decomposition

Period	D(Y)	D(K)	D(L)	D(EU)	D(OP)
2	97.00321	0.686043	0.002052	2.308651	4.03E-05
4	69.37477	1.738485	1.852581	26.42454	0.609622
6	53.70737	11.55870	2.045455	28.72185	3.966624
8	25.30227	47.41963	4.527890	20.37431	2.375901
10	10.09578	52.90085	4.953743	28.23161	3.818012
12	9.336121	48.13092	4.797189	32.40148	5.334283
14	13.64442	42.89433	4.445629	32.70225	6.313362
16	17.59790	41.25310	4.232906	30.41923	6.496865
18	18.85021	43.68436	4.283743	27.10862	6.073073
20	16.90895	48.86676	4.540788	24.29448	5.389016

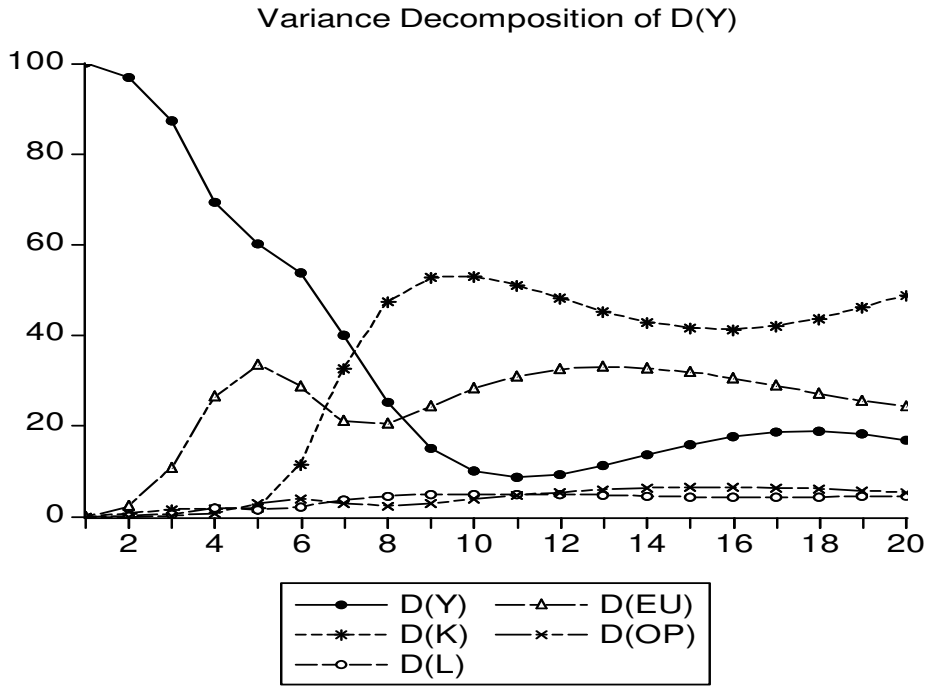

figure 4. the response of output growth to a one standard deviation innovation in inputs

Empirical results of the third regime (Q2 1983-Q4 2005)

From this third regime we can see that oil price and labor are presented with insignificant coefficient in the loading factor vector. Then, the both variables are excluded from the cointegrating relationship. These results explain the importance role of the energy in the Tunisian economic growth. As we can see in table 12 the labor effect on output growth is decreased in last period. This input enters only in the output growth short run relationship.

Table 12: The β and α Vectors

Variables	β_1	α_1

Y	1.000	0.149249
		{0.000}
		[3.61161]
EU	1.018052	-0.036810
	{0.000}	{0.000}
	[5.33182]	[-2.07771]
K	-0.415481	0.152191
	{0.000}	{0.000}
	[-4.18439]	[2.87838]
L	-2.731355	0.001489
	{0.007}	{0.0740}
	[-2.77603]	[1.19639]
OP	0.135792	-0.810129
	{0.003}	{0.0845}
	[2.60154]	[-1.77499]
Intercept	15.84201	
	{0.000}	
	[14.566]	

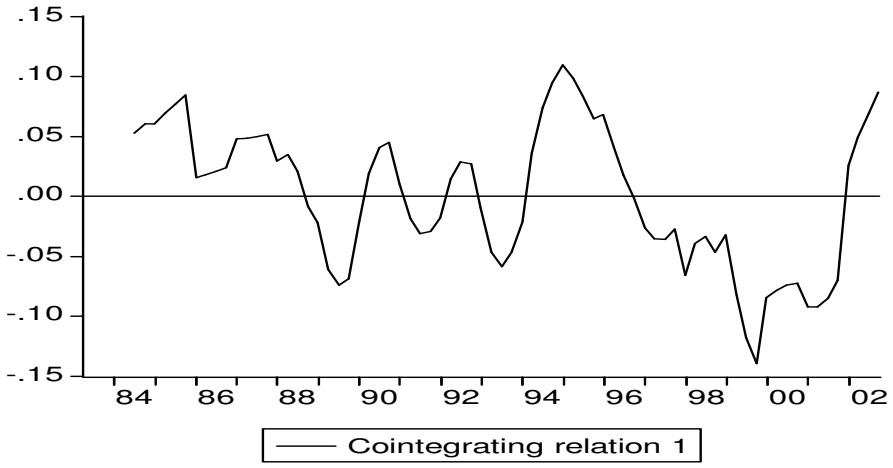

Figure 5: cointegrating relationship of the third regime

Table 13 reports the results of the Granger-causality tests. The results indicate that Granger-causality is running in only in one direction between only energy use and output growth (energy use causes output growth). The remaining of our results indicates that Granger-causality is not running between variables. Thus, in this period, our results for Tunisia also indicate that energy have a causal impact on output growth.

Table13 : Test Results for Granger-causality.

Null Hypothesis:	F-Statistic	Probability
EU does not Granger Cause Y	3.18105	0.01884
Y does not Granger Cause EU	1.75183	0.14918
OP does not Granger Cause Y	0.31185	0.86908

Y does not Granger Cause OP	0.35552	0.83930
OP does not Granger Cause EU	0.15934	0.95807
EU does not Granger Cause OP	0.37250	0.82743

The variance decomposition results are reported in table 14 and figure 6. Looking at the separate effects of factor inputs, capital has the highest effect on output growth followed by energy use then oil price and finally labor. About 12,48% of future changes in output growth are due to changes in capital, 12,11% due to oil price , 10,00% due to energy use, and 9,91 to labor. In this period the oil price choc explain an important percentage of the future changes. Thus, the oil price has an important effect of the economic growth in Tunisia.

Table14: Results of Variance Decomposition

Period	D(Y)	D(K)	D(L)	D(EU)	D(OP)
2	94.50051	1.488807	0.283504	3.696283	0.030900
4	84.98722	5.522722	0.454842	7.969954	1.065261
6	75.00471	12.64123	2.502585	7.623675	2.227803
8	68.60894	11.09578	8.725901	8.941704	2.627675
10	60.36874	10.54032	9.924830	10.68205	8.484062
12	57.94201	10.48181	9.620414	10.40498	11.55078
14	56.97258	11.39761	9.556908	10.41348	11.65942
16	55.46652	12.71463	9.616982	10.12712	12.07475
18	55.39910	12.76115	9.613349	10.18441	12.04199
20	55.48369	12.48203	9.912863	10.00307	12.11834

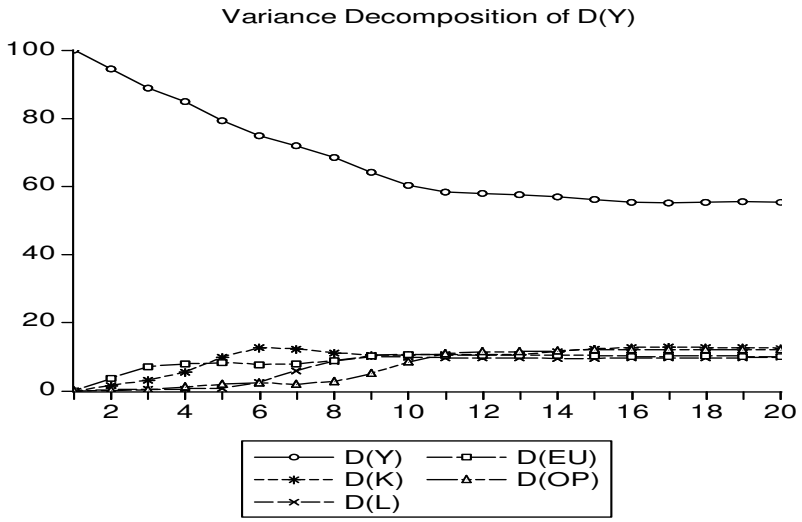

figure 6. the response of output growth to a one standard deviation innovation in inputs

Conclusion

By contrast to empirical works on oil exporting country, our econometric findings presented in this study demonstrate that oil price shocks have substantial effects on output growth in Tunisia over the period covered by the study.

However, this paper attempted to analyze the long run relationship between energy use, oil price and output growth in Tunisia. Based on the neo-classical one sector aggregate production technology, we examine the long-run determinants of GDP in Tunisia during the period 1960-2003 employing the Saikkonen and Lutkephol (2000) and Johansen and (2001) cointegration method. Prior to the cointegration analysis, the Zhongjun Qu and Pierre Perron (2007) tests are applied in order to endogenously determine the multiple structural breaks in the major drivers of economic growth, physical and human capital, oil price and energy use. The empirical results based on the unit root tests indicate the existence of unit root for all of the variables under investigation. Moreover, we found that the structural breaks over the last forty-five years occurred as a result of the oil sock in 1974 and the dept crisis in developing countries in 1983.

These results provide complementary evidence to models employing exogenously imposed structural breaks in the Tunisian macroeconomy.

Then, we employed the Saikkonen and Lutkephol (2000) and Johansen and al (2001.) cointegration approach to determine the long-run factors contributing to economic growth in Tunisia. It is important to use this approach in our cointegration test as during the sample period, the Tunisian economy has been subject to serious structural breaks such as: the world oil shock in 1973 and dept crisis in 1983. In the presence of these two structural breaks, the SL and Johansen cointegration tests conducted in this paper indicate that there is one cointegrating vector which link GDP with physical and human capital, oil price and energy use.

We developed a vector error-correction model after testing for multivariate cointegration between output, capital, labor, oil price and energy use. The cointegration test indicates that energy use and oil price enters significantly the cointegration space and indicates that no cointegrating relationship, in the three regimes, between oil price and output growth. Moreover, the short-run dynamics of the variables show that the flow of causality is running in both directions between output growth and energy use in the first and second regimes. But in the last period granger-causality is running only in one direction. Between oil price and output growth, the granger causality is running in both directions in first regime, one direction in the second regime and absent in the latest regime.

In our empirical results of the variance decomposition of the forecast-error variance of output growth, we found firstly, that energy use shocks cause forever changes in the future growth rates of output. Second, shocks to oil price cause have an increased effect on change in the future growth rates.

With this, our results seem to significantly reject the neoclassical assumption that energy is neutral to growth. Consequently, we conclude that energy is a limiting factor to output growth in Tunisia and, hence, shocks to oil supply will have an important effect on output. Moreover, shocks to oil price will have an important effect on output growth.

Finally, we conclude that the world oil price fluctuations have an important effect on economic growth in Tunisia because other factors of production such as labor and capital cannot do without energy. Oil price has a little effect on energy consumption which can be explained by the role of energy in the Tunisian economy and becomes one of the first necessity goods.

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Six Sigma and management control systems

Dr. John McLellan

Abstract

This study focuses on the introduction of a Six Sigma Continuous Improvement Program and the extent to which an organization's Management Control System (MSC) supports this new corporate strategy. The research findings show that the sustainability of a Six Sigma program requires the organization's MCS to expand and fully support this strategic initiative. The financial returns from the upfront investment of implementing a Six Sigma program can only be realized over a number of years. The maximization of those returns will be reached only when Six Sigma improvement tools and techniques receive rapid, organized deployment and are in everyday use by all employees. That is, when Six Sigma is no longer viewed as a standalone quality initiative but is an integral part of the corporate culture. The findings will have implications for organizations that are considering investing in a Six Sigma program. The paper will be of interest to academics, accountants and senior managers

Keywords

Six Sigma, management control system (MCS), continuous improvement

Model for Developing a Sustainable Six Sigma Program

Prior research into the relationship between an organization's corporate strategy and its Management Control System (MCS) has been limited to a few studies. Langfield-Smith (1997) concluded in her study that the knowledge of the relationship between MCS and strategy is that a great deal more research is required. This paper focuses on the introduction

of one new strategic thrust for many organizations namely, the implementation of a Six Sigma Continuous Improvement Program and examines to what degree the MCS of that organization supports this new corporate strategy.

It has been found that the effective implementation for many of the new modern management methods requires a level of sophistication that can only be developed over extended periods of time. Simon London in his article "When Quality is not Enough" stated that in the many years Joseph Juran has been involved in quality initiatives, Juran's experience has been that it takes from 6-10 years for a company to achieve a position of quality leadership. This implies that in many cases Six Sigma will have to outlive the tenure of the executive team that initiated the program. If Juran is correct, it would be imperative for Senior Management to make Six Sigma part of the corporate culture and not leave it as another "stand alone" quality program.

Therefore, systemization of these initiatives is strongly linked to the long-term consistency, commitment and results from these initiatives. Having a quality management system was once a competitive advantage for corporations. This is no longer necessarily the case. Today, a majority of large multi-national organizations find that competitive advantage can only be obtained by viewing their quality management system as a productive asset that must provide the maximum return on investment.

The financial returns from the upfront investment of implementing a Six Sigma program can only be realized over a number of years. The maximization of those returns will be reached only when Six Sigma improvement tools and techniques receive a rapid, organised deployment and are in everyday use by all employees. That is, when Six Sigma is no longer viewed as a solely a quality initiative but is now part of the corporate culture. In other words, Six Sigma becomes part of the corporate fabric.

The MCS of an organization is designed to focus and co-ordinate individual and departmental efforts and to recognize, measure and reward performance congruent with corporate strategies. To ensure the sustainability of a Six Sigma Continuous Improvement Program requires the MCS of a corporation to expand and fully support this new strategic initiative.

Literature Review

The Philosophy of Six Sigma

Sigma is a Greek alphabet letter used by statisticians to describe variability. A sigma quality level is an indication of how often defects are statistically likely to be produced by a process. The higher the sigma quality level of a process, the less likely the process will create defects. Consequently, as the sigma level of quality increases, product reliability improves, the need for product inspection declines, work in progress inventory is reduced, cycle time and costs go down; and customer satisfaction and subsequently profits should increase (Breyfogle & Meadows 2001; Harry 1998; Horngren, Foster & Datar 1994; Pande et al. 2000).

If a process is operating properly, variation in the desired measurement of the output would be normally distributed in a range of sigma values on either side of the mean. Depending on the capability of the process that range of sigma values can be from one sigma on either side of the mean, up to six sigmas on either side. Most processes operate at a value of two or three sigmas.

If the customer's upper specification limit (USL) and lower specification limit (LSL) for the product's tolerances happens to be the same as the three sigma level capability of the production process, and the mean of the output of that process is centred on the mid-point between the USL and LSL, then statistically, approximately 2,700 parts per million produced by such a process will fall outside the customer's specification limits and therefore be considered defective (Breyfogle, Cupello & Meadows 2001). In addition, a process can continue to produce a normal distribution in output while shifts in the mean of the distribution can occur as the mean "drifts" to either side of the centre-point between the USL and LSL of a component value. Research has shown that a typical process is likely to deviate from its natural centering condition by approximately 1.5 standard deviations at any given moment in time (Harry 1988). If a mean shift occurs, the capability of the production process declines and the result could be up to a maximum of 66,810 DPMO for a process at a three-sigma quality level.

The ultimate goal of the Six Sigma approach to process improvement is to fine tune the operating process to the point that the critical measurements of that output can be six standard deviations from the mean and still be within product production tolerances or in other words,

the range of customer expectations. With a centered normal distribution between Six Sigma limits, (see Figure 1) only two products per billion produced will be defective (see Table 1).

Figure 1: (Breyfogle 1999, p. 9)

Table 1 Defective Parts Per Million (Breyfogle 1999, p.9)

Sigma Level	% Good	PPM
2	95.45	45500
3	99.73	2700
4	99.9937	63
5	99.999943	0.57
6	99.9999998	0.002

With a mean shift of 1.5 standard deviations (Figure 2), a process with six sigma capability will produce only 3.4 defects per million (Table 2).

Figure 2 Performance (Breyfogle 1999, p.10)

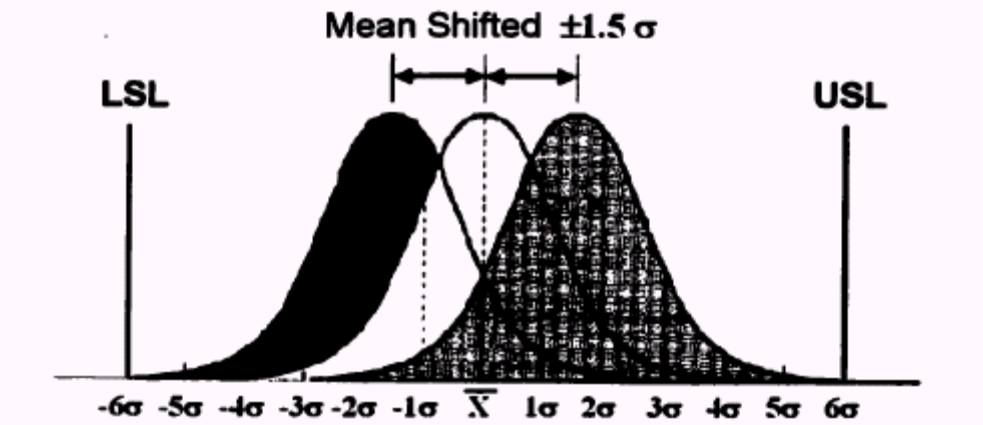

Table 2 Defective Parts per Million (Breyfogle 1999, p. 10)

Sigma Level (1.5σ Shifted)	% Good	PPM
2	69.13	308537
3	93.32	66810
4	99.379	6210
5	99.9767	233
6	99.99966	3.4

The Met Methodology of Six Sigma

The Six Sigma methodology is a deployment system of statistical techniques and other quality tools that follows a disciplined approach for identifying and improving processes in manufacturing, service, or not- for- profit businesses (Breyfogle & Meadows 2001). The improvement process is structured into five phases or steps: define, measure, analyse, improve and control (DMAIC).

