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THE MEDIATING EFFECT OF FIRM SIZE ON RAW MATERIAL PROCUREMENT DURING EXCHANGE RATE CHANGES: A STUDY OF LEAN FIRMS LISTED ON THE FTSE 100

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Abstract

Lean manufacturing practices which started from Toyota Production System have evolved in to a practice that promoted a rethinking of several manufacturing and service operations. As a result, several firms in different industries are implementing lean practices to achieve better operation and financial result and at the same time keeping pace with the competition. Inventory in terms of raw materials, work-in-progress and finish goods is one of the area which lean philosophy emphasized that should be kept low by procuring only when the need arise thereby avoiding stocking. Researchers had stressed that exchange rate fluctuations should be considered especially in overseas purchasing. However, few studies have investigated whether raw materials procurement can be affected by exchange rate changes. The objective of this research is to fill the gaps by investigating the mediating effect of firm size on exchange rate changes on raw materials procurement by lean firms in the United Kingdom. Led by the literature, this study develops a hypothesis to explore the answers to the research questions. Secondary data were collected from Bloomberg database and regression analysis through fixed effect estimators was used to analyse the data. Empirical results showed that exchange rate fluctuation have no significant effect on raw materials procurement by lean firms in the UK. However, when moderated by size, exchange rate fluctuations tend to have a significant effect on raw materials procurement. The study recommends that large lean manufacturing firms in the UK that have the facilities to stock extra quantities of raw materials can stock raw material inventory when they anticipate that there will be changes in exchange rate.

Keywords: Raw materials procurement, Lean production, Exchange rate changes

1.1 Introduction

Globalization of industrial activities has been seen to be successful in providing firms with raw materials from other parts of the world but has also brought strong competition for resources and market share. These competitions to Shah and Ward (2007) have prompted many firms in developed countries to adopt new manufacturing approaches such as lean manufacturing that was originally practiced by Toyota in Japan. As most organisations focus on enhancing their operational performance and firm value, lean manufacturing practices of Just-in-time (JIT) through JIT procurement, JIT delivery, frequent supplier delivery, kanban pull systems among others, provides opportunities for reducing the lead time from raw materials to finished goods, reducing the amount of waste in the process and reducing the quantity of physical units held by the firm (Capkun, Hameri and Weiss, 2009). Empirically, prior studies showed that firms that implemented lean manufacturing had improvements in process control, information flows, human factors, delivery, flexibility, profitability and quality (Norris Swanson and Chu 1994; Fullerton and McWatters, 2001; Cua McKone, Schroeder, 2001). Moreover, other studies reported a positive relationship between financial performance and implementation of lean production practices (Callen, Fader, Krinsky, 2000; Fullerton and McWatters, 2001; Fullerton, McWatters, Fawson, 2003).

Although inventory which is one of the areas which lean philosophy emphasised that should be kept low (i.e. procuring only when the need arise and no need for stocking) researchers such as Hu and Motwani (2013) had stressed that exchange rate fluctuations should be considered especially in overseas purchasing because the demand in the domestic selling is random. Thus there is the need to combine uncertainties both in purchasing and selling to determine when an order should be placed and what quantity must be ordered,

To this end, Hammamia, Temponi, Frein (2014) found that increase in exchange rate leads to significant increase in the total quantity purchased. Hence, noting the relevance of including exchange rate fluctuations during procurement and also acknowledging that organisations do not quickly change their policies or culture especially when such policies had worked for them in the past (Wankhade & Brinkman; Andrew, 2014), it is imperative to ascertain whether lean firms are likely to change their procurement policy when they are face with fluctuating exchange rates.

There are a considerable number of studies that has shown that firms that practice lean manufacturing in raw materials procurement and other aspect of organisation operations perform well (Mehra and Inman, 1992; White, 1993; Callen Fader and Krinsky 2000; Fullerton and McWatters, 2001; Fullerton McWatters, Fawson, 2003). Similarly, the study conducted by Hammamia, Temponi, Frein (2014) found that increase in exchange rate leads to significant increase in the total quantity of inventory purchased. However it is uncertain whether lean oriented firms are likely to take advantage of a favourable exchange to procure and stock more raw materials as lean production does not encourages buying or stocking excess inventory (Eroglu and Hoffer, 2011). Further the majority of the researches on inventory and exchange rate fluctuations are from the fields of economics and are focused on building models that explains the behaviour between inventory and various macroeconomic variables like exchange rate fluctuations (Fabian, Fisher, Sasieni and Yardeni, 1958; Arnold, Minner and Eidem, 2009; Biggart and Gargeya, 2002; Grubbstrom and Kingsman, 2004). This has left a gap to be filled from field of supply chain management perspective as organisational policy on lean procurement can be disrupted by macroeconomic issues of exchange rate fluctuations.

