Just in Time Strategy and Profitability Analysis in Financial Statements

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Abstract

The purpose of this paper is to describe some links between Just in Time (JIT) manufacturing strategy and performance financial analysis in financial statements. A rational, deductive, analytical and objective method was used; based on previous findings, a series of functions along with pre-post and linear regression analyses models are described as explicative of the relationships between JIT and financial statements analysis. Results show that Dirac function, value transformation function and transform kernel provide the foundations for a conceptual link between JIT and company performance in financial statements. Besides, the JIT relationship to business performance is explained by the following three models, selected from literature: a) pre-post model, explains changes in inventory and asset turnover, and their relationship to JIT; b) two-stage self-selection regression analysis model, explains how sales, inventory, company size and JIT adoption influence ROA changes; and c) lean manufacturing model, including JIT, allows explaining firm´s financial data. The conclusion is that JIT is part of a financial sequence of analysis strongly related to the structure of financial statements and company performance.

Keywords: Just in Time, Financial Statements, Performance, Profit.

1. Introduction

Productivity is crucial to company management and also a main concern of researchers, management schools or other science faculties that support administrative actions. It demands to pay increased attention and care to design strategies to make companies competitive in various economic sectors.

Several studies have pointed out the relevance of logistic administration to business productivity, which is usually reflected in profitability or indicators obtained from financial statement, especially profit or loss. Therefore, it is also necessary to focus not only on administrative processes affecting sustainability but also on the whole and the synergy effect (Litterer, 1991, p.45) that contribute to a great extent to productivity and profitability by making a proper decision taking (Van Fleet, 1982). The process goes from the acquisition of human capital and economic and technical resources, through transformation and delivery, to their final destination. The efficiency and effectiveness of management will be typified in the financial results obtained in the accounting period and reflected in the profits or losses of the company (Van Fleet, 1982); ratability indicators on the investment are a financial function that cannot be forgotten by the entrepreneur, manager or manager.

Contributing to company profitability requires of inputs so that it can be carried out in due time, so production costs are not affected. In that sense, poorly designed or supervised distribution channels increase the costs of products or services when supplied extemporaneously to users, as mode is reflected in the sensitivity of demand (Lasnier, 2007). Supply is a variable, as well as a price base, linked to demand affecting logistics distribution and business.

Consequently, time is a fundamental element for profitability and productivity and the proper use of this resource (Ferner, 1992, Mccay, 1995; Weber, 1985) must be considered through the classical administrative process of planning, organization, direction, coordination and control (Fayol, 1946) and also in studies about time and movements (Drucker, 1989; Taylor; 1911), which are incorporated in new administrative proposals. Thus, the sequential time of predecessor activities or arrivals allows allocating minimum costs, according to game theory (Lohmann, Born, and Sliker, 2014). Industrial leadership is not only based on quality, but also includes Just in Time strategy (JIT) (Ciampa, 1991, p. 26-27), reengineering (Hammer, 1994, p. 3, 5) and Six Sigma (Eckes, 2007), along with operations research (see Schroeder, 1983, 2005; Shamblim, 1974, pp. 1, 5).

It is also worth noting that, proposals such as JIT (Hay, 1989) as a factor of success in the culture of quality and impacts on globalization (Gubata, 2017), and the Six Sigma (Eckes, 2007), along with the support of statistics (Feng and Manuel, 2009), facilitate the optimization of the process management allowing to achieve continuous logistic improvements and contribute to the increase in profitability. However, regarding suppliers and the management of their negotiating power (Porter, 1980), JIT process must be implemented with caution since having only one supplier, or a small group of suppliers can impact company results. Company's profitability could be affected by relying on only one supplier, in the face of adverse situations that can lead to non-fulfillment of input orders (Hay, 1989). Thus, the significant challenge to implement JIT in a company is the relationship with suppliers. It is hard when it comes to suppliers from foreign countries since it is not easy to establish a mutual commitment to achieve the timely delivery of industrial inputs (Madanhire, and Mbohwa, 2016, p. 196).

JIT will reflect on the economic profitability of companies by financial indicators. Also, exogenous variables to businesses and the diversity of situations that managers must anticipate act as conditions affecting demand, JIT strategy, and profitability.