1)Define phase – this is the process of selecting the right projects based on the organisation's goals and objectives.

2)Measure phase – involves deploying quality tools to assist in determining the critical aspects affecting the performance of the process.

3) Analysis phase – the process in analyzed to identify ways to eliminate or narrow the gap between the processes' current capability and the desired goal.

4) Improvement phase – in this phase Six Sigma teams seek the optimal solution and develop a plan of action for implementing and confirming the solution.

5) Control phase – ongoing measures are implemented to keep the problem from recurring. The improved system is institutionalized by modifying policies, procedures, operating instructions or the MCS. A control plan is developed (Breyfogle 1999).

The DMAIC is a closed loop and continuous improvement system. The goal of the DMAIC approach is to move the process to a Six Sigma capability – essentially zero defects.

If an organisation adopts the Six Sigma philosophy and methodology as one of its strategic aims, then effective strategy implementation requires a fit between that strategic objective and the management planning and control system of the organisation (Teall 1992). Gage (1982) claims that the day-to-day activities of managing a business must reflect the strategic plan of that business, and if it fails to do so the strategic plan will gradually become irrelevant.

Management Control Systems

A Management Control System (MCS) is a planning and control mechanism by which senior management ensures that subordinates strive to attain the company's strategy (Anthony, Hawkins & Merchant 1999; Garrison et al. 2001; Hansen et al. 2001; Horngren et al. 2002; Ouellette 2002; Teall 1992;).

The framework of a MCS involves four phases of construction.

1) Strategic Corporate Planning – the setting of corporate goals.

2) Organisational Structuring – allocation of resources (budgeting).

3) Measurement and Reporting – performance monitoring and feedback.

4) Evaluation -recognition by rewarding of incentives

Each phase leads into the next phase and a continuous loop is formed. Evaluation of the effectiveness of the MCS feeds back into strategic corporate planning.

Strategic Corporate Planning

Strategy is at the core of any business. Strategy drives the operations of a company and guides managers in short term and long term planning (Horngren et al. 2002).The strategic planning stage first requires an explicit statement by senior management, regarding the company's overall competitive strategy. To be effective, the statement should address the key success factors (KSF) important for the continued viability and growth of the organisation (Teall 1992). If Six Sigma has been identified as a new strategic initiative, then management should make it clear to all employees why Six Sigma is important to the organisation and how Six Sigma aligns with existing corporate strategy.

Porter (1985) describes three generic strategies: cost leadership, differentiation and focus. Cost leadership implies that the organisation aims to be the lowest cost producer in its industry. The differentiation strategy focuses on providing customers with products or services that contain attributes highly valued by the customer. A focus strategy targets a particular market segment within an industry. Competitive advantage is based on either cost leadership or differentiation. An organisation pursuing a Six Sigma continuous improvement initiative may be attempting to achieve a low cost strategy, a differentiation strategy or a combination of both. Porter states that achieving cost leadership and differentiation are usually inconsistent goals because differentiation can be costly. However, he continues, if a firm can achieve cost leadership and differentiation the " rewards are great and the benefits are additive" (Porter 1985, p.18).

Organisational Structure

The second phase of an effective MCS involves structuring the organisation to support efforts for attaining the strategic goals. The implementation of a Six Sigma program would necessitate an organisational change in order to identify the roles and responsibilities of employees involved in Six Sigma projects.

Six Sigma experts suggest that self-directed teams should be formed and a project champion selected. Usually these teams are cross-functional, involving employees from different operational functions but none the less these employees own part of the process needing improvement (Costin 1999). A support team of quality improvement specialists termed "Black Belts" should be formed to assist the self-directed teams through mentoring, teaching and coaching. A rule of thumb for the number of Black Belts within an organisation is 1% of the

total number of employees. Black Belts receive technical support from a Master Black Belt (some organisations refer to this person as the Lead Black Belt). Black Belts also receive assistance from the project champion. The champion's role is to help eliminate organisational roadblocks to process improvement (Breyfogle 1999).

The literature on Six Sigma implementation clearly defines how an organisation should re-organise to accomplish an effective program. However, the literature on Six Sigma methodology provides little information on how to evaluate employee performance.

Measurement and Reporting

The next phase of an effective MCS is performance monitoring. This is an important phase serving a dual purpose. To begin with, performance monitoring lets management know how efficient the organisation has been in achieving stated goals and,in addition, lets employees know what top management sees as important factors for continued success (Venkatraman & Gering 2000).

For management attempting to change the focus of an organisation, performance measurement is a vital tool in effecting change (Armaratunga, Baldry & Sarshar 2001). The relationship between strategy and performance evaluation can be summed up in the adage of "what gets measured, gets done.".

For companies engaged in continuous improvement efforts, measurements of performance should be both financial and non-financial. In addition to controlling costs, the manager and employees of that responsibility centre are judged on other factors such as quality, flexibility, cleanliness, timeliness and other elements related to the key success factors of the organisation (Daniel & Reitsperger 1994; Hansen et al. 2001; Kaplan & Norton 1992; Kaplan & Norton 1996).

It is important for senior executives to track not only financial measures which indicate past performance but also non-financial measures such as back orders, customer retention, capacity utilization, on time delivery, inventory turnover and cycle time all of which are leading indicators of future performance. One performance measurement tool that addresses both financial and non-financial initiatives is the balanced scorecard.

Evaluation and Recognition by Rewarding of Incentives

The final phase of an effective MCS in a continuous improvement environment is the provision of quality based incentives to employees (Banker, Potter & Schroeder 1993). According to Crosby (1979), recognition is a vitally necessary component in any quality program and is often overlooked or carried out improperly. A number of studies have concluded that when an individual's reward is tied to performance along a certain set of criteria, behaviour is guided by the desire to improve on the performance of that criteria (Govindarajan & Gupta 1985).

A company engaged in continuous improvement recognizes that process improvement is a team effort and performance evaluation is a function of a number of financial as well as non-financial criteria (Daniel & Reitsperger; 1994; Kaplan & Norton 1992). Less traditional approaches for recognizing and rewarding performance as presented in the literature on quality programs include plaques, certificates, dinners, or as in the case of some Japanese firms, a week-long quality training course on a cruise ship dubbed the "Floating University" (Tribus 1984).

Research Question

In theory, an MCS should support the strategic aims of an organisation. Companies that have embraced a Six Sigma continuous improvement program as a strategic thrust for the future should have developed a means of monitoring performance of all employees and reporting that performance to all employees, as well as developing an incentive program to promote goal congruence between senior management and all levels of operating personnel (Banker et al. 1993).

This paper will attempt to determine the degree to which the MCS of an organisation has expanded to support the Six Sigma continuous improvement programs that have been implemented by North American companies over the past decade.

Research Methodology

This research project renders an evaluation of the current status of the MCS that exist in organizations that have adopted a Six Sigma program. Accordingly, this research project falls into the descriptive, multiple case studies category.

The theory for this study against which the actual data will be compared is that the MCS of Six Sigma corporations have:

1. Addressed the business objectives for introducing a Six Sigma continuous improvement program along with the strategies and plans to achieve the objectives;
2. Restructured the organization, introducing a level of management consisting of project management experts in quality improvements and also creating a steering committee dedicated to driving the Six Sigma program;
3. Developed a means of monitoring employee performance against set targets for Six Sigma achievements and reporting that performance back to employees in a timely manner, in graphic form and in financial as well as non-financial terms; and
4. Developed a reward system both in financial and non-financial terms, tied to the Six Sigma improvement objectives which includes all personnel – both in line and staff functions.

Unit of Unit of Analysis

The unit of analysis is the MCS in organisations that have been implementing a Six Sigma program for a period of a year or longer. The one-year time frame is necessary in order to allow the MCS a chance to evolve after the implementation of a Six Sigma program.

Sample size

The purpose of this study is not to identify a representative sample of the population of Six Sigma organizations but to include as many organizations as possible from as many industry classifications. This purposive approach was necessary because, to date, very few organizations have implemented Six Sigma into their operations. This study attempted to cast as wide a net as possible to include organizations in both Canada and the United States that have had a Six Sigma program working for at least one year.

Over a five-month period, 22 organisations were identified as potential participants, including 16 from the automotive industry. Fifteen companies were contacted and asked to participate. The participants were sent an introductory email stating the purpose of the research along with a copy of the interview questions. A signed informed consent form was obtained for all the firms that agreed to be interviewed. Three organisations refused to be interviewed; one as a

matter of policy regarding business research in general, and the other two after conferring with management at their headquarters in the United States.

The 12 companies in the case study were all situated in Southwestern Ontario (Table 3).

Table 3. Company characteristics

COMPANY	A	B	C	D	E	F	G	H	I	J	K	L
1. # OF PLANT EMPLOYEES	420	1100	1,000	400	450	450	600	680	1500	650	4000	500
2. MULTINATIONAL	Yes	Yes	NO	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
3. HEADQUARTERS CANADA	Yes	Yes	Yes	No	No	No	Yes	Yes	No	Yes	No	No
4. AUTOMOTIVE OEM								Yes	Yes		Yes	
		Y		Y	Y	Y	Y			Y		

5. AUTOMOTIVE TIER I & II		es		es	es	es	es			es		
6. PRIVATELY OWNED	Yes		Yes				Yes					

Key to companies

A – International manufacturer of production equipment and conveyors.

B – International manufacturer of die casts for the automotive industry.

C – Animal feed division of a large food processing company.

D – Manufacturer of fuel handling systems for the automotive industry.

E – Manufacturer of suspension systems for the automotive industry.

F – Manufacturer of automobile interiors.

G – Testing laboratories.

H – Manufacturer of heavy trucks.

I – Original equipment automobile manufacturer.

J – Manufacturer of automobile exhaust manifolds.

K – Original equipment automobile manufacturer.

L – Chemical manufacturer.

The other characteristics of the participating organizations were as follows:

- Three of the companies are privately owned corporations. The other nine are publicly traded on either the Toronto and/or the New York stock exchange.

-Ten of the companies studied are multinationals with operations in the United States, United Kingdom, Hungary, China and Japan. The other two have multiple operations situated across Canada. Of the ten multinationals, six have their headquarters outside Canada.

-Eleven organizations are in the manufacturing and processing businesses; one is in the service industry.

-The companies range in size from 400 to 4,000 employees.

Research Method

The research method involved face-to-face or telephone interviews of managers of the Six Sigma program, usually an MBB or Black Belt. The interview questions were designed to determine whether senior management were implementing the Six Sigma initiative as a standalone program or integrating it into each of the four phases of the organization's MCS and involving all the employees. Twelve organizations engaged in Six Sigma were identified from a database of over 15,000 companies in Southwestern Ontario. An introductory letter was sent to the MBB explaining the nature of the research and offering the opportunity to participate. In return, participants were to receive a copy of the final research report.

Research Instrument

With the help of an extensive literature review and a focus group of four quality experts, a set of 28 interview questions were developed. The questions covered the critical aspects of all four sections of the MCS to determine whether they supported the Six Sigma initiatives. The questions were based to on two models:

1. A 10-step model for the effective implementation and ongoing success of a TQM program (Kelada 1996).
2. A framework for measuring managing organisational performance (Otley 1999).

Kelada (1996) presents a model for the effective implementation of TQM, which is:

-Ccreate a steering committee to oversee the program;

-Appoint a coordinator;

-Mobilise internal and external partners;

-Initiate a total control diagnosis;

-Establish a training program;

-Organise for total control;

-Launch the process on a limited scale, then gradually extending it everywhere;

-Continuously evaluate the process and its results: making adjustments as necessary; and Set up a continuous reinforcement process.

Kelada's (1996) model is very similar to the issues addressed in the literature on the effective implementation of Six Sigma (Breyfogle et al. 2001; Eckes 2002; Pyzdek 2000). In addition, Otley (1999, p.365) presents five main sets of issues that need to be addressed in developing a framework for managing organizational performance:

1. What are the key objectives that are central to the organization's overall future success, and how does it go about evaluating its achievement for each of these objectives?
2. What strategies and plans has the organization adopted and what are the processes and activities that it has decided will be required for it to successfully implement these? How does it assess and measure the performance of these activities?
3. What level of performance does the organization need to achieve in each of the areas defined in the above two questions, and how does it go about setting appropriate performance targets for them?
4. What rewards will managers (and other employees) gain by achieving these performance targets?
5. What are the information flows that are necessary to enable the organization to learn from its experience, and to adapt its current behavior in light of that experience?

The interview questions were designed to cover the four phases of a typical MCS. The interviews were recorded on audiotape with the consent of the interviewees. The tapes along with the interview notes were used to summaries the key elements of the interviews. The summarized version of the interview was sent to each interviewee via email. The interviewees were free to add to or delete any part of the inquiry. The final version was returned to the researcher and was the only one used in the research project.

To assess whether the interpretation of the data was drawn in a logical and unprejudiced manner, this study relied on the judgment of an independent certified quality auditor.

Data analysis

Six Sigma planning process

All the interviewees revealed that the strategic planning for Six Sigma was a top-down process. That is, the CEO and the vice-presidents did all the planning (Table 4).

Organizing phase to achieve strategic goals

All the companies used a steering committee to some degree. However, the make-up of the committees and the number of times the committees met varied (Table 5). The speed with which the companies implemented Six Sigma also varied.

Performance evaluation and reporting

The performance motivational literature indicates that employees will tend to perform in a way that is consistent with the manner in which their performance is judged. In addition, the more the employee is involved in the planning process of his or her work detail the greater the motivation (Hansen et al 2001; Horngren et al. 2002). Therefore, it is likely that employee participation in the selection of projects and setting of targets will affect the level of motivation and enthusiasm for a Six Sigma program (Table 6).

Performance evaluation was carried out at different management levels within the organisation as well as at different times throughout the year.

Performance feedback is provided to employees at different stages of the Six Sigma program. In every instance performance was recognized upon the completion of a Six Sigma project

Reward and recognition

Performance was recognized and rewarded at three levels: upon successful completion of training; upon successful completion of every Six Sigma project and; at an annual competition of a best continuous improvement project. Only three companies recognized performance achievement at all three levels. All companies recognized achievement at either the first and/or second level (Table 7).

Table 4. Strategic planning phase for Six Sigma

The following is a summary of respondents' answers to questions probing the extent of senior management's involvement in the strategic planning phase of implementing Six Sigma.

STRATEGIC PLANNING PHASE FOR SIX SIGMA **COMPANIES**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	Respondents in the Affirmative	Auto Parts Supplier	Original Equipment Manufacturer	Other
1. Senior Management did all the strategic planning		X	X	X	X	X	X	X	X	X	X	X	11	5	3	3
2. Senior Management clearly defined strategic initiatives	X	X	X	X	X	X	X	X	X	X	X	X	12	5	3	4
3. Senior Management clearly defined business objectives			X				X	X	X	X	X	X	7	1	3	3
4. Business objectives developed at individual plant level				X		X		X	X		X		5	2	3	
5. Strategic initiatives were cost control	X	X	X	X	X	X	X	X	X	X	X	X	12	5	3	4
6. Strategic initiatives were quality improvement					X			X	X		X		4	1	3	
7. Strategic initiatives identified the customer				X		X	X		X			X	5	2	1	2
8. Strategic initiatives addressed product development					X								1	1		
9. Strategic initiatives were global					X							X	2	1		1
10. Strategic initiatives were corporate renewal								X					1		1	
11. Process improvement, cycle time, downtime etc. were mentioned as strategic initiatives			X			X	X	X	X	X	X		7	2	3	2
12. Standardizing the processes were mentioned as strategic initiatives			X										1			1
13. Viewed Six Sigma as an organizational change process				X									1	1		

Source: Analysis of Survey Data

Table 5. Six Sigma mobilization planning phase

The following is a summary of respondents' answers to questions regarding the way their Six Sigma program was launched.

SIX SIGMA MOBILIZATION PLANNING PHASE **Companies**	A	B	C	D	E	F	G	H	I	J	K	L	Respondents in the Affirmative	Auto Parts Supplier	Original Equipment Manufacturer	Other
1. Senior Management formed a Steering committee	X	X	X	X	X	X	X	X	X	X	X	X	12	5	3	4
2. A formal action plan was developed	X		X	X	X	X	X	X	X			X	9	3	2	4
3. Money for Six Sigma was budgeted	X		X	X	X	X	X					X	7	3		4
4. A Six Sigma training program was developed	X	X	X	X	X	X		X	X	X		X	11	5	3	3
5. CEO was ranked highly motivated by Lead Black Belt	X	X	X	X		X	X	X	X			X	9	3	2	4
6. Performed a Six Sigma project at Senior Management level			X	X	X	X		X	X				6	3	2	1
7. Plan to roll out Six Sigma to suppliers							X					X	2			2
8. Black Belt candidates identified by Senior Management			X	X	X		X		X	X		X	7	3	1	3
9. Held job competitions for Black Belts	X	X	X	X		X							5	3		2
10. Black Belt position to be rotated every two years				X	X			X					3	2	1	
11. Company hired Black Belts			X				X			X			3	1		2
12. Mentioned Black Belt training good for promotions					X	X						X	3	2		1
13. Staff from non-manufacturing departments were trained in Six Sigma			X	X	X	X		X	X	X		X	8	4	2	2
14. Company hired Black Belt director to launch Six Sigma								X				X	2		1	1

Source: Analysis of Survey Data

Table 6. Six Sigma performance measurement and reporting phase

The following is a summary of respondents' answers to questions probing how their company measured and reported performance on Six Sigma efforts.