2.1 Literature Review

Lean production according to Yang, Hong and Modi (2011) and McLachlin, (1997) is a multifaceted concept that may be grouped together as distinct bundles of organizational practices which in the view of Shar and Ward (2007) is responsible for the lack of a consensus definition among managers, consultants, or academics. Hence, Shar and Ward (2003) noted that Lean production is a multi-dimensional approach that encompasses a wide variety of management practices, including just-in-time, quality systems, work teams, cellular manufacturing, supplier management in an integrated system. In all, Bhamu and Sangwan (2013) after reviewing several literatures regarding the definition of lean production concluded that lean can be seen as a way (Storch, 1999; Howell, 1999), a process (Womack Jones, Roos, 1990), a set of principles (Womack et al., 1990), a set of tools and techniques (Bicheno, 2004), an approach (Taj and Morosan, 2011), a concept (Naylor et al., 1999), a philosophy (Liker, 1996; Cox and Blackstone, 1998; Singh, Garg, Sharma, 2009; Comm and Mathaisel, 2000; Liker and Wu, 2000; Shah and Ward, 2007), a practice (Simpson and Power, 2005), a system (Shah and ward, 2007; Hopp and Spearman, 2004), a program (Hallgren and Olhager, 2009), a manufacturing paradigm (Rothstein, 2004; Seth and Gupta, 2005), or a model (Alves, Dinis-Carvalho, & Sousa, 2012).

According to Treville and Antonakis (2006), lean production is an integrated manufacturing system that is aimed at maximizing the capacity utilization and minimize the buffer inventories of an operation through minimizing system variability (related to arrival rates, processing times, and process conformance to specifications). Also Yang, Hong and Modi (2011) had defined lean production as a set of practices focused on reduction of wastes and non-value added activities from a firm's manufacturing operations. Both definitions of Treville and Antonakis (2006) and Yang, Hong and Modi (2011) addresses the operational aspect of lean which could be said to be slightly narrow in contrast to Shar and Ward (2007) who defines lean production as an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability.

Manufacturing performance is often usually heavily measured by inventory turnover ratio because higher inventory turnover reflects that the firms have tied down capital in inventory such as raw materials, work-in-process, or finished goods (Yoho and Rappold, 2011). However, lean production has its main goal of reducing unwanted inventories and all sources of waste. Waste in the production circle can occurs when there is excess production than the required quantity which results to high quantity of finished goods that are likely to spend a longer time in the warehouse or might never be sold to the market.

Further, faulty productions can forces managers to maintain buffer inventory. But in lean production, through the practice of total productive maintenance (TPM) and total quality management (TQM) which primarily helps to maximize equipment effectiveness throughout its entire life and also continuously improving and sustaining quality products and processes; buffer inventory (WIP and RM) that are kept in anticipation of machine breakdown are eliminated (Demeter & Matyusz, 2011; Cua et al., 2001). That is to say, in lean manufacturing, inventory targets are set, and production capacity is scaled to be flexible to respond to customer requirements (Yoho and Rappold, 2011).

Further, lean practices of Just-in-Time through JIT procurement, JIT delivery, frequent supplier delivery, kanban pull systems, small lot sizes etc are means through which raw materials inventory are reduced. Taleizadeh and Noori-daryan (2014) had observed that raw materials procurement is a critical aspect of supply chains because an efficient decision on raw materials could cause higher revenue growth. Hence, when firms practice lean production and specifically JIT procurement and small lot sizes, they have the tendencies of eliminate excess inventory and gain higher revenue growth (Demeter and Matyusz, 2011). However, one major factor to be considered in JIT and small lot sizes raw is exchange rate changes especially when firms are procuring their raw materials from a foreign country. This is because the companies have to make payment place orders in advance at an agreed price that corresponds to a certain quantity. When there is reduction in the value of the currency, this can affect the quantity to be delivered. Thus firms in anticipation of a change in exchange rate can relax their lean policy and order more quantity of raw materials.