In the industrial sectors of Latin America, the logistic service participation is 28%, while 31% and 40% correspond to service sectors and building respectively (Barbero (2010). In the same vein, the most important logistics process costs are transport and distribution (5.3%), while inventories contribute to costs with 5% and storage with 2.5% (Barbero (2010). This study established that regarding logistics cost Colombia ranked 80 out of 150 countries and 72 in logistics performance. Similarly, as indicated by Mantilla and Sanchez (2012, p. 25) regarding Barbero´s research, the logistic performance index was low in Latin American countries, since only two Latin-American countries were above position 50.

Given the previous arguments, one of the main issues in Latin-American countries is the adoption of logistic strategies, such as JIT, to reduce costs and grow in profitability permanently and continuously. In this regard, it is important to identify the link between JIT and financial statement indicators of profitability; that is the purpose of this research.

2. Methods

The research uses a rational, deductive, analytical and objective method to provide a theoretical mathematical explanation about the link among JIT approach, financial statements interpretations and financial analysis of performance. First, a Dirac function represents JIT value creation; then, profit is obtained as a consequence of company operations and included in the balance sheet. Next, a value transformation is applied to profit, as indicated in previous findings (Juárez, 2016g, 2016h), and then, a transform kernel gives the probability associated to every transform value and the expected value.

Finally, based on previous researches, several models links company performance to financial ratios. The first model consists of a pre-post analysis to identify the changes in inventory and asset turnover; the second model identifies changes in *ROA* due to sales, inventory, company size and JIT adoption, while the last model introduces lean manufacturing bundle, of which JIT is a component, to observe firm´s financial data.

3. Analysis and Findings

3.1 Foundations of JIT in Financial Statements

JIT approach is mainly the problem of 0-time inventory or the offer-demand match, as it was already described (Jiménez, 2005, p. 9):

$$I(t) = O(0, t] - D(0, t] \tag{1}$$

where $O(0, t]$ = offer; $D(0, t]$ = demand; t = time. At time t it must be $O \geq D$, where the time of inventory existence must tend to 0, $t \rightarrow 0$.

Figures in financial statements represent economic transactions formulated as costs $C_i = (X_i, Y_i, A_i, t)$ (Willet, 1987, 1988), where C_i = transaction cost, X_i, Y_i = entities (or dependencies) involved in the transaction, A_i = resource subset of entities (or dependencies) to which the cost transaction applies, and t = transaction time. Debt amounts represent costs; i.e. X_i owes Y_i or Y_i owes X_i, where debt is in a scale D_c for the capital associated with that cost (Willet, 1987, 1988). An injective function f: $D_c \rightarrow \mathbb{R}_+$ maps D_c into the real numbers set $\mathbb{R}_+$. By doing so, costs are not in the usual discrete and finite monetary unit measure in financial statements, but in a continuous-infinite scale. Monetary units can be infinitely small, as well as their intervals on a scale, so the use of a continuous scale is appropriate. This idea was expressed in other occasions (Juárez, 2016a, 2016b, 2016c, 2016d) and included in several analyses (Juárez, 2016e, 2016f, 2016g, 2016h). Other authors say that different scales for the same unit are equivalent (Balzer and Mattessich, 1991).

Every figure in financial statements is the result of a transaction process; in that sense, company profit P is the total value represented by all the transactions C_i associated with operations, in which X_i supplies some resources A_i to Y_i at time t to operate with them; that is

$$P = \sum_{k=1}^{n} \boldsymbol{C_i} \tag{2}$$

The transactions work along the manufacturing or service chain and related activities; due to the required precision on the supply and use times of every part or service when a point in the chain fails all the rest fail.

Every point in the manufacturing/service chain takes the form of a function that activates at a given time t, the point on which *O-D* matches, and creates a transaction (X_i, Y_i, A_i, t). A delta Dirac function represents the required *O-D*. In case *O-D* matches at time t, value v is created, which is the debt associated with the transaction and added to increase gross profit. Value addition is a time function, $f_o(t) = v$, t should be the time on which *O-D* matches, so the following formula connects delta Dirac function and value creation:

$$F_o = \int_{-\varepsilon}^{+\varepsilon} f_o(t)\delta(t)dt \tag{3}$$

It has been demonstrated that the area under the so called curve of delta Dirac function is 1; so (3) shows how every time *O-D* matches delta Dirac function yields 1, and that result in *v*. It is irrelevant whether the supply is available before or after the time on which it is likely to be used, both conditions waste resources somehow.