SIX SIGMA PERFORMANCE MEASUREMENT AND REPORTING PHASE COMPANIES	A	B	C	D	E	F	G	H	I	J	K	L	Respondents in the Affirmative	Auto Parts Supplier	Original Equipment Manufacturer	Other
1. Lead Black Belt selected easy initial projects		X	X	X				X				X	5	2	1	2
2. Lead Black Belt picked problem processes					X	X	X						3	2		1
3. Team members set their own performance targets	X	X		X	X		X						5	3		2
4. Black Belts set project targets			X										1			1
5. Performance targets were financial	X	X	X	X	X	X	X	X	X	X	X	X	12	5	3	4
6. Performance targets were non-financial	X	X	X	X	X		X	X	X	X	X	X	11	4	3	4
7. Used a balanced scorecard			X					X	X				3	1	1	1
8. Lead Black Belt ranked employee first project motivation > 3	X	X		X			X		X	X		X	7	3	1	3
9. Lead Black belt ranked employees enthusiasm >3		X	X	X					X			X	5	2	1	2
10. Exceeded Project targets		X	X	X	X	X	X			X	X	X	9	5	1	3
11. Kept within project time line.												X	1			1
12. Performance targets tied to Corporate Objectives			X		X		X					X	4	1		3
13. Management specified target requirements			X			X		X		X		X	5	2	1	2
14. The company has a formal six sigma performance review		X		X		X							3	3		
15. Six Sigma part of annual performance evaluations	X		X	X					X	X		X	6	2	1	3
16. Performance appraisals are based on project targets		X		X		X			X	X	X	X	7	4	2	1
17. Accounting Department involved in Project estimated savings		X	X	X	X	X	X	X		X	X	X	10	5	2	3
18. Finance person did follow-up audit months after project completion			X			X	X		X			X	5	1	1	3

Source: Analysis of Survey Data

Table 7. Six Sigma reward/recognition phase

The following table is a summary of respondents' answers to questions regarding how their company recognized and rewarded performance on employees Six Sigma efforts.

SIX SIGMA REWARD/RECOGNITION PHASE COMPANIES	A	B	C	D	E	F	G	H	I	J	K	L	Respondents in the Affirmative	Auto Parts Supplier	Original Equipment Manufacturer	Other
1. Six sigma team members receive a financial reward.		X				X	X	X				X	5	2	1	2
2. Six Sigma team members receive a non-financial reward.		X	X	X		X	X	X		X	X		8	5	2	1
3. Employees participate in profit sharing.	X	X								X			3	2		1
4. Employees participate in gainsharing						X				X			2	2		
5. Internal competitions for best Six Sigma project held				X							X		2	1	1	

Source: Analysis of Survey Data

Results not anticipated from the literature review

A number of findings emerged that were not anticipated in the current literature on Six Sigma. The first unexpected result of the interview process was that many of the interviewees were under the age of 40. Employee involvement in the learning of quality improvement tools and a Six Sigma continuous improvement effort appears to be a matter of age; as younger people possibly view Six Sigma training as a career path.

Another unexpected result was that many of the companies reported that each Six Sigma team had a financial person, usually an accountant, whose role was not so much to participate in the improvement efforts but to independently measure and validate the improvements in both financial and non-financial terms. There is nothing in the literature that mentions employing a financial person as a member of the quality improvement team to audit the team's performance. In addition, nowhere in the literature was mentioned the need to re-measure process improvements to assure sustainability.

Final questions

To take advantage of the experience gained by the interviewees with Six Sigma implementation the researcher posed the following two, open-ended questions at the end of the interview:

1)

_____

What would you have done differently in implementing Six Sigma in your workplace if you could start over?

2)

_____

Can you describe how you would envision the Six Sigma process for your organization three years from now?

The answers to these two questions provide some ideas that could benefit other organizations that are considering the implementation of a Six Sigma program (Table 8).

Table 8. Interviewee comments

The following table is a summary of respondents' answers to the two final questions. The companies codes are outline in Table 2 (Page 8).

COMPANIES	COMMENTS
C, D	Train Black Belts quicker
H, F	Train Black Belts slower
E, G, B	Train Green Belts faster and better
I, J, G, D	Train more senior management
E	View Six Sigma as separate dept.
I, B, G	Make Six sigma more pervasive
G, C, L, F	Make Six Sigma part of culture
J, A, C	Involve accounting dept. more
B, I	Need to leverage Six Sigma
D	Involve HR
A, G	Start with fewer projects
K, D	More formal documentation

Conclusions

Langfield-Smith's (1997) study of organisational MCS and corporate strategy concluded that the relationship between the two has not been well researched. The purpose of this study,

therefore, was to look at one clearly defined strategic initiative, namely, the implementation of a Six Sigma program, and examine to what extent senior management employed the existing MCS to launch the program and ensure goal congruency among employees and the organisation's continuous improvement strategy.

Strategic planning for Six Sigma

The senior management team of all the organizations studied had clearly defined the strategic initiatives for the implementation of their Six Sigma program. This is an important first step for the eventual for the success of a continuous improvement program (Breyfogle et al. 2001; Eckes 2002; Pyzdek 2000).

The first phase of an MCS requires that senior management make explicit the company's overall competitive strategy and identify the key success factors for the continued viability and growth of the organization (Horngren et al. 2002; Teall, 1992).

The strategic initiatives mentioned in this study were, for the most part, congruent with Porter's (1985) low-cost strategy and differentiation strategy in order for an organization to achieve a competitive advantage.

Restructuring the organization for Six Sigma

In every organisation studied senior management had in place, or had formed, a steering committee to oversee the Six Sigma mobilisation plan. In many cases monies were budgeted for that training at the head office level, and management at the divisional level was responsible for travel and accommodations for employees selected for training. In addition, companies that trained Black Belts did not hire new personnel to fill the role left vacant. Eleven of the 12 organisations studied introduced a new layer of management responsible solely for leading process improvement projects. This approach is consistent with the recommendations in the literature (Blakeslee 1999; Breyfogle et al 2001; Eckes 2002; Harry 1988; Pyzdek 2000). However, this study adds to the literature a number of different strategies employed in staffing this additional management layer. These include:

1. Identifying key employees within the organisation, either individually or through an interview process, and training them in Black Belt statistical techniques.
2. Hiring Black Belts from other organisations.
3. Some combination of (1) and (2).

Another strategy employed by these organisations that was not part of the literature was the idea of rotating the role of Black Belt on a two-year basis. A number of interviewees

mentioned that the plan was to eventually make Six Sigma so pervasive throughout the organisation that employees would continue to use the improvement techniques in their various roles.

The organisations mostly followed Breyfogle's (1999, p.14) advice that Black Belts should be selected based on their 'capability of learning and applying statistical methodologies' as well as their ability 'to work with others through mentoring, teaching and coaching'.

The literature on effective deployment of a Six Sigma program suggests that senior management should be given an overview training session on Six Sigma techniques and be assigned as project champions (Breyfogle & Meadows 2001; Eckes 2002; Harry 1998.). This was observed in most of the organisations studied.

Six Sigma experts advocate that organisations should involve their suppliers in their improvement efforts (Breyfogle et al. 2001; Eckes 2002; Harry 1998). None of the companies studied had, to date, involved their suppliers; however, two had plans to do so.

One notable fact was that there was no involvement of the board of directors with Six Sigma in any of the organisations. The practice of involving board members of an organisation to oversee that organisation's continuous improvement efforts was noted by Tribus (1984) in his study of continuous improvement programs in Japanese firms. Such a practice might result in greater participation in Six Sigma by senior managers.

Six Sigma performance measurement and reporting phase

For management to attempt to change the focus of an organisation, performance evaluation is a vital element in affecting that change (Amaratunga et al. 2001).

The literature on Six Sigma is lacking in emphasis in the area of employee performance evaluation, except to imply that the success of the project reflects on the team members. The literature on MCS outlines a number of aspects of an effective performance measurement program. Anthony and Govindarajan (2001) state that the relationship between strategy and performance can be summed up as 'what gets measured gets done', and that performance measurement is a key factor in ensuring successful implementation of the organisation's strategy. For companies involved in continuous improvement efforts, performance should be measured both in financial terms as well as non-financial aspects, such as key operating metrics (Daniel & Reitsperger 1994; Hanson et al 2001; Kaplan & Norton 1996). Kaplan and Norton (1996) have suggested a multidimensional approach to performance measurement, which they call the balanced scorecard. This approach fosters a balance between financial and

operating measures linking performance to rewards (Hanson et al. 2001). Although all the organisations indicated that Six Sigma performance is being measured in both financial and non-financial terms, only three employed the balanced scorecard as a measurement tool. Another aspect of an effective performance measurement system concerns the participation of employees in the determination of evaluation standards. If performance targets are set by management and are difficult to achieve, dysfunctional behaviour may result (Anthony & Govindarajan 2001; Garrison et al. 2001; Hansen et al. 2001; Horngren et al.1994; Horngren et al. 2002).

Management in approximately half the companies studied set the Six Sigma targets. Black Belts and team members selected targets in the other 50% of cases. Young (1988) found that standards imposed on employees may lead to dysfunctional consequences. This fact was not evident in this research project, as for the most part employee enthusiasm and motivation was ranked 3 or greater on a scale of 5 by the interviewees.

This study contradicts Daniel and Reitsperger's (1994) claim that North American companies have not modified their MCS to provide quality improvement feedback. The performance evaluation function has changed in Six Sigma companies to become more pervasive and formal. The researcher observed that in many cases project successes were communicated to all employees via newsletters, storyboards, graphs and charts. Thus, Six Sigma organisations are following Venkatraman and Gering's (2000) advice that data display is an important concept in communicating operating metrics to all personnel.

In conclusion, organisations implementing a Six Sigma program have expanded the scope of the performance evaluation phase of an MCS by introducing formal evaluation procedures directly related to the Six Sigma efforts of employees. A Six Sigma program also expands the time frame for performance evaluation of employee efforts beyond the traditional one year as improvements are re-measured six to 18 months after project completion. In addition to expanding the scope of an MCS of a Six Sigma organisation, the performance evaluation function deepens the MCS beyond the management level to include the efforts of Green Belt employees at the operating level.

Six Sigma reward/recognition phase

A number of studies have concluded that when an individual's reward is tied to performance along a certain set of criteria, behaviour is guided by the desire to improve on the performance of those criteria (Govindarajan & Gupta 1985). All the participants in the

organisations studied received recognition for their continuous improvement efforts uniformly. Crosby (1979) made the point that financial rewards are not personal enough to provide effective recognition. This study bears out the fact that non-financial rewards are common in Six Sigma organisations.

The data show that Six Sigma has expanded the scope and depth of the reward and recognition phase of an MCS. Recognition occurs at a number of different points throughout the year depending on completion of a Six Sigma project or training and not just at particular time periods such monthly or quarterly. In addition, Six Sigma has expanded the depth of the reward/recognition to include not only managers who were team leaders but also team members from both staff and line responsibilities. This finding agrees with the literature that companies engaged in continuous improvement recognise process improvement as a team effort (Daniel & Reitsperger 1994; Kaplan & Norton 1992).

Employee participation in the decision-making process and the development of cooperative workplace solutions is evident in Six Sigma organisations as suggested by Lawler (1994). This alternative approach to traditional management involves the employee in a more democratic role where employees, management and owners benefit in a new 'win-win' work structure. This research supports the findings of Agus & Hassan (2000), Costin (1999), Crosby (1979), Harrington & Akehurst (2000), Hendriks & Singhal (1997) and Silos (1999) in regard to the relationship between TQM, employee involvement and business performance.

The Deming (1982) 14-point management model as developed by Anderson et al. (1994) is very much evident in the organisations in this study.

Implications for theory

The major conclusion of this study is that companies are deploying Six Sigma as an integral part of their MCS and not as a standalone quality improvement program.

A model for the effective implementation of Six Sigma already exists in the literature – the management planning and control model (Anthony & Govindarajan 2001; Garrison et al. 2001; Hansen et al. 2001; Horngren et al. 1994; Horngren et al. 2002). This model is designed to organise, measure and reward performance of employees consistent with the aims and strategies of the organisation.

The literature on Six Sigma focuses on the methodology of the program in terms of the use of improvement tools and implies that once a program is up and running it will take on a life of its own. However, it fails to address the measuring and rewarding of employee performances

congruent with strategic aims. The literature on MCS, on the other hand, is rich in the efficacy of performance evaluation procedures as well as effective recognition methods and rewards for employee efforts congruent with the strategic goals of an organisation. Therefore, if companies implemented Six Sigma by integrating the program into their MCS, then that MCS would necessarily expand to incorporate that program.

The conclusion of this research is that in the majority of the firms studied the MCS changed. To begin with, senior management's announcing of a Six Sigma program as part of the future plans for an organisation expands the existing strategic planning phase of an effective MCS. Next, the allocation of corporate resources to achieve the Six Sigma strategic initiative is the second phase of an MCS and requires senior management to invest in training employees in Six Sigma tools and techniques, introduce an additional layer of managers, namely, the continuous improvement project leaders, initiate a steering committee to oversee the program, and assume an additional role at the senior management level as project champions.

In addition, Six Sigma has also broadened the scope of the performance measurement and reporting system, the third phase of an MCS by increasing the frequency of employee evaluations. Evaluations regarding Six Sigma efforts occur after training programs – in some cases at each stage of the DMAIC process, in every case after completed projects, as part of the annual performance review and, in some companies, continues beyond a 12-month period. The Six Sigma program has also deepened the MCS by including all project team members and not just the team managers. The performance evaluation feedback is communicated to employees as frequently as the evaluations occur. Finally, the fourth phase of an MCS has expanded because of Six Sigma to increase the frequency of recognition and rewards provided to employees. Recognition is provided at times of evaluations and rewards are both in financial terms and non-financial. In conclusion, the Six Sigma Continuous Improvement Program has broadened each phase of a corporation's MCS.

Implications for further research

Research into the efficacy of a Six Sigma Continuous Improvement Program has been nonexistent to date. Limitations of this research project consist of the fact that not many organisations to date have a Six Sigma program and that those that have implemented Six Sigma have done so in recent years. This means that there are not sufficient financial data on the relationship between the efficacy of Six Sigma and bottom line overall corporate net profits. Thus this study was limited to the use of qualitative data only. This research has

concluded that companies implementing Six Sigma are, to varying degrees, integrating that program into their MCS. The results suggest that Six Sigma is not another standalone, continuous improvement program but rather a strategic initiative that organisations are incorporating into the daily work activities of all employees. As such, this research project has a number of implications for possible future research efforts.

To begin with, it may be useful to conduct a longitudinal study with the subjects in order to correlate the degree of integration of a Six Sigma program into the MCS of an organisation and the long-term sustainability of that Six Sigma program. There is also the need for quantitative research to establish a correlation between the corporate profits of an organisation over the period of the Six Sigma program and the ideal management control model that supports the Six Sigma program as presented in this research project.

Another area for possible research is examining how a Six Sigma company manages corporate knowledge. Documenting Six Sigma process improvements provides a clearly defined set of data the company can use to improve other processes. Questions arise as to how the company is storing and communicating that information and finding ways to leverage process improvements. The structured DMAIC approach provides an organisation with valuable operating process information. That information has been costly to develop but once a process improvement has been achieved effective knowledge management can save a company a lot of money on improving similar processes as well as similar activities within other or related processes.

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Fluctuation in stock prices and its relationship to different measures of performance in listed Jordanian companies

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Abstract

This study is an attempt to examine empirically the effect of performance measures results (by using annual reports and the Jordanian Shareholding Companies Guide) and to investigate the relationship between stock price fluctuations and listed companies in the Amman Financial Market. Financial ratios (different measures of performance) for the years 2004, 2005 and 2006 were used in the study.

The study finds that: Earnings per Share has a positive relationship and affected share price significantly for the three years under study; return on equity has a negative relationship and affected share price significantly for the three years; whereas return on investment and return on total assets have positive relationships with share price but are not significant for the three years. The study also finds that investment turnover for the years 2004 and 2005 has a positive relationship and is not significant for 2004 but is significant for 2005, whereas it has a negative relationship but is significant for the year 2006.

This study suggests a number of effective recommendations that could improve the performance measures in corporate annual reporting practices in Jordan.

Keywords

Share, price, fluctuation, ratios, performance, measures, Jordanian, ROI, ITO, EPS, ROE, ROA, ASE.

Introduction

The evaluation of performance measures is a necessary procedure for the management of large-scale organizations. These measures should provide incentive to the lower level of employees to make decisions that are consistent with overall company objectives. Similarly, they should provide information to top executives to help them to identify those areas of the company's operations that require more attention.

Various tools are available for measuring performance, but the accuracy of these measures is subject to certain interpretations. The limitations of the accountant's ability to measure performance with absolute correctness must be recognized. Return on Investment (ROI) is a very important and useful measure of operating performance.

Top management and other related parties need to evaluate and measure performance of the company. So, they use different mechanisms to predict the company's future performance and its financial position through the analysis of financial ratios (how a company operates in comparison with other companies in the same sector of the market).

Performance evaluation is the process by which an organization obtains feedback about the effectiveness of its operations. It is a difficult process since many factors (including environmental, organizational, individual and financial ratios) are included.

Financial ratios have been used by accountants and financial analysts as a means of summarizing and analyzing financial data (balance sheet, income statement). Financial ratios could be used to indicate trends about the firm's financial position and how it operates, because these measures reflect the firm's current position in the market (stock price reactions due to earnings announcements and other important events). Based on the level of ratios certainty, users' reactions may be quite volatile and detrimental.

Stock price fluctuations and evaluating performance measures of the company are important indicators for company management itself, investors, shareholders and creditors.

The results of the current study are expected to help management to make accurate decisions and to operate in the market effectively.

Investors may also benefit from the results of the current study in deciding whether or not to invest in the company depending on its performance in the market. Stock price fluctuations may be a good indicator for them when making investment decisions (buy, sell or hold securities of the company in the market).