3.1 Methodology

The population of the study are the firms listed in the FTSE 100. The justification of using FTSE 100 companies is because the FTSE 100 companies are considered the biggest companies in the UK financial whose report are readily available and they meet certain ethical criteria (George, Power and Stevenson, 2009). Base on the type of data required for this study, it is necessary to use a sample from such companies. Also, since the study is focused on raw materials procurement in manufacturing firms, the study follows Eroglu and Hoffer (2011) to impose the following criteria and screen out non-manufacturing firms and firms with negative sales and inventory figures. Furthermore, firms in industries with less than 10 firm-level observations were eliminated from the data set. In an additional screening step, observations with obviously questionable data (such as observations with gross profit margins greater than 100%) were not included consistent with Eroglu and Hoffer (2011). Also, since this study is interested in lean firms, the study employs the empirical lean indicator (ELI) consistent with Eroglu and Hoffer (2011) to remove non-lean firms from the population of the study. Consequently, a new population of 35 lean manufacturing firms listed in the FTSE 100 were used. The period covered is 2008 to 2014 while the financial and inventory data of sample firms are obtained from the Bloomberg database.

3.2 Variable Measurement and Model Specification

Measurement of Inventory Leanness

Previous studies had used four main measures as proxy for firm's inventory leanness. These groups are the absolute measures, the standardize measures, the complex measures and the empirical lean indicator. Details of these measures as stated as follows:

Absolute Measures

The absolute measure of inventory leanness was used by King and Lenox, (2001). In their approach they measured the maximum amount of inventory which they then take a natural log of the inventory to form their maximum inventory level (King and Lenox, 2001). However, this approach has been criticized for ignoring size-adjusted average. Thus, Eroglu and Hoffer (2011) argue that absolute measures of inventory management effectiveness can be misleading.

Standardized Measures

The standardized measures of inventory leanness uses variants such as inventory turnover, inventory-to-sales ratios and days of supply to measure inventory leanness (Koumanakos, 2008; Schonberger, 2007; Swamidass, 2007; Gaur et al., 2005). The standardized measures are the most widely used measures of a firm's inventory leanness (Chen et al., 2005; Gaur, Fisher, Raman, 2005). However, it has been observed that such measures ignore economies of scale in inventory management Eroglu and Hoffer (2011). Prior research has proven that if a firm's sales double, its inventories does not necessarily double due to economies of scale (Buzacott, Cantley, Glagolev, Tomlinson, (1982). Thus, when economies of scale results in biased estimates of a firm's inventory leanness is ignored, it might yields biased estimates of the marginal effect of inventory leanness on firm performance (Eroglu and Hoffer, 2011).

Complex Measures

The complex measures of inventory leanness rely on complex analytical models (Bayou and de Korvin, 2008; Wan and Chen, 2008). This approach requires expertise in solving such models and interpreting the results which have been based on fuzzy set theory and data envelopment analysis (Bayou and de Korvin, 2008; Wan and Chen, 2008). This measure due to its complexities has been observed not well suited for widespread use by managers (Eroglu and Hoffer, 2011).

Empirical Leanness Indicator

The empirical leanness indicator takes into account economies of scale in inventory management and is anchored with respect to industry-specific inventory management practices, and is easy to calculate and communicate.

The empirical leanness indicator was developed by Eroglu and Hoffer (2011). The ELI is in part, based on the work of Ballou (1981, 2000, 2005). Its distinctive feature is that it evaluates a firm's inventory leanness relative to firms of comparable size within a narrowly defined industry.

In ELI measure of inventory leanness, they adopted Ballou (1981, 2000, 2005) approach who uses a flexible functional form, $I = \beta\lambda^{\alpha}$, to estimate a turnover curve. An estimate of shape parameter $\alpha < 1$ indicates economies of scale (increasing inventory turnover), $\alpha > 1$ diseconomies of scale (decreasing inventory turnover), and $\alpha = 1$ a constant inventory turnover (Ballou, 2000).