Every transaction along the company activities creates a debt, a value *v*, as far as in every transaction *O-D* matches; in case they do not, the operations stop or yields negative values for the company. If JIT works properly, each transaction aggregates value to the one already existing from previous or concurrent transactions. Profit is the sum of all transaction debts $v_1 + \ldots + v_n$, and, by (3) and previous arguments, it is:

$$F_o = \int_{-\varepsilon}^{+\varepsilon} \delta(t)\,(v_1 + v_2 + \cdots + v_n)\,dt \tag{4}$$

where $v_1+...+v_n$ = sum of every associated transaction debt; $\delta(t)$ = delta Dirac function. The result of this value aggregation leads to company profit.

Now, in financial statements, profit is a monetary unit quantity that comes from the proper use of the business assets to produce an equity increase. As every monetary unit in financial statements has a dual quality, it is both assets and claims on assets simultaneously, every one of them located in claims on the asset side, be it equity or liabilities, also is located on the asset side. It has been demonstrated that under this dual aspect, for the balance sheet to balance the relationship between assets and claims on assets requires further computations and a value transformation on one side of the equation (see Juárez, 2016e, 2016f, 2016g, 2016h). It also requires finding the parameters associated with the transformation, and a transform kernel that associates a probability with every possible resulting transformed value (Juárez, 2016g, 2016h), in this case, profit.

Let us assume some identified asset sets A_i matching profit, and the monetary units in resources A_i linked to those in profit P_i; therefore, the relationship $A_i = P_i$ is known, and P_i adds to E_i (Equity). Hence, monetary units in A_i allocated to operations and their corresponding monetary units in equity E_i are identified, and $A_i = E_i$, i.e. monetary units are the same on both sides of the accounting equation. That condition is the dual concept of monetary units and, for this paper, they are identified, but usually, that is not straightforward. As mentioned before, a profit transformation function exists within profit account:

$$F_T(v_1 + \ldots. + v_n) \tag{5}$$

Besides, a transform kernel $k(d, t)$ gives the probability density function for the transformed values F_T at time *t*. Hence, the formal expression is

$$F_p = \int_{-\varepsilon}^{+\varepsilon} F_T(t)\,k(d,t)\,dv \tag{6}$$

where $k(d, \cdot)$: $[0, \infty) \to \mathbb{R}_+$, $\int_0^\infty k(d,t)dt = 1$; $\int_0^\infty tk(d,t)\,dt = \varepsilon(d)$, $t \in [0, \infty)$ and $d > 0$, following the description by Neamt (2014). $F_T(t)$ expresses the transformation operation, the type of which is not relevant now but it has been suggested a linear transformation among others (see Juárez, 2016g. 2016h). However, the type of kernel and transformation are yet to be defined more precisely.

Profit is part of company performance analysis, usually made by *ROA* and *ROI*. More precisely, computations are: *ROA* = Net Income / Total Assets; *ROI* = (Net Income – Investment) / Investment; where Investment = Stockholder´s equity + Claims; Net Income/Profit is the result of previous transactions (4, 5, 6) such as gross profit = sales minus costs of goods sold, operating profit = gross profit minus operating expenses, and net profit/income = operating profit minus taxes and interest.

Introducing the previous formulations profit (as part of equity) is the composition of functions $P = F_P(t) \circ F_T(t) \circ F_o(t)$, where inventory, sales, profit or income and performance are intrinsically connected.

3.2 Mathematical Models of JIT Impact on Performance

Although the evidence on financial performance impact of adopting JIT production management is mixed and results multi-faceted, some studies like Inman and Mehra, (1993), Alles, Datar, and Lambert (1995), Balakrishnan, Linsmeier, and Venkatachalam (1996), Fullerton and McWatters, (2001), Kinney and Wempe (2002), Fullerton, McWatters, and Fawson (2003), Relph and Barrar (2003), Chen, Frank, and Wu (2005, 2007), Fullerton and Wempe (2009), Yang et al. (2011) have found that JIT adopters tend to minimize waste and increase efficiency showing a better delivery performance, manufacturing cycles, inventory turnover, a lower inventory-to-total assets ratio and a higher returns on assets (*ROA*) and on invested capital (*ROIC*), due to the elimination of production costs that do not add value. Today it is recognized that the implementation of JIT and other lean production practices can improve operational and financial outcomes, a fact that has been called “the new inventory paradigm’’ (Chikán, 2009, 2011).