Moreover, shareholders may benefit from the results of the current study when deciding whether or not to increase their percentage of ownership.

Creditors need information to make decisions when deciding to grant loans to the company. They try to predict future conditions of the company.

Bad conditions may mean that the company is facing many troubles and crises that may lead to liquidation, but good conditions mean that company is doing well.

Creditors depend heavily on performance measures and financial ratios, especially debt ratio, liquidity level and earnings from investments, to classify the firm's financial risk and to identify its ability to repay the loans when due.

The main purpose of this study is to examine the relationship between stock price fluctuations and the firm's financial ratios (different measures of performance).

Although this study has specific relevance to the market of Jordan, it is believed that many other developing countries, especially those countries in the Middle East that face similar problems and needs, could be the beneficiary of its findings. In the light of globalization, global financial markets demand international consistency in accounting and auditing standards and approaches (Ernst & Young, 2004). Thus, this study is considered highly relevant because it emphasizes the development of financial markets in the Middle East region, through improving the comparability, reliability, and relevance of financial information. Jones (2005) stated, "The global markets require a similar set of international rules to achieve a smooth functioning of the market economies".

The remainder of this paper is divided into five sections. The main contributions in the relevant literature and theoretical background are discussed in Section 2. Section 3 presents the methodology of empirical research including data and main measures. A summarization of the empirical results is presented in Section 4. The last section offers a summary of the research and the conclusions.

Background and literature review

Since the information regarding the variables of the study was obtained from the Jordanian Shareholding Companies Guide (JSCG) issued by the Amman Financial Market (AFM), it is important to provide background information about AFM.

The Amman Financial Market (AFM), currently called Amman Securities Exchange (ASE), was established in March 1999 as a non-profit, private institution with administrative and financial autonomy. It is authorized to function as an exchange for the trading of securities. The exchange is governed by a seven-member board of directors. A chief executive officer oversees day-to-day responsibilities and reports to the board. ASE membership is comprised of Jordan's 70 brokerage firms.

The ASE is committed to the principles of fairness, transparency, efficiency and liquidity. The exchange seeks to provide a strong and secure environment for its listed securities while protecting and guaranteeing the rights of its investors. To provide this transparent and efficient market, the ASE has implemented internationally recognized directives regarding market divisions and listing criteria.

To comply with international standards and best practices, the ASE works closely with the Jordan Securities Commission (JSC) on surveillance matters and maintains strong relationships with other exchanges, associations, and international organizations. The exchange is an active member of the Union of Arab Stock Exchanges (UASE), Federation of Euro-Asian Stock Exchanges (FEAS), a full member of the World Federation of Exchanges (WFE), and an affiliate member of the International Organization for Securities Commissions (IOSC).

The ASE is charged with providing enterprises with a means of raising capital by listing on the exchange, encouraging an active market in listed securities based on the effective determination of prices and fair and transparent trading, providing modern and effective facilities and equipment for trading the recoding of trades and publication of prices, monitoring and regulating market

trading, coordination with the JSC as necessary, to ensure compliance with the law, a fair market and investor protection, setting out and enforcing a professional code of ethics among its member directors and staff, ensuring the provision of timely and accurate information of issuers to the market and disseminating market information to the public.

The term 'performance' is the process of systematically evaluating and measuring company strength and weakness and determining ways to improve its performance. Performance Measures, such as ratios in which the management attempts to maximize the firm's profits or owner's wealth, include: Return on Investment, Investment Turnover, Profit Margin on Sales, Return on Total Assets, Return on Common Equity and Earnings per Share.

Stock price fluctuation is the current stock price of the firm in the market. This price represent the firm's total value and can be fluctuated by increasing or decreasing of shares prices in the market which may depend on the demand of the company's shares, the firms financial results and their annual report for the year and on the dividend payout ratio (earning announcement). The issues related to the financial market have attracted a number of researchers. Most of these studies are country-specific; however, there are studies which include more than one country. Martikainen (1989) conducted a study aimed to find out which economic dimensions of the firm are reflected in stock price behaviour in the Finish stock market. The study used four economic dimensions: profitability, financial leverage, cooperating leverage and corporate growth. Twelve financial ratios are then selected to represent these four dimensions. All of the four expected dimensions above are found in the empirical classification pattern of ratios. On the cross-sectional level, profitability and financial levirate are reported as determinants of stock price behavior. Corporation growth is merely connected to the risk of the common stock. Empirical evidence strongly indicates that financial ratios represent pricing relationships in a substantive manner.

Gaver, Gaver and Battistel (1992) conducted a study to examine the stock market reaction to the adoption of long-term compensation agreements for top management that are based on accounting goals. This study highlights the difficulties inherent in analyzing the stock market reaction to announcements made in proxy statements. The results of the study were that performance plan adoptions significantly increase shareholder wealth. The adoption is viewed by market participants as a relatively minor change in the compensation contract that will not alter significantly managerial incentives.

Dechow (1994) conducted a study aimed to measure firm performance under (something missing here) that the accruals are predicted to improve earnings ability. The study concluded that realized cash flow have more severe timing and matching problems and are less able to reflect firm performance. It also concluded that accruals are less likely to mitigate timing and matching problems in realized cash flow.

Chen and Lee (1995) conducted a study to evaluate various accounting measures of business performance. The results of the study indicate that the traditional return on investment (ROI) is highly correlated with the measures of business performance and the extra profit index based on the ROI is correlated significantly also with the ex-ante growth of the firm. Sloan (1996)

conducted a study which examined whether stock prices reflect information about future earnings contained in the accruals and cash flow component of current earnings. The study concluded that stock prices fully reflect all publicly available information and stock prices act as if investors fail to identify correctly the different properties of the two components of earnings.

Wolfgang and Tom (1996) conducted a study aimed to provide new evidence on the stock-market reaction to dividend cuts and omissions by commercial banks. The study concluded that the negative reaction to dividends cut by banks should be more severe than for non-financial firms. It further shows that the stock-market reaction to a bank dividend cut appears to be more severe than the reaction to announcement of other unfavorable events for financial institutions.

Ittner, Larcker, and Madhave (1997) conducted a study focused on annual bonuses using a gross-sectional variable regression model and the incorporation of non-financial performance measures. The study examines some factors influence on financial and non-financial performance measures of chief executive officers' (CEO) annual bonus contracts. The study reveals that firms spurring an innovation-oriented prospector strategy tend to place relatively greater weight on non-financial performance in their annual bonus contracts. These results support the notion that firms attempt to link compensation policies to strategic objectives to ensure that management incentives and organizational goals are aligned. They also provide some evidence that regulations influence the choice of compensation.

Chiang, Davidson and Okunev (1997) conducted a study that examines the relationship between dividends, earnings and incorporated a modified form of the linter model. The study concludes that earnings are means reverting towards a time varying mean, and the modified formation performed as effectively as the original linter approach.

Sponholtz (2005) conducted a study examined the empirically simultaneous announcements of current dividends, current earnings and management forecast of net year's earnings using Danish data. The study finds that the stock market reacts to the surprise in management forecasts of next year's earnings and the current dividend. The study also reveals that the signaling models and free cash flow hypothesis provide explanation for separate components of the market reaction.

Dikolli and Vaysman (2006) conducted a study examined the use of earnings, forward-looking performance measures, and stock price in managerial compensation. The study found that when the owner and the manager have conflicting time preferences, the noisy stock price is useful for contracting. At the same time, they indicate that forward-looking performance measures 9such as customer satisfaction) can induce a desirable allocation of management effort between the short-term and long-term more efficiently than the stock price can.

Salma (2007) conducted a study that examined firms in the S & P 500 index and the type of performance measures used in short-term compensation. He found that firms using both financial and non-financial performance measures have higher discretionary accruals, especially accounts receivables accruals, than the firms that use only financial performance measures. This is because these firms suffer from low earnings quality which makes the accounting numbers less meaningful.

Verbeeten and Boons (2009), conducted a study to investigate whether the strategic priorities of an organization are associated with the use and effectiveness of specific performance measures. The results of the study indicate that specific strategic proprieties (i.e., the importance of market, customer orientation, innovation and personal development) tend to be associated with the use of non-financial performance measures. In addition, institutional factors appear to affect the use of specific performance measures.

To the best knowledge of this researcher, there are very few studies about stock price fluctuations and firm financial ratios in developing countries, especially in Jordan; and if available, they are old. This gives the current study great relevance and was the impetus for the researcher to begin his investigation.

Methodology

This section discusses the statistical methods used to test the study hypotheses, presents a description of the sample and sample selection, sources of data, and study variables. It is structured as follows: Section 3.1 describes measures of the performance variables. Section 3.2 presents the hypotheses. Section 3.3 presents the sample and sample selection. Section 3.4 presents sources of data, and Section 3.5 presents study variables.

Measures of the performance variables

The following variables are used in this study:

Return on Investment (ROI) is measured by dividing the earnings by investments:

ROI = Earnings ÷ Investments

Investment Turnover (ITO) is measured by dividing the sales for the year by investments:

ITO = Sales ÷ Investments.

Earnings per Share (EPS) are measured by dividing net income by the number of shares of common stock outstanding:

EPS = Net Income ÷ No. of Shares

Profit Margin on Sales (PMOS) - This ratio is measured by dividing net income (NI) by sales:

MOS = Net Income / Sales

Return on Common Equity (ROE) is measured by dividing net income available to common stock holders on common equity:

ROE = Net Income available to common stock ÷ Common equity

Return on Total Assets (ROA) is measured by dividing net income (NI) on total assets:

ROA = Net Income ÷ Total Assets

Earnings Rate (ER) is measured by dividing earnings by sales:

ER = Earnings ÷ Sales

Hypothesis

Based on the previous studies, this study examines the following hypotheses:

1. Stock price reflects a company's performance in the market with respect to financial ratios.

2. The financial ratios of the company (those related to evaluate the performance of the company) have a positive effect on the company's polices and decisions.

3. Stockholders in Jordanian corporations implement performance criteria effectively.

The financial data collected from annual reports of the Jordanian Shareholding Companies Guide was used to test the first hypothesis.

The data collected by questionnaire (a copy of the questionnaire is available upon request) was used to test the second and third hypotheses.

The questionnaire contains 15 questions. Questions number 1, 3, 7, 8, 10, 12, 13 were used to test the second hypothesis and questions 2, 4, 5, 6, 9, 11, 14, 15 were used to test the third hypothesis.

Population and Sample of the study

The population of the study includes all Jordanian listed companies of all sectors (banks and financial companies, insurance companies, service companies, and industrial companies).

For the purpose of the study, a three-year period (2004, 2005, and 2006) was selected. The corporations involved in the study should meet all of the following criteria:

1. Listed on the Amman Financial Market.

2. Fiscal year ending December 31.

3. Availability of information.

4. The company establishment date should be as of 2004 or earlier.

5. The firm must be traded relatively frequently during the period from 2004 to 2006.

Table (1) shows the distribution of sample companies:

Table (1): Distribution of sample companies

Sector name	No. of firms	Percentage of sector
Banks and financial companies	15	88.23%
Insurance companies	15	65.21%
Services companies	19	30.64%
Industrial companies	46	51.11%
Total sample	95	49.47%

Note: The sample shown in Table 1 is used only for financial ratios analysis.

Sources of data

Information for variables was obtained from the 2004 - 2006 Jordanian Shareholding Companies Guide (JSCG) issued by the Amman Financial Market (AMF). Annual reports were also used to determine the revenue for banks and financial companies; whereas to test the second and third hypotheses, information was collected through the questionnaire.

Study Variables

Share price represents the dependent variable. Whereas, independent variables include the following:

ROI, ITO, EPS, ROE, ROA, PMOS, and ER.

Research results and discussion

The analysis is divided into two major parts:

4.1. The analysis of financial ratios includes the following:

- 4.1.1. Descriptive statistics.
- 4.1.2. Multiple regression analysis.
- 4.1.3. Correlation coefficients.

Descriptive Statistics

The annual reports of companies were used to collect data. Annual reports for 95 firms for the period from 2004 – 2006 were obtained from the Amman Financial Market Library. Descriptive Statistics for the dependent and independent variables for the entire sample are shown in Table (2):

Table (2): Descriptive statistics for dependent and independent variables by year

	2004			2005			2006		
The Variable	Mean	St. Dev.	Coeff. of variation	Mean	St. Dev.	Coeff. of variation	Mean	St. Dev.	Coeff. of variation
Share Price	5.32	18.47	3.47	5.63	23.90	4.25	5.42	25.76	4.75
EPS	0.37	1.64	4.43	0.40	1.87	4.68	0.55	2.52	4.58
ROI	4.55	4.87	1.07	4.34	4.70	1.08	3.80	4.74	1.25
ITO	6.67	6.97	1.05	6.46	6.69	1.04	5.39	6.60	1.22
ROE	9.23	7.78	0.84	8.86	8.10	0.91	7.86	7.18	0.91
ROA	4.55	4.87	1.07	4.34	4.70	1.08	3.80	4.74	1.25
ER	15.25	15.63	1.25	15.44	17.11	1.11	12.52	15.70	1.25
PROS	11.07	11.61	1.05	11.76	14.75	1.25	10.46	13.94	1.33

Table 2 shows that there is an increase in the coefficient of variation 'share price' over the years 2004, 2005, and 2006 (3.47, 4.25 and 4.75 respectively).

It also shows that there is an increase in the coefficient of variation of EPS over the years 2004, 2005, and 2006 (4.43, 4.68 and 4.58 respectively). This means that firms are doing well in generating profits and reducing operating costs.

An increase in the coefficient of variation of ROI over the years 2004, 2005, and 2006 (1.07, 1.08 and 1.25 for ROI respectively) can be seen in the table. There is also an increase in coefficient of variation of ROA over the years 2004, 2005, and 2006 (1.07, 1.08 and 1.25 respectively. Again, this means that firms are doing well in generating profits and reducing operating costs.

Regarding ITO, the table shows that there is a decrease in the coefficient of variation over the years 2004, 2005, and 2006 (1.05, 1.04, and 1.22 respectively). This decrease may be because firms sales to total investments are not improved (sales decrease from year to another) and the firms' utilization degree of their resources are doing well. However, there is an increase in 2006 (1.22), which means that firm's sales to total investments started to improve.

Relative to ROE, Table 2 shows that there is an increase in the coefficient of variation over the years 2004, 2005, and 2006. This increase means that the firms' net incomes are increasing.

Regarding the PROS, the table shows that there is an increase in the coefficient of variation over the years 2004, 2005, 2006.

Relative to ER, the table shows that there is a greater decrease in the coefficient of variation in 2005 than in 2004, but it increased in 2006 to a level equal 2004. This may give a bad indication about how effectively the firm operated as it gained in sales.

Based on the above analysis, it seems that companies in Jordan are doing well. EPS was increased and this gave the firms a positive indication in the market. However, it is not a good indicator that companies achieved high net income because most companies may declare dividends through decreasing the retained earnings reserved. As well, companies face some difficulties in that they may not have utilized assets effectively or could not find a good source of financing (interest rates on loans may be high). Finally, some of these ratios affect share prices with different percentages such as EPS (when firms declare dividends), PROS (when sales of companies decrease or increase), and ROE (when the income for each shareholder is increased or decreased).

Multiple Regression Analysis

Table 3 presents the multiple regression analysis.

Table (3): Multiple regression analysis for dependent and independent variables

	2004			2005			2006		
Adj. R^2	0.9888			0.9958			0.7811		
Variables	*B*	*T*	*SIG.*	*B*	*T*	*SIG.*	*B*	*T*	*SIG.*
EPS	11.30	87.53	0.000	12.90	144.1	0.000	9.418	17.40	0.000

ER	0.010	0.345	0.731	-0.03	-0.92	0.358	-0.57	-1.17	0.244
ITO	0.014	0.161	0.873	0.149	1.858	0.067	-0.77	-2.33	0.022
PROS	-0.03	-0.88	0.383	0.020	0.520	0.604	0.635	1.212	0.229
ROE	-0.01	-2.06	0.042	-0.20	-5.25	0.000	-0.22	-0.67	0.504
ROA	0.029	0.234	0.816	0.096	-0.87	0.387	1.194	2.126	0.036
ROI	0.029	0.234	0.816	0.096	-0.87	0.387	1.194	2.216	0.036

Where:

Adj. R^2 represents the portion of the total variation in the dependent variables that is explained by its relationship with the independent variable.

The results in the table show the following:

For Year 2004

There is a positive relationship between EPS, ER, ITO, ROI, ROA and the share price. This relationship is very significant with EPS, but with other independent variables it is not significant. Whereas the other independent variables, PROS and ROE, have a negative relationship with share price, it is significant with ROE and not significant with PROS. The relationship between independent variables is strong according to the value of Adj. R^2 (0.9888).

For Year 2005

There is a positive relationship between EPS, ITO, PROS, ROI, ROA and the share price.This relationship is very significant with EPS and ITO. Whereas the other independent variables, ER and ROE have a negative relationship with share price, and are very significant with ROE. The relationship between independent variables is strong according to the value of Adj. R^2 (0.9958).

For Year 2006

There is a positive relationship between EPS, PROS, ROI, ROA and the share price. This relationship is very significant with EPS, ROI and ROA, but not significant with PROS. The other independent variables, ER, ITO and ROE have a negative relationship with share price (it's significant with ROE and ITO). The relationship between independent variables is medium according to the value of Adj. R^2 (0.7811).

Correlation Coefficient

Table 4 presents the correlation coefficient between share price and independent variables for the 3 years.

Table (4): Correlation coefficient between share price and independent variables for the 3 years

Variable Name	***2004***	***2005***	***2006***
EPS	0.9940	0.9965	0.8805
ER	0.0344	0.0095	0.0481
ITO	-0.0228	-0.0330	-0.0298
PROS	0.0243	0.0034	0.0298
ROE	0.1331	0.1198	0.1506
ROA	-0.0172	-0.0309	-0.0248
ROI	-0.0172	-0.0309	-0.0248

Earnings per Share (EPS).