Eroglu and Hoffer (2011) argued that the turnover curve is a suitable tool to control for size differences between otherwise largely homogeneous firms within narrowly defined industries and identify prevalent industry-specific inventory practices. Hence, turnover curves are estimated for each narrowly defined industry. The curve represents the size-adjusted industry average inventory turnover. Any deviations of firms from the turnover curve are the basis for the assessment of a firm's inventory leanness: consequently, firms that are below this curve are considered to be "lean" as they hold fewer inventories than firms of similar size. The ELI is then calculated as the studentized residual estimated during the fitting of the turnover curve for a specific industry.

To calculate the ELI as model by Eroglu and Hoffer (2011), total inventories are regressed on sales for each industry *i* and year *t* as stated thus:

$\ln(Inva_{ift}) = \alpha_{it} + \beta_{it} \ln(Sale_{ift}) + u_{ift}$, $\forall i = 1, 2, \ldots, 54; \forall t = 2003, \ldots, 2008$ …..(eq. 1)

Where:

Ln= ($Inva_{ift}$) is the natural logarithm of the firm's average total inventory (measured in a given currency) in year *t* (the average of total inventories reported at the end of years $t-1$ and *t*).

Ln ($Sale_{ift}$) = is the natural logarithm of the net annual sales volume (measured in a given currency) of firm *f* in industry *i* and year *t*.

In the Eroglu and Hoffer (2011) model, the disturbance term u_{ift} is the basis of the ELI. The residuals are studentized and subsequently multiplied by (−1) so that negative deviations (below expected inventory levels) produce positive ELI measures and positive deviations (above expected inventory levels) gives negative ELI measures. Eroglu and Hoffer (2011) noted that the advantage of using studentized residuals (99% of studentized residuals range from −3 to 3) to calculate the ELI is that it makes it comparable across firms, industries, and years, and also facilitates the interpretation of parameter estimates in subsequent analyses.

The serial correlation of a firm's ELI measures is calculated over the years of the study to ascertain that the ELI measures systematic inventory management practices rather than only noise and random variability in inventory leanness levels.

Eroglu and Hoffer (2011) further stressed that it is important to keep in mind that the ELI estimates will also be impacted by changes in competitors' inventory and operations practices.

For the purpose of this study, the empirical leanness indicator of Eroglu and Hoffer (2011) will be adopted as the measure of inventory leanness.

The following model will be used to the test the hypothesis formulated:

$RM_{it} = \beta_1 EXCHNG_{it} + \beta_2 FRMSIZE_{it} + \beta_3 (EX*SIZE)_{it} + e_{it}$.... (Eq. 3)

Where:

RM= Raw materials measured as change in the natural logarithms of total raw materials procured for the year

EXCHNG = Exchange rate change measured as change in the natural logarithms of average exchange rate for the year in Pounds sterling to US dollar

FRMSIZE = Firm size measured as natural logarithms of total asset

Raw Materials Quantity
Raw materials quantity is measured in this study as change in the logarithms of total raw materials quantity for the year. The reason of transforming the raw materials data is for standardization and easy comparison with the other data collected (Gujarati & Porter, 2010).

Exchange rate change
Exchange rate change is the change is measured as the change in logarithm of the exchange rate consistent with (Gao, 2000; Gujarati & Porter, 2010).Since the study is using panel data from large set of firms that might procure goods from different countries, it will be difficult to examine company by company and transaction by transaction to ascertain raw materials and exchange rate figures. Thus this study measure the Great Britain Pound (GBP) which is the domestic currency of all UK firms against the US dollar. The US dollar is chosen as a comparative currency because it has been relatively stable as compared to Euro that is largely affected by economic or political events of any of its member countries or Yuan which could be changed by the government any time. This study assumes that as the GBP gains strength against the dollar, it also gains strength against other currencies (Biasco, 2013). It is expected that a positive exchange rate movement, i.e. an appreciation of the home currency, makes exporting goods more expensive in terms of foreign currencies and this may lead to a fall in foreign demand and foreign sales revenue. On the other hand, the importing firm may benefit from an appreciation of the domestic currency, as its imports become cheaper in terms of home currency.

Firm Size
This study measure firm size as the logarithms of total assets consistent with Eroglu and Hoffer (2011). Several researchers (e.g. Chandler, 1962; Child, 1972) have observed that because most administrative task tends to be more complicated in large firms, managers are unlikely to change; rather they may allow existing systems to continue. This is according to Shar and Ward (2003) is equally true of implementation of new operational practices. That is, large organizations may suffer from structural inertial forces that negatively affect the implementation of lean manufacturing practices (Hannan and Freeman, 1984).

Nevertheless, Shar and Ward (2003) argues that firm size also implies the availability of both capital and human resources that facilitate adoption and implementation of lean practices as well as returns to scale for investments associated with lean practices. The influence of size is apparent and has been identified in relation to technology practices and manufacturing practices (White

Pearson and Wilson, 1999; Cindy, Germain, and Dröge 1994; Ahmed Tunc and Montagno, 1991). Thus, while theoretical arguments can be made both for and against a positive and a negative relation between large size and implementation of lean practices, empirical evidence overwhelmingly supports a positive relationship (Shar and Ward, 2003). As a result, this study controls for the size effect of firms.

Data Analysis Technique

This study uses a pooled linear regression model estimable by Fixed effects and Random effects procedure to analyse the data collected. Both Fixed effects and Random effects regression technique are adopted to prevent the weaknesses that are associated with the use of pool OLS regression method. Gujarati & Porter, (2010) observed that Random effects model is used in the analysis of panel data when one assumes no fixed effects (that is no individual effects). While fixed effects model on the other hand assumes there are individual specific effects. Nonetheless, Hausman specification test is applied to decide the appropriate model for the study (Gujarati & Porter, 2010).

In analysing the data collected, this study starts by determining firms that practice lean manufacturing using the empirical lean indicator model of equation one (Eq. 1) consistent with Eroglu and Hoffer (2011). Further, to test the hypothesis of the study, the independent variables of equation one, two and three are regressed on the dependent variables. Additionally in equation two which is aimed at testing the effect of raw materials procurement on profitability during exchange rate fluctuation, the study will run the regression model twice. Firstly, the regression model is run without exchange rate fluctuation and the secondly with exchange rate fluctuation. This is done because exchange rate fluctuation in equation two stands as the moderating variable (Gujarati & Porter, 2010).

4.1 Findings and Discussion

Summary Statistics

Variable	Mean	Median	Minimum	Maximum
InventoryQTY	499,159,000.00	171,600,000.00	0.00	3,282,000,000.00
Exchange Rate	0.66	0.67	0.63	0.67
SIZE_EXR	8.452874644	8.02423931	0.00	9.166548515
NET_ASSETS	10,996.60	4,014.00	85.80	110,895.00

Variable	Std. Dev.	Skewness	Ex. Kurtosis
Inventory QTY	6.44963e+008	1.57814	1.75672
Exchange Rate	0.0139512	-0.825499	-0.489124
SIZE_EXR	4.25630e+008	1.57785	1.73247
NET_ASSETS	1.3221	0.67885	0.46002
Variable	5% Perc.	IQ range	Missing obs.
Inventory QTY	2.72000e+006	6.08800e+008	0
Exchange Rate	0.632000	0.0240000	0
SIZE_EXR	1.76472e+006	3.89045e+008	0

NET_ASSETS	611.768	6591.41	0

Table 1 shows the summary descriptive statistic which presents basic features of the data used in this study. It shows that the average raw material inventory quantity maintained by lean firms that forms the sample of this study has a mean value of 499,159,000.00 units of stock items while the minimum raw material inventory kept for during the period was 0.00. The 0.00 value for raw material inventory suggest the lean nature of the firms, while the maximum inventory is 3,282,000,000.00 units this shows that despite the tendency of the firms to keep low quantity of inventory, they also at some periods keep very high levels of inventory quantities. The skewness and kurtosis of the inventory quantity indicates that the data is relatively normal. A skewness of 1.57814 is slightly above the 1.00 benchmark for skewness, indicating a slight positive skew in the data while the kurtosis is significantly below the benchmark of 3 Gujarati & Porter, (2010).