The results show there is a high positive correlation with share price for the three years and are positively affected. If EPS increase, so share price will increase also, but at an unknown percentage (the percentage increase depends on the effect of announcements of EPS in the market).

Earnings Rate (ER).

For the three years of the study, there is a strong weak positive correlation with share price, and it is near zero, especially in year 2005.

If ER increases, share price reaction will increase (share price sensitivity to this action is very low).

Investment Turnover (ITO).

For the three years under study, there is a strong weak negative correlation with share price, and it's near zero for the three years. This means that share price will be increased or decreased by changes in ITO.

Profit Margin on Sales (PROS).

There is a strong weak positive correlation with share price, and this means that if PROS increases, share price may also be increased.

Return on Common Equity (ROE).

For the three years under study, there is a positive correlation with share price. This means that share price will be increasing or decreasing according to fluctuations in ROE. For the three years, ROE decreased as did the share price.

Return on Investment (ROI) and Return on Total Assets (ROA).

There is a strong weak negative correlation with share price, and this means that if ROI and ROA increase, share price will decrease by a small amount.

The analysis of the questionnaire: This part presents the analysis for the questionnaire. One-hundred and twenty (120) questionnaires were distributed; 97 questionnaires were received, with a response rate of 80.8 percent.

The following statistical methods were used in the analysis:

4.2.1. Descriptive Statistics.

4.2.2. Correlation Coefficients.

Descriptive Statistics

Table 5 presents the distribution of respondents according to personal data.

Table (5): Distribution of respondents according to personal data

Variable	Frequency		Percent (%)
Sex	Male	78	80.41
	Female	19	19.59
Specialization	Accounting	33	34
	Finance	24	24.8
	Business	17	17.5
	Others	23	24.7
Qualification	Secondary school	10	10.3
	College	18	18.5
	Bachelor	53	54.6
	Master	14	14.4
	PhD	0	0
	Others	2	2
Experience	Below 3 years	7	7.22
	3-6 years	21	21.65

	6-10 years	25	25.77
	More than 10 years	44	45.36

Table 5 above shows that the majority of the respondents (80.41 percent) are male, 34 percent are accountants, 24.8 percent are finance, and 17.5 percent are employed in the business sector. This result means that the respondents are qualified to answer the questionnaire. Also, the table shows that those who hold bachelor degrees or above constitute a high percentage (69 percent). Again, this result means that the respondents are qualified to respond to the questionnaire. Regarding the variable 'experience', the table shows that people with experience of 6 years or above have the highest percentage (71.3 percent).

Analysis of second hypothesis

Question numbers 1, 3, 7, 8, 10, 12 and 13 are included to test the second hypothesis.

The mean is classified into a 5-point Likert scale as follows:

-2 to -1: Strongly Disagree

-1 to 0: Disagree

0 : No opinion

0 to 1: Agree

1 to 2: Strongly Agree

Table 6 presents the analysis of variables related to second hypothesis.

Table (6): Descriptive statistics for the questionnaire

	Strongly Agree	Agree	No Opinion	Disagree	Strongly disagree
Questions	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)
Q1: When the balance sheet is prepared, EPS and ROI are the important indicators for evaluating the amount of profit.	63 64.95%	26 26.8%	5 5.15%	2 2.06%	1 1.03%
Q3: Financial ratios reflect the firm's financial position carefully.	51 52.58%	27 27.84%	11 11.34%	7 7.22%	1 1.03%
Q7: Company compares its performance with others in the same sector.	52 53.6%	35 36.08%	7 7.22%	2 2.06%	1 1.03%
Q8: Company distorts the financial information for annual report in order to show a good prospect about the company.	17 17.53%	7 7.22%	16 16.5%	22 22.68%	35 36.08%
Q10: Company is interested in the availability of information about it.	48 49.48%	35 36.09%	6 6.19%	7 7.22%	1 1.03%
Q12: There is a relationship between the ability of the company to repay loans and getting any commercial facilities.	41 42.7%	37 38.14%	12 12.4%	10 10.31%	3 3.09%
Q13: ROI is considered the most important performance measure for the company.	41 42.27%	38 39.17%	8 8.25%	9 9.22%	1 1.03%

Table 6 above reveals the following results:

Regarding Question 1, Agree and Strongly Agree constitute 91.75 percent of the respondents. This result shows a good indicator about preparing balance sheets by companies and an interest in calculating profitability ratios EPS, ER, and PROS.

Regarding Question 3, Agree and Strongly Agree constitute 90.42 percent of the respondents. This result assures the fact those firms' financial statements reflect the financial position of the firm through calculating performance measures.

Regarding Question 7, Agree and Strongly Agree constitute 89.68 percent of the respondents. This result indicates that each company in the market is interested in comparing its annual results with other companies in the same sector. Regarding Question 8, Disagree and Strongly Disagree constitute a high negative from 58.76 percent of the respondents. This result indicates that companies are committed to regulations and do not distort the figures of financial statements. Regarding Question 10, Agree and Strongly Agree constitute 75.56 percent of the respondents. This result indicates that companies are interested in the availability of information about them in the Jordanian Shareholding Companies Guide.

Regarding Question 12, Agree and Strongly Agree constitute 80.41 percent of the respondents. This result indicates that companies agree on linking the commercial facilities they get from lenders with the companies' ability to repay (default risk is very low).Regarding Question 13, Agree and Strongly Agree constitute 81.44 percent of the respondents. This result indicates companies considered ROI as the most important performance measure for evaluating the company position.

Table 7 shows the analysis for correlation coefficient for variables related to the second hypothesis.

Table (7): Correlation coefficient for variables related to the second hypothesis

Variables	A1	A3	A7	A8	A10	A12	A13
A1	1.0000	0.8933	0.9059	0.6132	0.8814	0.8505	0.8408
A3		1.0000	0.9389	0.6996	0.9565	0.9061	0.9368

A7			1.0000	0.6792	0.9349	0.8682	0.8950
A8				1.0000	0.6912	0.7755	0.7480
A10					1.0000	0.9033	0.9364
A12						1.0000	0.9338
A13							1.0000

The table shows that the correlation coefficient between variables of the second hypothesis is relatively high. It ranges from 0.9565 between A3 and A10, and 0.6132 between A8 and A1. This means that the relationship between questions is strong.

Analysis of third hypothesis

Table 8 shows descriptive statistics for variables related to the third hypothesis.

Table (8): Descriptive statistics for variables related to the third hypothesis

	Strongly Agree	Agree	No Opinion	Disagree	Strongly disagree
Questions	Freq (%)	Freq (%)	Freq (%)	Freq (%)	Freq (%)
Q2: Company does comparisons between current year and previous years.	65 67.01	29 29.90	3 3.09	0 0	0 0
Q4: Company performance is evaluated through share price from one year to another without depending on other performance measures.	30 30.93	14 14.44	8 8.24	35 36.10	10 10.30

Q5: Company share price doesn't reflect the firm financial position specifically.	31 31.96	41 42.27	10 10.30	12 12.36	3 3.09
Q6: Positive financial ratios help firms to have easy access to financial market.	43 44.33	36 37.13	11 11.33	5 5.15	2 2.06
Q9: Companies issue annual reports yearly.	52 53.61	33 34.04	3 3.09	6 6.18	3 3.09
Q11: Companies have a reasonable level of liquidity to prevent any unexpected financial crisis.	48 49.48	34 35.07	9 9.27	4 4.12	2 2.06
Q14: Improving the company's performance through increasing the sales level.	41 42.27	34 35.07	10 10.30	8 8.24	4 4.12
Q15: Company's repurchase its stock to increase EPS when net income is below expectations.	25 25.77	16 16.50	16 16.50	23 23.71	17 17.53

The table shows the following results:

Regarding Question 2, Agree and Strongly Agree constitute 96.91 percent of the respondents.This result is a good indicator about the net income the companies generate. Regarding Question 4, the respondents are divided almost equally between Agree and Strongly Agree with 45.37 percent and Disagree and Strongly Disagree with 46.40 percent. This result indicates that companies depend on other performance measures to evaluate their performance. Regarding Question 5, Agree and Strongly Agree constitute 74.23 percent of the respondents. This result is a good indicator about net income the companies generate. This result indicates that investors may take wrong decisions if they consider share price as an indicator for evaluating performance, because share price does not reflect all information related to company and may be speculation takes place.

Regarding Question 6, Agree and Strongly Agree constitute 81.46 percent of the respondents. This result indicates that if companies have positive performance measures, they may obtain loans to finance their operations at low interest rates.

Regarding Question 9, Agree and Strongly Agree constitute 85.05 percent of the respondents.

This result indicates that companies implement the requirements of laws and regulations (i.e.,

issue annual reports).

Regarding Question 11, Agree and Strongly Agree constitute 77.34 percent of the respondents. This result shows a good indicator about the liquidity of companies.

Regarding Question 14, Agree and Strongly Agree constitute 87.65 percent of the respondents. This result shows that most companies accept the opinion of increasing the size of sales and performance through granting discounts and other facilities in repayment of debts.

Regarding Question 15, the respondents are divided almost equally between Agree and Strongly Agree with 42.27 percent and Disagree and Strongly Disagree with 41.24 percent. This result indicates that although the results are almost equal, it seems that the idea of increasing EPS through repurchase of its stock is acceptable.

Correlation Coefficient

Table (9) presents the analysis of correlation coefficient for variables related to the third hypothesis.

Table (9): Correlation Coefficient for variables related to the third hypothesis

Variable	A2	A4	A5	A6	A9	A11	A14	A15
A2	1.0000	0.7213	0.8363	0.8098	0.8178	0.8171	0.5310	0.7616

A4		1.0000	0.8489	0.8571	0.8102	0.8384	0.5758	0.9562
A5			1.0000	0.9093	0.8637	0.8952	0.7012	0.8793
A6				1.0000	09128	0.9534	0.6951	0.8658
A9					1.0000	0.9428	0.6599	0.7841
A11						1.0000	0.6688	0.8307
A14							1.0000	0.5944
A15								1.0000

The results in the table indicate that the correlation coefficient between the variables of the third hypothesis is relatively high. It ranges from 0.9562 between A4 and A15, and 0.5310 between A14 and A2. This means that the relationships between questions are strong.

Conclusions and recommendations

This study has examined the effects of performance measures and their relationship to share price fluctuations in Jordanian companies listed in the Amman Financial Market for the years 2004, 2005, and 2006.

The study reveals that Earnings per Share have a positive relationship and affect share price significantly for the three years of the study.

The study found that return on equity has a negative relationship and affected share price significantly for the three years; whereas return on investment and return on total assets have positive relationships with share price but are not significant for the three years.

The study also found that investment turnover for the years 2004 and 2005 has a positive relationship, but it is not significant for 2004; significant for 2005, and has a negative relationship and is significant for the year 2006.

Furthermore, the study reveals that profit margin on sales has a negative relationship with share price for the year 2004, but is not significant; whereas it has a positive relationship but is not significant for the years 2005 and 2006.

Finally, the study concluded that the earnings rate for 2004 has a positive relationship with share price but is not significant; whereas it has a negative relationship but is not significant for the years 2005 and 2006.

This researcher suggests a number of effective recommendations that could improve the corporate reporting practices in Jordan. They include: a) companies be required to increase their efficiency in generating more revenue by producing high-quality products and services at minimum costs by using modern technology; b) companies be required to follow disclosure standards in financial statements in order to encourage investors to increase their investments, which in turn increase the companies' profits; c) the emphasis should be on the development of the Amman Financial Market through the adoption of international accounting standards that will improve the comparability, reliability, and relevance of financial information.

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An examination of TQM critical success factors at Qatar's Oil & Gas industry

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Abstract

This study examines TQM critical success factors implementation in State of Qatar's oil and gas industries. This study attempts to determine what companies implementing TQM programs and what critical issues hindering the implementation of their TQM programs. This study further attempt to determine whether critical success factors are contributing to the success or failure of foreign and local TQM programs in oil and gas companies equally, and whether there is a relationship between critical success factors, and performance of oil and gas companies. This study concludes that there is a strong correlation between critical success factors and performance of oil and gas industry in the State of Qatar. This relationship suggest that foreign companies operating in Qatar are more likely to consider the implementation of critical success factors as essential elements of their TQM programs (Appendix-I). This study also suggests that critical success factors are not contributing to the failure of TQM programs in the Qatari oil and gas industry. The study findings also support the proposition that cultural elements are contributing factors to the failure of TQM programs in large oil and gas companies.

Introduction

Critical Success Factors "CSF" are concerned with measures within the organization that produces successful implementation of total quality management activities, Haim (1993). Various research has been conducted on the implementation of TQM in USA and Europe, little tangible results in terms of productivity has been reported, (Harari, 1993). Furthermore, over seventy percent of company's implemented TQM programs abandoned them before completion because of lack of results, Brown (1995). Therefore, diverse industries are forced to alter the way the view TQM. As a result, deeper examination and understanding of TQM problems in various industries world-wide is required to increase our understanding of CSF and implications on TQM in an effort to avoid future implementation failures.

Furthermore, an investigative study of TQM's critical success factors is required because of the broad variation between intended objectives and actual results. Examination of the critical success factors and the soft elements of TQM through empirical research can provide significant contribution to the understanding of TQM as an evolving discipline. Such research is specially needed in Qatar and surrounding countries for better understanding and implementation of TQM programs since the region is one of the largest suppliers of oil and gas to the world (U.S. Energy Information Administration, 2009). Currently, little literature is available that examines TQM in Qatar's oil and gas industries. Qatar's industries are considered to be the world second largest natural liquid gas producer and advancing to be the world first producer of liquid natural gas.

Moreover, a study that investigates critical success factors in TQM programs in the Gulf Cooperation Council (GCC) and Qatar is needed to observe the impact of cultural values on the success and failure of TQM measures in the region as well. Culture tends to be an important element and a decisive factor in the success and failure of TQM programs, Tennant and Wu (2005). Hence, this study is thought to be a necessity to a country with expanding economy and industrial base. The primary objectives of this study are:

- The examination of TQM critical success factors implementation in Qatar's primary industries; oil and gas.
- To determine what companies implementing TQM programs and what critical issues hindering the implementation of TQM
- To assess critical success factors and determine whether it is contributing to the success or failure of TQM programs in State of Qatar foreign and domestic oil and gas companies.
- To verify whether there is a relationship between critical success factors and performance of oil and gas companies.

Research questions

1- Is there a relationship between critical success factors and performance of oil and gas industry?
2- Are critical success factors contributing to the success or failure of TQM programs in oil and gas industry?

Literature Review

Numerous researches have been investigating the design and application of TQM methods. Research has been concerned with increasing the effectiveness of TQM programs to product quality, provide value, and increase competitiveness, Powell (1995). TQM programs among businesses take various approaches depending on the level of change desired and organization structure. However, the common goal is

creating significant change and organization transformation and measuring success or failure to determine implementation efficiencies.

The philosophy of process management and quality is not limited to one aspect or one department of an organization, Grover and Kettinger (2000). It is a process that is adopted and implemented across the entire organization, a process that lies in the minds and hearts of all employees as crucial part of their core philosophy, Sambamurthy (2000). Khalil (1996) stated that businesses may consider the utilization of TQM processes and tools for various reasons. However, Grover and Kettinger (2000) noted that implementation of TQM methodologies in modern organizations assist in providing systematic guidance to evaluate, measure projects in the ongoing effort of conducting assessment, and compare the implementation of organizational performance with one another. Khalil (1996), and Grover & Kettinger (2000) share Khalil view that specific task, program, and function in the overall organizational performance are not successful without the employment of performance measurement tools such as critical success factors. Baark (1999) and Clott (2004) agree that the utilization of critical success factors is to assist companies not only in performance measurement, but in examining measuring strategies, capitalization on opportunities, and assessment of TQM performance within organizations. Fincham and Evans (1999) also agreed that critical success factors adopted by organizations can provide the necessary instrument as to how everyone in the same industry is measuring up, and provides indications as to why customers reacting to certain products the way they do.

Additionally, Appelbaum and Steed (2005), suggests that examination of critical success factors helps determines essential factors being incorporated by various players within the same industry, and leads to performance improvement. Hence, organizations are more able to pinpoint key elements contributing to their TQM implementation performance and adjustments needed. The limitations of critical success factors however, is that examination of factors is not homogenous to all countries, Hsien, Khoo, and Tan (2002). Each institution enjoys varying characteristics where the applications of many tools are not necessarily the best tools to implement, when other business process reengineering tools might be more applicable depending on the organization's situation and culture values.

Methodology

A quantitative research approach in the form of self-administered survey was distributed to all oil and gas companies operating in Qatar. Each survey was designed with likert-scale to facilitate data analysis. Data collected from participants was entered into an SPSS statistical analysis software version 15. In order to analyze the results and findings of the study, descriptive statistics and cross-tabulation in addition to correlation coefficient was applied to determine the presence and degree of association, or absence, of a relationship between any pair of variables chosen to be analyzed. A 2-tailed correlation analysis was also

used to explore how demographic variables are related to various responses. This also allows the examination of observations frequencies that belong to specific categories of more than one variable. Results of analysis are presented in the following pages.

Sample of the study

The population for this study is comprised of all Qatar's oil and gas companies including foreign owned companies. The sample of the study included most companies in the population because of their small number, geographical location, and ease of access. The total number of questionnaires distributed was 240. The majority of questionnaires circulations were at Qatar Gas (QAGAS) and Qatar Petroleum (QP) since they represent the largest oil and gas companies in the nation, employ the largest number of people, and invest the largest amount of money per employee among their rivals in the industry. A total of 47 usable questionnaires were returned, giving a response rate of (80%).

Questionnaire

To investigate critical success factors in the oil and gas industry a questionnaire developed. Each participant was asked to complete one self-administered questionnaire presented in English language. The questionnaire was divided into the following segments: organizational demographics such as participant's roles and positions, total quality management questions, education and training questions, assessment of employee's satisfaction within their prospective organizations, and critical success factors segment. A five-point Likert-scale is used to represent the degree of a respondent's agreement and disagreement with statements ranging from "0" to "5".