The exchange rate shows a relatively stable trend over the period of the study with a mean, median, minimum and maximum of 0.66, 0.67, 0.63 and 0.67 respectively. This indicates a high level of stability in the exchange rate between United Kingdom Pounds Sterling and the United States Dollars. The standard deviation in the exchange rate is 0.01395 indicating some level of volatility despite the relative stability. The skewness and kurtosis of the data at -0.825499 and -0.489124 respectively indicates that the data is normal Gujarati & Porter, (2010).

The size of the firm measured as the net asset of the firm shows a wide difference in size between the largest firm with a net asset of £110,895.00 billion and the smallest firm with a net asset of £85,800,000 million. The average size of lean firms on the FTSE 100 is around £10,996,600,000 with a median value of £4,014.00 (all in billions). However, the Skewness (3.44026) and Kurtosis (11.2231) statistics of the data indicates that the size of the firms is positively skewed and leptokurtic because their values are above the benchmark for required for normality. This is further indicated by the size of the standard deviation of in the data of 22,415.7 which indicates a high level of difference amongst the sizes of firms. However, the log of net assets was taken to normalize the data set at a skewness of 0.67885 and kurtosis of 0.46002 which make the data for size normal Gujarati & Porter, (2010).

The interaction term (Exchange rate*size) is a product of size and exchange rate which serves as the moderator and is intended to account for the extent to which size influences the relationship between exchange rate and the leanness of firms accounted for by the raw materials inventory quantity. The summary statistic of this data indicates that the minimum and maximum units of raw materials inventory kept by lean firms of the FTSE 100 given their size is 0.00 and 2,130,020,000.00 units of items respectively. However, their mean raw materials inventory is much lower than the maximum at 329,238,000.00 units and a median quantity of 114,457,000.00, these are both closer to the minimum inventory than the maximum indicating a slight positive skew in the data. The skewness and kurtosis of the data at 1.57785 and 1.73247 respectively indicates not leptokurtic peak in the data but a slight skew.

Generally, the data has shown a mixed nature with difference in levels of averages, skewness maximum, minimum, kurtosis and median. The individual abnormality of any particular observation does not translate into abnormality in the residuals of the data which could affect its usefulness and the validity of the results when used in parametric analysis and hypotheses testing (Hair, Christian and Marko., 2010)

Correlation Matrix

Table 2: Correlation among variables

Raw Material Inventory_QTY	ExchRate	l_NET_ASSETS	SIZEEXR	
1.0000	0.0107	0.6917	0.9997	RM Inventory_QTY
	1.0000	0.0307	0.0263	ExchRate
		1.0000	0.6911	l_NET_ASSETS
			1.0000	SIZEEXR

The correlation matrix shows the coefficients of the joint correlation amongst the covariates in the model as show in table 2. The collinear relationship between the quantity of raw material inventory maintained and the foreign exchange rate during the period of the study is 0.0088 **(0.0107)** which signifies a very low level of positive association between the two variables. The correlation between the moderating variable which is the product of size and exchange rate on the other hand is 0.9997 **(0.9997)** which suggests a very high level of association between the two variables. Net Assets as a proxy for size of firms also turnout to have a strong positive correlation 0.6095 **(0.6917)** with inventory levels maintained by firms.

However, the collinearity amongst the covariates, albeit, exchange rate, net asset and the interaction effect between size and exchange rate are all very low positive correlation except size and the interaction variable which is expected as size was used as the moderator. The general view of the correlation matrix is one that suggests low level of multicolinearity. Although the Variance Inflation Factor (VIF) and the Tolerance Limit (TL) are used to determine if there is existence of harmful multicolinearity in the data Gujarati & Porter, (2010).

Langranger Multiplier and Hausman Specification Test

The Breusch-Pagan Langrenger Multiplier (LM) test which provides the decision criteria for either selecting the REM or using a pooled OLS estimation technique indicates that the REM is more appropriate for the study. The null hypothesis for this test stipulates that the pool OLS is more consistent that REM in estimating the equation. Therefore a low P-value for the Chi-square of the LM test counts against the use pooled OLS to estimate the equation and thus accepting that the GLS is preferred for estimation technique (Gujarati & Porter, 2010; Wooldridge, 2012).

LM = 2.58695e-006 with p-value = prob (chi-square (1) > 2.58695e-006) = 0.998717 (A low p-value counts against the null hypothesis that the pooled OLS model is adequate, in favour of the random effects alternative.)