Results

Table 1 shows that (89.4%) agree and strongly agree that communication links established between employees and management is important, but only (61.7%) thinks it is actually taking place (Table 2). Table 1 further shows that employees' views are acted upon ranks (87.9%) in importance, but in reality only (44.7%) agree and strongly agree it is being practiced.

Descriptive analysis further shows (Table 1) that participants agree and strongly agree on the importance of employees get trained for job-related skills (93.6%), while only (55.3%) agree and strongly agree it is actually acted upon (Table 2). (85.1%) agree and strongly agree that investment decisions are based on sound resources consideration within their organizations but only (57.5%) believe it is practiced. (80.9%) agree and strongly agree that it is important for employees to be trained in quality-specific tools and techniques (Table 1), yet only (48.9%) thinks that it is actually happening (Table 2).

When asked how important for employees to be trained on total quality concepts (78.7%) agree and strongly agree that it is important (Table 1), yet only (40.4%) thinks that it is being practiced. (87.3%) agree and strongly agree that training time should be provided for employees (Table 1), and (48.9%) agree that training time is being provided for employees (Table 2). (91.3%) believe that it is important that continuous learning is provided through education and training, (57.4%) feel that they are actually continuous learning is provided through education and training.

(89.3%) agree that it is important to have a pleasant environment at working place, (65.9%) agree that they are enjoying a pleasant work environment. (93.6%) concur that it is important for management to foster such positive values as trust, honesty, hardworking. Only (55.3%) agree that such values are actually being fostered by management. (93.6%) assent that teamwork and involvement are important normal practices at their workplace, yet only (68.1%) thinks that it is actually taking place. (87.3%) thinks that it is important to motivate employees to contribute towards building a quality culture, (72.3%) agree that this is actually taking place.

Table 1: The Importance of critical success factors to organizations

Factors	Strongly agree		Agree		Uncertain		Disagree		Strongly disagree	
management participation in decision making	12	26.7	29	61.6	4	8.5	0	0	1	2.1
Quality tools and techniques are widely used										
There is a quality improvement coordination body (e.g. quality steering committee)										
Appropriate teqneques are implemented when necessary	6	12.8	27	57.4	3	6.4	1	2.1	8	17.0
Systems and procedures for quality assurance are implemented										
Statistical techniques used in design processes										
Continuous improvement conducted to improve processes										
Management act as key driver in continuous										

improvement										

Employees are trained in quality specific tools and teqneques	14	29.8	24	51.1	7	14.9	1	2.1	1	2.1
Employees are trained in total quality concepts	9	19.1	28	59.6	6	12.8	1	2.1	2	4.2
Training time is provided or employees	13	27.7	28	59.6	5	10.6	1	2.1	0	0
Continuous learning is provided through education and training	15	31.9	28	59.6	2	4.3	1	2.1	1	2.1
Management always update their knowledge	15	31.9	27	57.4	1	2.1	1	2.1	3	6.4
Employees are trained for job-related skills	21	44.7	23	48.9	2	4.3	1	2.1	0	0
Management build an improvement culture										
Employees views are listened and acted upon	13	27.7	28	59.6	4	8.5	1	2.1	1	2.1
Communication links established betwee employees and management	31	66.0	11	23.4	5	10.6	0	0	0	0

Table 2: The Practice of critical success factors in organizations

Factors	Strongly agree		Agree		Uncertain		Disagree		Strongly disagree	
management participation in decision making	6	12.8	20	42.6	17	36.2	2	4.3	2	4.2
Quality tools and techniques are widely used										

There is a quality improvement coordination body (e.g. quality steering committee)										
Appropriate teqneques are implemented when necessary	3	6.4	16	34.0	12	25.5	5	10.6	9	19.1
Systems and procedures for quality assurance are implemented										
Statistical techniques used in design processes										
Continuous improvement conducted to improve processes										
Management act as key driver in continuous improvement										
Employees are trained in quality specific tools and teqneques	8	17	15	31.9	18	38.3	4	8.5	2	4.2
Employees are trained in total quality concepts	4	8.5	15	31.9	22	46.8	3	6.4	2	4.2
Training time is provided or employees	7	14.9	16	34	16	34	5	10.6	3	6.4
Continuous learning is provided through education and training	4	8.5	23	48.9	14	29.8	3	6.4	3	6.4
Management always update their knowledge	3	6.4	25	53.2	9	19.1	2	4.3	4	8.5
Employees are trained for job-related skills	8	17	18	38.3	15	31.9	3	6.4	3	6.4
Management build an improvement culture										
Employees views are listened and acted upon	2	4.3	19	40.4	17	36.2	3	6.4	6	12.8

Communication links established betwee employees and management	13	27.7	16	34	15	31.9	1	2.1	2	4.3

Conclusion

This study concludes that there is a strong correlation between critical success factors and performance of oil and gas industry in the State of Qatar. This relationship suggest that foreign companies operating in Qatar are more likely to consider the implementation of critical success factors as essential elements of their TQM programs (Appendix-I). This study also suggests that critical success factors are not contributing to the failure of TQM programs in the Qatari oil and gas industry. The study findings also support the proposition that cultural elements are contributing factors to the failure of TQM programs in large oil and gas companies. These findings also supports Appelbaum and Steed (2005) findings that examination of critical success factors helps in the determination of elements that leads to organizational performance improvements. Additionally, findings of this study supports Hsien et, al. (2002) findings that cultural characteristics are determining factors in the makeup of organizations and are contributing factors to the success or failure of TQM programs.

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APPENDIX-I

Correlation analysis of critical factors

VAR00008	VAR00011	VAR00013	VAR00015	VAR00016	VAR00020	VAR00024	VAR00038	VAR00061
0.1080897	0.1476625	0.143555	0.1787762	0.2055505	0.0708559	0.1997373	0.1658246	0.6318756
0.4695604	0.3274239	0.3412063	0.2292318	0.1657197	0.6476356	0.1883504	0.2652975	1.904E-06
47	46	46	47	47	44	45	47	47
0.0566752	0.3374499	0.3344118	0.6368773	0.692593	0.4726546	0.5949821	0.6199932	0.2324507
0.7051426	0.0218228	0.0231163	1.489E-06	6.901E-08	0.0011963	1.629E-05	3.358E-06	0.1158779
47	46	46	47	47	44	45	47	47
1	0.4776775	0.570673	0.5188204	0.4258113	0.3256539	0.2032005	0.4748895	0.0273316
	0.0007877	3.458E-05	0.0001868	0.0028443	0.0309947	0.1806462	0.000744	0.8552966
47	46	46	47	47	44	45	47	47
0.4776775	1	0.8434198	0.3545287	0.3930816	0.4432638	0.3501773	0.4985004	0.1305983
0.0007877		1.888E-13	0.0156294	0.0068847	0.0025827	0.0197922	0.0004221	0.3869853
46	46	46	46	46	44	44	46	46
0.570673	0.8434198	1	0.4078055	0.46231	0.3485157	0.41031	0.5249032	0.0472378
3.458E-05	1.888E-13		0.0049053	0.0012179	0.0204246	0.0056695	0.0001803	0.7552387
46	46	46	46	46	44	44	46	46
0.5188204	0.3545287	0.4078055	1	0.8695357	0.7057448	0.5741889	0.7954718	0.1323893
0.0001868	0.0156294	0.0049053		2.204E-15	8.771E-08	3.721E-05	2.388E-11	0.3750309
47	46	46	47	47	44	45	47	47
0.4258113	0.3930816	0.46231	0.8695357	1	0.6951984	0.6705701	0.8161485	0.1570447
0.0028443	0.0068847	0.0012179	2.204E-15		1.635E-07	4.662E-07	2.742E-12	0.2917862
47	46	46	47	47	44	45	47	47
0.3256539	0.4432638	0.3485157	0.7057448	0.6951984	1	0.4635985	0.6570547	0.0874875
0.0309947	0.0025827	0.0204246	8.771E-08	1.635E-07		0.0019873	1.27E-06	0.5722748
44	44	44	44	44	44	42	44	44
0.2032005	0.3501773	0.41031	0.5741889	0.6705701	0.4635985	1	0.7063585	0.2289432
0.1806462	0.0197922	0.0056695	3.721E-05	4.662E-07	0.0019873		5.916E-08	0.1303425
45	44	44	45	45	42	45	45	45

0.4748895	0.4985004	0.5249032	0.7954718	0.8161485	0.6570547	0.7063585	1	0.2203829
0.000744	0.0004221	0.0001803	2.388E-11	2.742E-12	1.27E-06	5.916E-08		0.1366046
47	46	46	47	47	44	45	47	47
0.0273316	0.1305983	0.0472378	0.1323893	0.1570447	0.0874875	0.2289432	0.2203829	1
0.8552966	0.3869853	0.7552387	0.3750309	0.2917862	0.5722748	0.1303425	0.1366046	
47	46	46	47	47	44	45	47	47
-0.067503	0.0563373	0.0537501	0.3883181	0.4002091	0.1296186	0.4492073	0.4552015	0.5405375
0.6521117	0.7099833	0.7227581	0.0069917	0.005314	0.4017013	0.0019656	0.0013049	8.774E-05
47	46	46	47	47	44	45	47	47
0.4336883	0.2338924	0.2460193	0.2185561	0.1728895	-0.0338723	0.1431389	0.3150585	0.0410806
0.0023238	0.117708	0.0993313	0.1399687	0.2451824	0.827213	0.3482305	0.0310028	0.7839567
47	46	46	47	47	44	45	47	47
0.4600359	0.3300002	0.2952715	0.6244651	0.5717166	0.3226551	0.329509	0.5209854	0.408125
0.0012969	0.0251086	0.0463513	3.519E-06	3.32E-05	0.0326684	0.0289479	0.0002055	0.0048685
46	46	46	46	46	44	44	46	46
0.207377	0.4616878	0.3615204	0.2259488	0.3201244	0.2280295	0.3767771	0.309717	0.2401711
0.1667024	0.0012391	0.0135643	0.1310722	0.0300926	0.1365599	0.0117029	0.0362062	0.1078962
46	46	46	46	46	44	44	46	46
0.3534443	0.4837223	0.4748254	0.3607134	0.4285126	0.2346354	0.3363517	0.4919111	0.1284874
0.0172331	0.0007617	0.0009818	0.0149239	0.0033164	0.129899	0.0274325	0.0005993	0.4002585
45	45	45	45	45	43	43	45	45
0.1999861	0.1932248	0.188013	0.6670083	0.6610168	0.3833881	0.4942744	0.5396805	0.2435487
0.1777299	0.1982291	0.2108369	3.064E-07	4.255E-07	0.0102025	0.0005586	9.049E-05	0.0990104
47	46	46	47	47	44	45	47	47
0.2441018	0.2316233	0.3354986	0.6974229	0.8056559	0.4846551	0.5206621	0.6014552	0.1049158
0.0982222	0.1214154	0.0226464	5.12E-08	8.493E-12	0.0008564	0.0002458	7.78E-06	0.4827798
47	46	46	47	47	44	45	47	47
0.0595176	0.1174984	0.0894381	0.4912634	0.5076742	0.6425701	0.2520265	0.4379996	0.3067276
0.7011487	0.4474962	0.5637062	0.0007087	0.0004355	2.569E-06	0.1073675	0.0029437	0.0428537
44	44	44	44	44	44	42	44	44
-0.132591	0.1093945	0.1166158	0.3964405	0.4990515	0.2283276	0.7752662	0.5122012	0.3675868
0.3852516	0.4796428	0.4509391	0.0070173	0.0004838	0.1458446	4.046E-10	0.0003222	0.0129876

45	44	44	45	45	42	45	45	45
0.2188306	0.3035461	0.2604691	0.6509844	0.6235937	0.5253674	0.4781285	0.8039853	0.2886723
0.1394594	0.0402905	0.0804141	7.257E-07	2.835E-06	0.0002504	0.0008942	1.01E-11	0.0490838
47	46	46	47	47	44	45	47	47

VAR00063	VAR00066	VAR00067	VAR00069	VAR00071	VAR00073	VAR00074	VAR00078
0.3599502	-0.0745091	0.3024586	0.0989058	-0.0770685	0.1899426	0.198783	0.2049552
0.012949	0.6186628	0.0410479	0.5131395	0.6148291	0.2009694	0.1804068	0.1820076
47	47	46	46	45	47	47	44
0.6574139	-0.063773	0.4772068	0.3356664	0.3685266	0.5961995	0.6865822	0.4610522
5.166E-07	0.6702049	0.0007985	0.0225745	0.0127403	9.779E-06	9.928E-08	0.0016343
47	47	46	46	45	47	47	44
-0.067503	0.4336883	0.4600359	0.207377	0.3534443	0.1999861	0.2441018	0.0595176
0.6521117	0.0023238	0.0012969	0.1667024	0.0172331	0.1777299	0.0982222	0.7011487
47	47	46	46	45	47	47	44
0.0563373	0.2338924	0.3300002	0.4616878	0.4837223	0.1932248	0.2316233	0.1174984
0.7099833	0.117708	0.0251086	0.0012391	0.0007617	0.1982291	0.1214154	0.4474962
46	46	46	46	45	46	46	44
0.0537501	0.2460193	0.2952715	0.3615204	0.4748254	0.188013	0.3354986	0.0894381
0.7227581	0.0993313	0.0463513	0.0135643	0.0009818	0.2108369	0.0226464	0.5637062
46	46	46	46	45	46	46	44
0.3883181	0.2185561	0.6244651	0.2259488	0.3607134	0.6670083	0.6974229	0.4912634
0.0069917	0.1399687	3.519E-06	0.1310722	0.0149239	3.064E-07	5.12E-08	0.0007087
47	47	46	46	45	47	47	44
0.4002091	0.1728895	0.5717166	0.3201244	0.4285126	0.6610168	0.8056559	0.5076742
0.005314	0.2451824	3.32E-05	0.0300926	0.0033164	4.255E-07	8.493E-12	0.0004355
47	47	46	46	45	47	47	44
0.1296186	-0.0338723	0.3226551	0.2280295	0.2346354	0.3833881	0.4846551	0.6425701
0.4017013	0.827213	0.0326684	0.1365599	0.129899	0.0102025	0.0008564	2.569E-06

44	44	44	44	43	44	44	44
0.4492073	0.1431389	0.329509	0.3767771	0.3363517	0.4942744	0.5206621	0.2520265
0.0019656	0.3482305	0.0289479	0.0117029	0.0274325	0.0005586	0.0002458	0.1073675
45	45	44	44	43	45	45	42
0.4552015	0.3150585	0.5209854	0.309717	0.4919111	0.5396805	0.6014552	0.4379996
0.0013049	0.0310028	0.0002055	0.0362062	0.0005993	9.049E-05	7.78E-06	0.0029437
47	47	46	46	45	47	47	44
0.5405375	0.0410806	0.408125	0.2401711	0.1284874	0.2435487	0.1049158	0.3067276
8.774E-05	0.7839567	0.0048685	0.1078962	0.4002585	0.0990104	0.4827798	0.0428537
47	47	46	46	45	47	47	44
1	0.1152953	0.5661139	0.388937	0.3108855	0.5538327	0.5070962	0.3886183
	0.4402809	4.121E-05	0.0075538	0.0376528	5.382E-05	0.0002751	0.0091353
47	47	46	46	45	47	47	44
0.1152953	1	0.1862898	0.4835524	0.6041798	0.411961	0.2610725	-0.1214071
0.4402809		0.2151261	0.0006632	1.11E-05	0.0040124	0.07631	0.4324241
47	47	46	46	45	47	47	44
0.5661139	0.1862898	1	0.4246862	0.3867842	0.5658129	0.5733395	0.4834265
4.121E-05	0.2151261		0.0032637	0.0086741	4.169E-05	3.117E-05	0.0008867
46	46	46	46	45	46	46	44
0.388937	0.4835524	0.4246862	1	0.7320836	0.4838579	0.4547992	0.1123312
0.0075538	0.0006632	0.0032637		1.1E-08	0.0006573	0.0014962	0.4678557
46	46	46	46	45	46	46	44
0.3108855	0.6041798	0.3867842	0.7320836	1	0.5528797	0.5391516	0.1518528
0.0376528	1.11E-05	0.0086741	1.1E-08		8.201E-05	0.0001327	0.3310129
45	45	45	45	45	45	45	43
0.5538327	0.411961	0.5658129	0.4838579	0.5528797	1	0.7948754	0.4131926
5.382E-05	0.0040124	4.169E-05	0.0006573	8.201E-05		2.533E-11	0.0053088
47	47	46	46	45	47	47	44
0.5070962	0.2610725	0.5733395	0.4547992	0.5391516	0.7948754	1	0.4864016
0.0002751	0.07631	3.117E-05	0.0014962	0.0001327	2.533E-11		0.0008149
47	47	46	46	45	47	47	44
0.3886183	-0.4324241	0.4834265	0.1123312	0.1518528	0.4131926	0.4864016	1

	0.1214071						
0.0091353	0.4324241	0.0008867	0.4678557	0.3310129	0.0053088	0.0008149	
44	44	44	44	43	44	44	44
0.6857799	0.1567004	0.3715096	0.4301079	0.4072234	0.6474156	0.6225056	0.3246589
2.009E-07	0.3039661	0.0130299	0.003568	0.0067236	1.536E-06	4.977E-06	0.035929
45	45	44	44	43	45	45	42
0.5776985	0.3347057	0.5429974	0.3675416	0.5848462	0.5593396	0.6216568	0.5019
2.12E-05	0.0214705	9.658E-05	0.0119769	2.454E-05	4.369E-06	3.106E-06	0.0005183
47	47	46	46	45	47	47	44

VAR00082	VAR00096
0.2373889	0.0854417
0.1163732	0.5679784
45	47
0.609048	0.5245579
9.012E-06	0.0001538
45	47
-0.132591	0.2188306
0.3852516	0.1394594
45	47
0.1093945	0.3035461
0.4796428	0.0402905
44	46
0.1166158	0.2604691
0.4509391	0.0804141
44	46
0.3964405	0.6509844
0.0070173	7.257E-07
45	47
0.4990515	0.6235937
0.0004838	2.835E-06
45	47

0.2283276	0.5253674
0.1458446	0.0002504
42	44
0.7752662	0.4781285
4.046E-10	0.0008942
45	45
0.5122012	0.8039853
0.0003222	1.01E-11
45	47
0.3675868	0.2886723
0.0129876	0.0490838
45	47
0.6857799	0.5776985
2.009E-07	2.12E-05
45	47
0.1567004	0.3347057
0.3039661	0.0214705
45	47
0.3715096	0.5429974
0.0130299	9.658E-05
44	46
0.4301079	0.3675416
0.003568	0.0119769
44	46
0.4072234	0.5848462
0.0067236	2.454E-05
43	45
0.6474156	0.5593396
1.536E-06	4.369E-05
45	47
0.6225056	0.6216568
4.977E-06	3.106E-06

45	47
0.3246589	0.5019
0.035929	0.0005183
42	44
1	0.5856207
	2.38E-05
45	45
0.5856207	1
2.38E-05	
45	47

APPENDIX-II

Survey

Introduction

This survey forms part of a study on the implementation of Total Quality Management (TQM) programs in Qatar oil and gas companies. In particular our main interests are in the adoption of TQM within Oil/Gas industry. This survey will try to investigate critical success factors that help in successful quality implementation. The information obtained will be useful in advancing the understanding of TQM implementation in Qatar. All responses given will be treated with the utmost confidence. The results will be used for research purposes only and no attempt will be made to identify any individual or organisations in any publication.