However, the Hausman Specification Test (HST) was carried out to determine the most suitable approach to estimate the panel regression for this study (Gujarati & Porter, 2010). The test allows us to select between the Fixed-Effect Model (FEM) and the Random Effect Model (REM) (Appendix 1). The Chi-square result of 0.009354 (with a p-value of 0.996) shows that the null hypothesis which favours the REM should be rejected and therefore accepting that the FEM is more suitable for estimating the relation between the variables. The result of the HST indicated that the REM implying that the Generalized Lease Square are not more consistent than the FEM estimation technique (Gujarati & Porter, 2010; Wooldridge, 2012).

Table 4: Regression result 1b of conditional effect model

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Const	401,310,000.00	3.49799e+07	11.4726	<0.00001	***
Exchange Rate	-587,362,000.00	5.35598e+07	-10.9665	<0.00001	***
NET_ASSETS	109.856	274.388	0.4004	0.68930	
SIZEEXR	1.46242	0.0155638	93.9628	<0.00001	***

Mean dependent var	4.30e+08		S.D. dependent var	5.56e+08
Sum squared resid	2.76e+16		S.E. of regression	11537406
R-squared	0.999635		Adjusted R-squared	0.999570
F(37, 207)	15316.86		P-value(F)	0.000000

The result from Table 4 above shows the impact of exchange rate, size and the interaction between exchange rate and size on quantity of inventory procured by lean firms during the period of the study. This model intends to identify if size moderates the relationship between exchange rate and quantity of raw materials inventory procured by lean firms listed on FTSE100. The introduction of the interactive term ‘exchange rate and size’ (SIZEEXR) into model equation tests for impact of the conditional effect of exchange rate on inventory in lean firms listed on FSTE100.

The F-stat value of 15316.86 (p-value, 0.000) is statistically significant at 1% and thus implies that the model is fit to explain the relationship being tested in the equation. While the coefficient of determination accounts for the predictive powers of the model measured by the R-squared value of 0.999 which indicates that up to 99% of the variability in inventory quantity is explained by changes in the dependent variables.

Also from table 4, the coefficients of the predictor variables show that exchange rate has a negative relationship with quantity of raw materials inventory procured by lean firms. Based on this result, it can be inferred that £1 change in exchange rate will result in a 587,362,000.00 unit change in the quantity of raw materials inventory procured by lean firms.

5.1 Conclusions

The aim of the research was to investigate whether lean firms change their raw material procurement pattern when there is fluctuation in exchange rate. In order to achieve this aim, the basics of lean manufacturing had to be understood first. Hence, literature review of some related articles were done to gain an understanding of the concept of lean manufacturing. Study of previous literature revealed that idea of lean manufacturing started with Toyota production system. Thus, the definition of the concept encompasses several dimensions like JIT procurement; JIT delivery and kanban pull systems. The Just-in-time technique was practiced in raw materials procurement to eliminate waste and unnecessary inventory by procuring raw materials in small lots size. As procurement in large firms involves different countries, the issue of exchange rate changes is considered as an impediment to implementing lean procurement practice when raw materials are procured using a different foreign currency that changes over time.

Since the study was based on internal organizational practice such as raw materials procurement by lean firms and external macro economic factors such as exchange rate changes, empirical literature from both supply chain and economics where reviewed. The review showed how most studies from economics where concerned with building mathematical models to determine exchange rate changes on raw materials, work-in-progress and finish goods inventory while researches from supply chain management are interested in investigating organization behaviour with regards to lean practices.

This research has contributed to the knowledge of lean philosophy in terms of raw materials procurement during exchange rate changes by analyzing the raw material procurement pattern of lean firms in the UK. The procurement pattern of the lean firms where studied because in international transactions that involves different currencies, the exchange rate changes over time. To achieve this, data on raw materials procurement and exchange rate was sourced from Bloomberg database for UK manufacturing firms listed in the FTSE 100. The results of the study suggested that when size of firms is not considered, exchange rate changes do not affect raw materials procurement in lean firms. Also raw materials procurement does not affect financial performance. However, in the presence of firm size, exchange rate changes affect raw materials procurement by lean firms in the UK. This proves that size moderated raw materials inventory procurement and exchange rate changes and it supports the findings of Hammamia, Temponi, Frein (2014).

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