Instructions: This questionnaire consists of two (2) main sections. Please read the questions carefully before answering them. Where appropriate, tick in the box or complete the answer in the space provided.

Note: Total Quality Management could also mean quality improvement programs, quality initiatives, etc.

SECTION 1 GENERAL INFORMATION

In this section we would like to know about you in general.

1. Where do you belong?

❑ Ras Gas ❑ Other (Please specify) ---------- ❑ Qatar Gas

2. **To which category do you consider yourself to belong?**

❑ Others ❑ Supervisory ❑ Middle management ❑ Top management

3. What is the highest level of formal education you have attained?

❑ Others ❑ Master's degree or higher ❑ University Degree ❑ High School

SECTION 2 PERCEPTION ON SUCCESS FACTORS of Total Quality Management

In this section, we are trying to determine your perception of the factors that are important for quality implementation in your company. Please circle your level of perception on the importance of each statement listed below and the extent to which it is current practice in your organisation. Please use the following scales:

(1) Importance - the level of perceived importance of the factor : 0 = don't know/unsure,

1 = not important at all, 2 = not important, 3 = neutral importance, 4 = important, 5 = very important.

(2) Practice - the extent or degree of practice in your organization: 0 = don't know/unsure, 1 = very low,

2 = low, 3 = moderate, 4 = high, 5 = very high

(for example : Management practice participation in decision making - If Importance = 4, this means it is an important indicator for successful TQM; and if Practice = 5, this means very highly practised inside your organisation)

FACTORS	(1) Importance	(2) Practice
1. Management provide policies promoting customer satisfaction.	0 1 2 3 4 5	0 1 2 3 4 5
2. Management build an improvement culture.	0 1 2 3 4 5	0 1 2 3 4 5
3. Management practice participation in decision making.	0 1 2 3 4 5	0 1 2 3 4 5
4. Communication links established between employees and management.	0 1 2 3 4 5	0 1 2 3 4 5
5. Management solve problems on systems.	0 1 2 3 4 5	0 1 2 3 4 5
6. Management are concerned about the welfare of employees.	0 1 2 3 4 5	0 1 2 3 4 5
7. Clear mission developed regarding business objectives.	0 1 2 3 4 5	0 1 2 3 4 5
8. Management act as key driver in continuous improvement.	0 1 2 3 4 5	0 1 2 3 4 5
9. There is a quality improvement coordinating body (e.g. quality steering committee).	0 1 2 3 4 5	0 1 2 3 4 5
10. Improvement teams exist in all functions.	0 1 2 3 4 5	0 1 2 3 4 5
11. Quality tools and techniques are widely used.	0 1 2 3 4 5	0 1 2 3 4 5
12. Recognition given for contributions on improvement ideas.	0 1 2 3 4 5	0 1 2 3 4 5
13. Continuous improvement conducted to improve processes.	0 1 2 3 4 5	0 1 2 3 4 5
14. Customer satisfaction levels are measured and monitored.	0 1 2 3 4 5	0 1 2 3 4 5
15. A system to feedback customer concerns is established.	0 1 2 3 4 5	0 1 2 3 4 5
16. Internal measures (such as quality costs, no. of rejects) collected to monitor quality improvement.	0 1 2 3 4 5	0 1 2 3 4 5

17. Employees views are listened to and acted upon.	0 1 2 3 4 5	0 1 2 3 4 5
18. Critical processes are identified for improvement.	0 1 2 3 4 5	0 1 2 3 4 5
19. Measurements from critical processes are taken for improvement purposes.	0 1 2 3 4 5	0 1 2 3 4 5
20. Statistical techniques used in design processes.	0 1 2 3 4 5	0 1 2 3 4 5
21. Statistical techniques used in production processes.	0 1 2 3 4 5	0 1 2 3 4 5
22. Training on tools and techniques provided.	0 1 2 3 4 5	0 1 2 3 4 5
23. Non-production related functions such as marketing and sales use quality tools for improvement activities.	0 1 2 3 4 5	0 1 2 3 4 5
24. Appropriate techniques are implemented when necessary.	0 1 2 3 4 5	0 1 2 3 4 5
25. Suppliers are involved in customer's improvement activities.	0 1 2 3 4 5	0 1 2 3 4 5
26. Supplier audit and evaluation are important activities to be conducted.	0 1 2 3 4 5	0 1 2 3 4 5
27. Suppliers provide relevant quality data.	0 1 2 3 4 5	0 1 2 3 4 5
28. Working with suppliers towards long term partnerships.	0 1 2 3 4 5	0 1 2 3 4 5
29. Training of suppliers is conducted.	0 1 2 3 4 5	0 1 2 3 4 5
30. Suppliers selected on the basis of quality aspects.	0 1 2 3 4 5	0 1 2 3 4 5
31. There is a system for job advancement in the company.	0 1 2 3 4 5	0 1 2 3 4 5
32. Employees are trained for job-related skills.	0 1 2 3 4 5	0 1 2 3 4 5
33. Employees equipped with quality-related knowledge.	0 1 2 3 4 5	0 1 2 3 4 5
34. Employee performance always feedback by their superiors.	0 1 2 3 4 5	0 1 2 3 4 5

35. Good communication methods (such as newsletter, meetings) implemented.	0 1 2 3 4 5	0 1 2 3 4 5
36. An appraisal system based on quality performance is established.	0 1 2 3 4 5	0 1 2 3 4 5
37. People satisfaction initiatives (such as suggestion schemes, etc.) are implemented	0 1 2 3 4 5	0 1 2 3 4 5
38. Systems and procedures for quality assurance are implemented.	0 1 2 3 4 5	0 1 2 3 4 5
39. Information and data collection system established to monitor improvement activities.	0 1 2 3 4 5	0 1 2 3 4 5
40. Relevant training system in place.	0 1 2 3 4 5	0 1 2 3 4 5
41. Marketing information system established.	0 1 2 3 4 5	0 1 2 3 4 5
42. Key business processes identified, improved and monitored.	0 1 2 3 4 5	0 1 2 3 4 5
43. Key business processes focused on meeting the needs of customers.	0 1 2 3 4 5	0 1 2 3 4 5
44. Sufficient financial resources provided to support improvement activities.	0 1 2 3 4 5	0 1 2 3 4 5
45. Human resource availability considered in improvement activities.	0 1 2 3 4 5	0 1 2 3 4 5
46. Investment decisions based on sound resources consideration.	0 1 2 3 4 5	0 1 2 3 4 5
47. Technical resources (e.g. software, equipment) are provided.	0 1 2 3 4 5	0 1 2 3 4 5
48. Employees are trained in job-specific skills.	0 1 2 3 4 5	0 1 2 3 4 5
49. Employees are trained in quality-specific tools and techniques.	0 1 2 3 4 5	0 1 2 3 4 5
50. Employees are trained on total quality concepts.	0 1 2 3 4 5	0 1 2 3 4 5

51. Training time is provided for employees.	0 1 2 3 4 5	0 1 2 3 4 5
52. Management always update their knowledge.	0 1 2 3 4 5	0 1 2 3 4 5
53. Continuous learning is provided through education and training.	0 1 2 3 4 5	0 1 2 3 4 5
54. A pleasant environment exists in working areas.	0 1 2 3 4 5	0 1 2 3 4 5
55. Positive values such as trust, honesty, hardworking, are fostered by management.	0 1 2 3 4 5	0 1 2 3 4 5
56. Teamwork and involvement are normal practices.	0 1 2 3 4 5	0 1 2 3 4 5
57. Attitudes and behaviors are reinforced through a caring culture.	0 1 2 3 4 5	0 1 2 3 4 5
58. The current scheme motivates employees to contribute towards building a quality culture.	0 1 2 3 4 5	0 1 2 3 4 5

Which of the following would you consider the *five (5)* most critical factors for implementing total quality management/Quality initiatives? Please tick only *five*.

- ❑ Leadership and support from top management
- ❑ Conducting continuous improvement
- ❑ Measuring results and performance
- ❑ Selective application of tools and techniques
- ❑ Involving suppliers in improvement activities
- ❑ Desirable human resource practices
- ❑ Adopting a quality assurance system (e.g. ISO 9000)
- ❑ Sufficient financial resources
- ❑ Providing relevant training for senior management/staff level
- ❑ Providing effective and appropriate training for employees

❑ Favorable work environment and culture

THANK YOU FOR PARTICIPATING IN THIS STUDY. ALL RESPONSES WILL BE TREATED WITH THE UTMOST CONFIDENCE AND NO SINGLE SET OF RESPONSES WILL BE READILY IDENTIFIABLE.

NSE vs BSE: Who Leads the Rally

Dr. Rajni
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Abstract

Abstract: India has currently two leading stock exchanges: The Bombay Stock Exchange (BSE) and National Stock Exchange (NSE)**.** There are opinions that National Stock Exchange dominates the stock market because it has exhibited better turnover than Bombay Stock Exchange. This study is to understand who the leader is in the sense of price discovery. Whether increase in price index (Sensex) of BSE leads to increase in price index (nifty) of NSE or vice versa. The methodology uses Correlation coefficient between the level, and the first differences series of BSE and lagged NSE and NSE and lagged BSE. Regression analysis has also been used for ascertaining the relationship. Ganger causality test is finally used to prove which of the two indices causes the other to move. The result of the study shows that if there is change in BSE then this causes the change in NSE. The result indicates that BSE is leading NSE in the sense of price discovery. The regression analysis also indicates that BSE is causing NSE and bi-causal relationship is found in case of first differences. The result of the Granger causality test also indicates the same results. However it is also noticed that since the corporatization of BSE, it has started leading the NSE.

Key words
Bombay Stock Exchange (BSE), National Stock Exchange (NSE), Granger Causality.
JEL Codes: G11; G14; E44; O53

Introduction

Recently the most interesting features of the global securities market is the intense competition for orders and volume turnovers. In late 1980's and early 1990's there was a battle between Singapore and Japan Stock Exchanges on the question who would dominate futures trading on the Japanese Stock market index. In India we also observe the same type of competition between the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE), for stock orders. There are opinions that National Stock Exchange dominates the stock market because it has exhibited better turnover than Bombay Stock Exchange. Basic question is whether the turnover determines

the leadership or is it the discovery of price or price formation, in an exchange, which determines leadership. We have not yet come across such a study giving insight into this question. Our contention is that it is the price discovery, which makes the stock exchange a leader. The greater turnover in an exchange can be due to greater transparency, low cost of transactions and better infrastructure facilities. This paper tries to look at: which of the price index of a stock exchange makes the price index of other stock exchange to move.

The BSE, by virtue of being the oldest stock exchange, has the largest number of companies listed (4868) on it. It held the dominant position in terms of business transacted until the setting of the fully computerized National Stock Exchange. Now the volume of business transacted on the NSE has grown exponentially ever since its establishment because it was fully automated. Of late, BSE has also switched over to online trading system known as BSE on line trading system (BOLT). But trading costs still remain high on the BSE as compared to NSE.

Now the NSE is leading BSE not only in average daily turnover but also in the trading volume of futures and options on individual securities. This study is to understand who is the leader in the market in the sense of price discovery[9]. Since the stock exchange index is a composite index representing the price behaviour of stocks. Therefore price indices have been used to resolve the research question. It is quite possible that some of stocks might be discovering the price at NSE, while the others might be discovering in the BSE, but stock index of the exchange indicates over all price discovery behavior. Therefore the problem is analyzed on the basis of movement of indices of BSE and NSE i.e. whether the increase in price index sensex[10] of BSE leads to increase in price index[11] nifty of NSE or vice versa i.e. which moves first and causes the other to move.

[9] The question of price discovery in the stock market has many dimensions and nuances. How quickly, and with what patterns, do adjustments to news occur? Does announcement timing matter? Are the magnitudes of effects similar for "good news" and "bad news," or, for example, do markets react more vigorously to bad news than to good news? Quite apart from the direct effect of news on assets prices, what is its effect on financial market volatility? Do the effects of news on prices and volatility vary across assets and countries, and what are the links? Are there readily identifiable herd behavior and/or contagion effects? Do news effects vary over the business cycle?

[10] The SENSEX, short form of the BSE-Sensitive Index, is a "Market Capitalization-Weighted" index of 30 stocks representing a sample of large, well-established and financially sound companies. It is the oldest index in India and has acquired a unique place in the collective consciousness of investors. The index is widely used to measure the performance of the Indian stock markets. SENSEX is considered to be the pulse of the Indian stock markets as it represents the underlying universe of listed stocks at The Stock Exchange, Mumbai. Further, as the oldest index of the Indian Stock market, it provides time series data over a fairly long period of time (since 1978-79).

[11] Nifty is an index or an indicator of the performance of the companies listed in national stock exchange situated in delhi. Nifty constitutes of 50 companies and the change in the Nifty index (Up or down) indicate the trend in the majority of the stocks.Nifty is a joint holding of National Stock Exchange (NSE) and India Index Services and Products Limited (IISL) and Nifty accounts for 70% of total market capitalization

There have been various studies (Karolyi and Stulz 1996, Forbes and Ringobon 2002, Lee and Kim 1993, Pndycle and Rotemberg 1993,) dealing with the co-movement of price in stock exchanges. Some studies have found contagion (Carhin, Kumar and McDermott 1995) while others have negated such behaviour (Forbes, Ringobon 2002). However (Forbes, Ringobon 2002, Bertero and Mayer 1990) asserted that there is interdependence. Since researchers have tried to find out correlation in returns of global markets (Longin, Francois, Solnik 1995) and tried to assert interdependence of stock markets (Bertero, Elisabetta, Mayer, 1990). While there has been plethora of studies concerning the quality of stock exchange of developing countries, there has been negligible research attention devoted to the comparative study of stock markets in India. Shah (2000a) compared the competition between NSE vs SGX vs BSE, in respect of derivative trading and concluded that in years to come competition will emerge in Index trading among these exchanges. Shah (200b) has studied competition for order flow between BSE and NSE by decomposing transactions costs into two parts, which may be termed systemic cost and impact cost. Using these costs Ajay Shah proved that there is a competition for order flow between NSE and BSE, stock exchanges and that NSE is the leader in terms of order flow and volumes. Eugene Lim (2000) conducted a study entitled "Competition, Liquidity and Volatility-A comparative study of Bombay Stock Exchange and National Stock Exchange" where in he analyzed whether differences in ownership structures, geographic reach, internal control systems, and institutionalized risk management facilities between these stock exchanges contribute to variation in observed measures of quality of markets. They used a paired comparison approach and document significant differences in liquidity and price volatility between the two markets. The market efficiency coefficient and price volatility as measures of liquidity, show that liquidity is indeed better in NSE than in BSE.

There is no other study that has dealt with this leadership question of the two India's important stock exchanges in terms of impact of rise in price index of one exchange on the price index of the other.

It is clear from the above discussion that the only objective of the study is to examine the question that: which of the two main stock exchanges of India[12] makes the stock to discover its price. In other words which of the indices of the two stock exchanges moves first to make the other to move. The paper assumes that the price index of the exchanges subsumes the price discovery of stocks as were other than reflecting the demand and supply for stocks.

Methodology and database

To achieve the objective; we have chosen two indices BSE sensitive Index from the Bombay Stock Exchange, and the Nifty from the National Stock exchange. The methodology involves four steps. In the first step we compare correlation coefficients giving association of movement between current levels of indices of BSE and lagged index of NSE [Cor.(BSE_t,NSE_{t-1})], and between current level of index of NSE and lagged index BSE [Cor. (NSE_t , BSE_{t-1})] as a tool to analyze the leader and the follower relationships over the period under study. If the computed correlation between BSE_t and NSE_{t-1} is consistently higher than correlation between NSE_t and BSE_{t-1} then we may presume that NSE is the leader and vice versa. Basic idea is that the past day's index of one-exchange pushes the index of the other exchange on the following day then that exchange is the leader in price formation. This would indicate whether the levels have a leader follower relationship or not. In the second step with the same idea, to examine the leader and follower relationship of first differences of these indices have been used. We will calculate the correlation between first differences of BSE_t and NSE_{t-1} and NSE_t and BSE_{t-1}. If the computed first differences correlation between any of these two sets is consistently higher than the other then we say that the variable with lagged value is the leader. The analysis of first differences was necessary because this causes the skew-ness and kurtosis of the variable to change To substantiate the above results thereafter we started with the basic argument that if NSE's Nifty is able to forecasts of BSE sensex better than NSE causes BSE, and the converse was also tested. In the third step we used regression analysis, firstly by regressing the dependent variable into it self and

[12] India Stock Exchanges are a structured marketplace for the proper conduct of trading in company stocks and other securities. There are 23 recognized stock exchanges in India, including the Over the Counter Exchange of India for providing trading access to small and new companies. The main services of the India Stock Exchanges all over the country is to provide nation-wide services to investors and to facilitate the issue and redemption of securities and other financial instruments. The two most important exchange houses of the Indian stock market are the Bombay Stock Exchange and the National Stock Exchange . Many of the regional stock exchanges have obtained the membership of these two stock exchanges in India. The index of the Bombay Stock Exchange , BSE Sensex is a value-weighted index composed of 30 companies.

then adding the exogenous variable to see whether it increases explanatory power of the equation in terms of R^2 and $\overline{R}^2$

To do the testing following regressions were run.

$$BSE_t = \alpha + \sum_{i=1}^{n} \beta_i BSE_{t-1} + \varepsilon_t \qquad n=1,2,3,$$

$$BSE_t = \alpha + \sum_{i=1}^{n} \beta_i BSE_{t-1} + \eta NSE_{t-1} + \varepsilon_t \qquad n=1,2,3,$$

$$NSE_t = \alpha + \sum_{i=1}^{m} \beta_i NSE_{t-1} + \varepsilon_t \qquad m=1,2,3,$$

$$NSE_t = \alpha + \sum_{i=1}^{m} \beta_i NSE_{t-1} + \eta BSE_{t-1} + \varepsilon_t \qquad m=1,2,3,$$

Where n and m were decided by Akaike criterion.

To test further the nature of causality the above twelve regression were also run on first differences of variables ΔBSE_t and ΔNSE_t.

$$\Delta BSE_t = \alpha + \sum_{i=1}^{n} \beta_i \Delta BSE_{t-1} + \varepsilon_t \qquad n=1,2,3,$$

$$\Delta BSE_t = \alpha + \sum_{i=1}^{n} \beta_i \Delta BSE_{t-1} + \eta \Delta NSE_{t-1} + \varepsilon_t \qquad n=1,2,3,$$

$$\Delta NSE_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta NSE_{t-1} + \varepsilon_t \qquad m=1,2,3,$$

$$\Delta NSE_t = \alpha + \sum_{i=1}^{m} \beta_i \Delta NSE_{t-1} + \eta \Delta BSE_{t-1} + \varepsilon_t \qquad m=1,2,3,$$

Fourthly we have used basic argument provided by Granger's causality test to prove which of the two indices causes the other to move. As per Granger's causality criterion, if it is possible to

predict a variable better with the help of another variable as compared to its autoregressive process, the variable causes the variable being predicted.

Granger causality test for integrated variable assumes the form:

$$\Delta Yt = \alpha + \sum_{i=1}^{n} \beta i \Delta Yt - i + \sum_{j=1}^{m} Yj \Delta Xt - j + \phi \varepsilon_{t-1} + Ut \qquad (1)$$

$$\Delta Xt = \alpha + \sum_{i=1}^{n} \beta i \Delta Xt - i + \sum_{j=1}^{m} Yj \Delta Yt - j' + \phi \varepsilon'_{t-1} + U't \qquad (2)$$

To reject the null hypothesis that x Granger causes y, it is necessary not to reject that $\Sigma_{j-1}{}^{m} Yt\Delta x_{t-j} = 0$ (this can be verified by F test).

Since our methodology to resolve research question involves regression and auto regressions therefore we need to test stationary of the variable included in the equations. For testing stationary augmented Dickey Fuller (ADF) tests and Phillips-Perron (PP) tests were used to check whether data series are integrated of order zero or not.

We used the secondary data for this study. The data for the BSE and NSE are taken on the monthly average basis for period 1995:1 to 2009:2 from various issues of RBI bulletin. From the Bombay stock exchange we have picked up BSE sensex and from National Stock exchange it is the nifty that has been picked up because largely these indices reflect the market sentiments.

Estimation and Results

Unit Root tests

The ADF tests and PP tests were undertaken under the assumption of the existence of a unit root (H_0) and a stationary variable in the alternative hypothesis (H_1). If the calculated statistics is greater than McKinnon's critical value, then the (H_0) or that the variable is not stationary and (H_0) is not rejected. Results of the ADF and PP tests are given in table 1. The table shows the order of integration of the variables. The implication of ADF and PP is that the values at the level reflect that both the series are auto-correlated and that the means and standard deviation are time dependent while the differenced series reflect the stationarity. The first difference of variables is of order zero and the level series are of order one.

Table-1

Variable	ADF	PP	Order of Integration

BSE	-4.361488	-9.591199	I(1)
NSE	-5.083224	-11.32288	I(1)
ΔBSE	-4.377691	-9.618647	I(0)
ΔNSE	-5.106022	-11.35098	I(0)

Critical value at 1% -3.4819, Critical Value at 5%, -2.8838, Critical Value at 10% -2.5785

The correlation analysis for the all the year in levels data and first difference gives us the following result.

Results

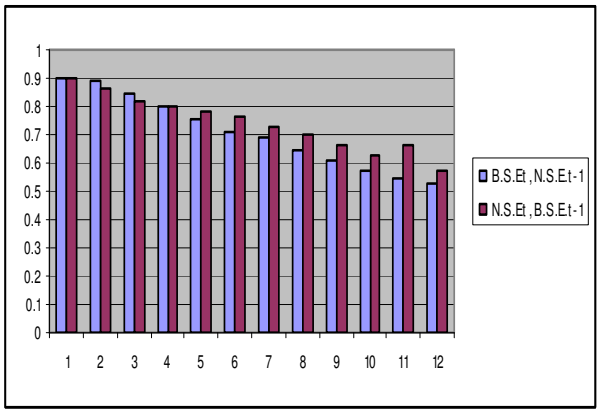
Results on the basis of level series:

When the whole period was examined with twelve lagged periods from Jan, 1995 to Feb, 2009 the correlations obtained are shown in Table A.1 and Graph 1.1. The table shows that the correlation between (BSE_t, NSE_{t-1}) is greater than (NSE_t, BSE_{t-1}) for the first two lags there after the correlation of (NSE_t, BSE_{t-1}) is greater than (BSE_t, NSE_{t-1}) for the remaining lags. It implies that BSE led NSE. During the whole period it was the BSE that led the NSE.

Table A.1 (year Jan1995-feb2009) **Graph 1.1 (Year Jan1995-Feb 2009)**

$B.S.E_t$, $N.S.E._{t-1}$	**$N.S.E_t$, $B.S.E._{t-1}$**
.891	.863
.844	.818
.797	.800
.753	.780
.710	.760
.687	.728
.648	.698
.607	.660

.572	.626
.543	.663
.527	.571



Result of the first differences

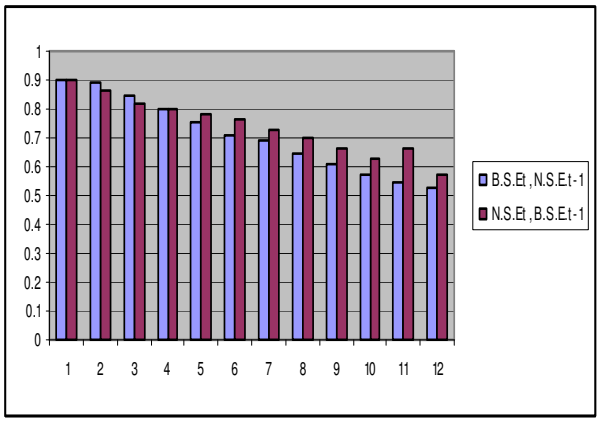
The first differences represent the amount of shock that creates changes in skewness, kurtosis and variances of series; therefore it was necessary to have this analysis. When the correlation between first difference of (BSE_t, NSE_{t-1}) and (NSE_t, BSE_{t-1}) were calculated for 12 lags period from Jan, 1995 to Feb, 2009 shown in table A.2 and Graph 1.2, the first difference correlation coefficient between (NSE_t, BSE_{t-1}) is greater than (BSE_t, NSE_{t-1}) for eight lags and in four lags the first difference correlation of (BSE_t, NSE_{t-1}) is greater than (NSE_t, BSE_{t-1}) indicating that BSE leads NSE.

It was also found that over the whole period BSE Sensex lagged value had high correlation with current value as compared to lagged value of NSE's Nifty with current value of sensex. So far as the results of correlation coefficients of first differences is concerned, the behaviour of association is the same that BSE leads NSE.

Table A.1 (year Jan1995-feb2009)

$B.S.E_t$, $N.S.E._{t-1}$	$N.S.E_t$, $B.S.E._{t-1}$
.891	.863
.844	.818
.797	.800
.753	.780
.710	.760
.687	.728
.648	.698
.607	.660
.572	.626
.543	.663
.527	.571

Graph 1.2 (Year Jan1995-Feb 2009)



(C) The Regression Analysis

We ran the twelve regressions (equation 1, 2, 3 and 4), the results of which have been given in table 3 and table 4.

Table-3

Dependent Variable BSE_t

Independent variable	Eq-1	Eq-2	Eq-3	Eq-4	Eq-5	Eq-6
Constant	72.37616 (1.116626)	-55.73926 (-0.305135)	72.64050 (1.160579)	-33.55804 (-0.190368)	70.90908 (1.130681)	-48.78906 (-0.276062)

BSE_{t-1}	0.993934* (105.8583)	0.953348* (17.36404)	1.283897* (17.24259)	1.248755* (13.5184)	1.320990* (17.00317)	1.282349* (13.59486)
BSE_{t-2}			-0.292666* (-3.92443)	-0.291101* (-3.894479)	-0.456248* (-3.668416)	-0.458154* (-3.677549)
BSE_{t-3}					0.127845*** (1.642456)	0.130681*** (1.674330)
NSE_{t-1}		0.166452 (0.750300)		0.137808 (0.644598)		0.154967 (0.24580)
R^2	0.9853	0.9854	0.9865	0.9865	0.9867	0.9867
$\bar{R}^2$	0.9852	0.9852	0.9864	0.9863	0.9864	0.9864
F	11205.98	5588.61	6048.94	4018.48	4041.814	3022.659
DW	1.419699	1.411993	1.925469	1.91451	1.94975	1.928864

(Notes: t value are in the parenthesis. *, ** and *** indicates 1%, 5% and 10% level of significance respectively)

Table-4

Dependent Variable NSE_t						
Independent variable	Eq-1	Eq-2	Eq-3	Eq-4	Eq-5	Eq-6
Constant	35.83841 (1.229821)	170.0205* (2.818948)	39.08120 (1.339656)	211.4747* (3.432855)	36.58144 (1.249235)	201.2927* (3.217389)
NSE_{t-1}	0.98660* (77.41694)	0.804090* (10.97756)	1.117458* (14.48946)	0.948215* (10.27195)	1.133747* (14.58661)	0.968590* (10.27912)
NSE_{t-2}			-0.133006*** (-1.723909)	-0.197448* (-2.53555)	-0.271232* (-2.336867)	-0.297693* (-2.617094)
NSE_{t-3}					0.123893 (1.593731)	0.092990 (1.212949)
BSE_{t-1}		0.045845* (2.52900)		0.058456* (3.153940)		0.055518* (2.960331)
R^2	0.9729	0.9739	0.9733	0.9748	0.9736	0.9750
$\bar{R}^2$	0.9727	0.9736	0.9729	0.9743	0.9732	0.9744
F	5993.382	3096.713	3009.542	2118.475	2007.460	1579.496
DW	1.73713	1.622816	1.967263	1.920765	1.977669	1.929019

(Notes: t value are in the parenthesis. *, ** and *** indicates 1%, 5% and 10% level of significance respectively)

The table 3 having BSE_t as dependent variable reveals that equation 6 explains the highest variation in the dependent variable BSE_t i.e. Sensex. But NSE_{t-1} is not found to be a significant variable in any of the equation. Similarly table-4 reveals that equation 4 explains the highest variation among the six equations. In this equation BSE_{t-1} (i.e. Sensex) is also a significant variable at 1% level of significance in explaining the variation in NSE_t. The two tables indicate that BSE is causing NSE.

The results of the regression of the first difference series have been summarized in Table 5 and Table 6.

Table-5

Dependent Variable ΔBSE_t

Independent variable	Eq-1	Eq-2	Eq-3	Eq-4	Eq-5	Eq-6
Constant	-31.06215 (-0.678080)	-31.15175 (-0.68656)	-36.12414 (-0.787432)	-36.48883 (-0.804092)	28.16994 (0.622547)	-27.58725 (-0.619769)
ΔBSE_{t-1}	0.287444* (3.876919)	0.139812 (1.360839)	0.325734* (4.221651)	0.173857*** (1.672926)	0.355085* (4.646794)	0.182015*** (1.793909)
ΔBSE_{t-2}			-0.133771*** (-1.733176)	-0.141917*** (-1.85680)	-0.205450* (-2.576981)	-0.221681* (-2.817366)
ΔBSE_{t-3}					0.220305* (2.882208)	0.241230* (3.189192)
ΔNSE_{t-1}		0.627048* (2.054720)		0.655001* (2.153211)		0.758738* (2.53955)
R^2	0.08257	0.105326	0.098948	0.123721	0.142599	0.175426
$\bar{R}^2$	0.07707	0.094546	0.088027	0.107692	0.126819	0.155066
F	15.0305	9.77177	9.056968	7.718336	9.036488	8.616278
DW	1.922771	1.898589	1.94089	1.909708	2.026749	1.992513

(Notes: t value are in the parenthesis. *, ** and *** indicates 1%, 5% and 10% level of significance respectively)

Table-6

Dependent Variable ΔNSE_t

Independent	Eq-1	Eq-2	Eq-3	Eq-4	Eq-5	Eq-6

variable						
Constant	-8.924117 (-0.559523)	-6.665601 (-0.425371)	-10.62151 (-0.665378)	-8.419115 (-0.544743)	-9.772636 (-0.607868)	-7.553496 (-0.48555)
ΔNSE_{t-1}	0.125109*** (1.629341)	-0.076609 (-0.726876)	0.141465*** (1.833725)	-0.115367 (-1.103684)	0.152230** (1.949919)	-0.105393 (-1.002157)
ΔNSE_{t-2}			-0.131950*** (-1.710087)	-0.217918* (-2.773883)	-0.143522*** (-1.836295)	-0.230465* (-2.898769)
ΔNSE_{t-3}					0.081709 (1.046618)	0.085641 (1.134488)
ΔBSE_{t-1}		0.097106* (2.736763)		0.128804* (3.509124)		0.129430* (3.518006)
R^2	0.015648	0.058144	0.032776	0.100328	0.039222	0.107413
$\bar{R}^2$	0.009754	0.046797	0.021052	0.083870	0.021539	0.085374
F	2.654753	5.123896	2.795646	6.096212	2.218033	4.873719
DW	1.966203	1.935477	1.978287	1.941840	2.010770	1.970388

(Notes: t value are in the parenthesis. *, ** and *** indicates 1%, 5% and 10% level of significance respectively)

In table 5 ΔBSE_t is the dependent variable and we find that whenever the lagged value of ΔNSE_{t-1} is added to the regression equation 4 and 6, the lagged dependent variable becomes significant at 10% otherwise it was significant at 1% level of significance (equation 1,3, 5). However the coefficient of ΔNSE_{t-1} has been significant at 1% level of significance (equation 2,4,6). This indicates that ΔNSE_{t-1} is significant determinant of ΔBSE_t.

If we look at table 6 where ΔNSE_t is the dependent variable ΔBSE_{t-1} is a significant determinant of ΔNSE_t (equation 2,4,6) at 1% level of significance. Equation 4 is the relevant equation where we find that first two lags of the dependent variable are significant and when we add third lag it

become insignificant (equation 5and 6). This table also shows that ΔBSE_t is a significant determinant of ΔNSE_t.

The table (5 and 6) show bi-causal relationship because table 5 states that ΔNSE_t is a significant determinant of ΔBSE_t where as Table 6 indicates that ΔBSE_t is a significant determinant of ΔNSE_t. Combining these two results together show the bi-causal relationship.

To further strengthen the results, Granger causality test was also applied. The results of the test are given in table 7.

(D)-Granger Causality Test

The Granger causality approach measures the precedence and information provided by a variable (X) in explaining the current value of another variable (Y). Furthermore, it says that Y is said to be granger-causal by X if X helps in predicting the value of Y. In other words, the lagged values of X are statistically significant. The null hypothesis H_0 tested is that X does not granger cause Y and Y does not granger causes X. Outcomes of the granger causality tests are summarized in table 7. The F-statistics are given in the table.

Table-7

Result of Granger Causality tests (1995-2005)

Direction of Causality	Lag 1	Lag 2
NSE does not Granger causes BSE	0.56295(0.45414)	2.05307(0.13165)
BSE does not Granger causes NSE	0.01237(0.01237)	7.32945 (0.00080)
ΔNSE does not Granger causes ΔBSE	4.22188(0.04147)	2.64016(0.07440)
ΔBSE does not Granger causes ΔNSE	7.48987(0.00688)	6.21029(0.00252)

(The p value are in parenthesis)

The result of the granger causality tests shows that the direction of causality is statistically significant at the 1% level and in case of level data BSE is causing NSE and in case of first differences we find bi-directional causality between BSE and NSE.

Conclusion

The analysis of monthly series of BSE sensitive index and NSE-50 index reveals that BSE lead NSE. As expected, the correlation coefficient of a variable at 't' with increasing lag tells, justifies the memory function of times series of BSE and NSE. Overall what we found that BSE is leading NSE in case of correlation of level series as well as first difference series. The regression analysis indicates that BSE is causing NSE and bi-causal relationship is found in case of first difference. The result of the Granger Causality tests also indicates the same results. This shows that if there is change in BSE then this also causes the change in NSE and vice-versa. Till now BSE enjoy the status of being the oldest stock exchange of India.

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