JIT is not only an inventory control system but a management system that impacts productivity, efficiency and profitability. Therefore, a model that tries to explain the financial repercussion of adopting JIT should take into account a comprehensive performance indicator. According to Atkinson, Banker, Kaplan, and Young (2001), *ROA* may be such indicator, given that profit margin is a suitable measure of efficiency, while asset turnover is an appropriate indicator of productivity:

$$OA = \text{profit margin x asset turnover} = \frac{net\ income}{sales} \times \frac{sales}{total\ assets} = \frac{net\ income}{total\ assets} \quad (7)$$

Since JIT has an impact on inventory levels, as a result on the balance sheet a firm can calculate the pre and post adopting JIT values of financial ratios that include the inventory in its calculation and evaluate its behavior (Klingenberg, Timberlake, Geurts, and Brown, 2013). Because inventory changes in response to demand and production, it may increase simply as a result of an increase in sales. Therefore, as mentioned by Obermaier and Donhauser (2012), it is not appropriate to use absolute inventory measures, while it is more accurate to use financial indicators based on relative inventory measures. Table 1 shows a summary of these indicators and the expected effect of adopting JIT.

Table 1: Financial ratios and expected effect of JIT adopting.

Ratio	***Formula***	***Expected post JIT adoption effect***
Inventory to Current Assets.	$\frac{Inventory}{Current\ Assets}$	Decrease (even to zero).
Inventory turnover.	$\frac{Sales}{Average\ Inventory}$	Increase.
Current ratio.	$\frac{Current\ Assets}{Current\ Liabilities}$	Decrease.
Quick ratio.	$\frac{Current\ Assets - Inventory}{Current\ Liabilities}$	Decrease (until it is equal to current ratio).
Average Days to Sell Inventory.	$\frac{Inventory}{Cost\ of\ Sales}\ x\ Number\ of\ Days\ in\ the\ Year$	Decrease (even to zero).
Days Inventory Outstanding.	$\frac{360\ Days}{Inventory\ Turnover}$	Decrease (even to one).
Operating Cycle.	$Days\ Inventory\ Outstanding + Sales\ Outstanding$	Decrease (until it is equal to Days Sales Outstanding).

From a more rigorous perspective, a first step to measure JIT’s financial performance impact would be to compare pre-adoption (pre) and post-adoption (post) values of financial indicators in a sample of adopting versus non-adopting firms through a given period (for instance, t-5 until t+5). Following Kinney and Wempe (2002), a Wilcoxon signed rank test can be applied to analyze the changes in inventory turnover (*IT*), inventory investment (*II*), return on assets (*ROA*), asset turnover (*AT*) and profit margin (*PM*):

$$DIF\Delta IT = post\ inventory\ turnover\ -\ pre\ inventory\ turnover \quad (8)$$

$$DIF\Delta II = \frac{post\ total\ inventory}{total\ assets} - \frac{pre\ total\ inventory}{total\ assets} \tag{9}$$

$$DIF\Delta ROA = post\ ROA - \ pre\ ROA \tag{10}$$

$$DIF\Delta AT = post\ asset\ turnover - pre\ asset\ turnover \tag{11}$$

$$DIF\Delta PM = post\ profit\ margin - pre\ profit\ margin \tag{12}$$

To evaluate whether changes in profit margin (*PM*) or changes on asset turnover (*AT*) have a dominant impact on return on assets (*ROA*), it is possible to conduct a relative-effect signed rank test as follows:

$$PM\_effect = DIF\Delta PM \ \times \ pre\ AT \tag{13}$$

$$AT\_effect = DIF\Delta AT \ \times \ pre\ PM \tag{14}$$

Now, we can evaluate whether the total effect on *ROA* (*ROA_effect*) is explained by profit margin changes or by asset turnover changes by calculating:

$$ROA\_effect = PM\_effect \ - \ AT\_effect \tag{15}$$

If this result is positive, there is evidence that profit margin changes of adopting JIT have a larger impact on *ROA* than changes in asset turnover.

A standard method that is used to estimate the effect of a group of variables on a particular outcome in a cross-section data case is to compare differences between JIT and non-adopting-JIT firms, using ordinary least-squares regressions. Kinney and Wempe (2002) along with Maiga and Jacobs (2008) propose a two-stage self-selection analysis similar to that presented in Maddala (1977, 1983, 1991) and Hogan (1997) papers, to explain profitability performance and evaluate possible endogeneity effects on *ROA* inferences. This analysis begins with a probit model of JIT adopting choice:

$$JIT\_Adopt = \ \beta_0 + \beta_1 PreSales + \beta_2 PreIT + \beta_3 PreVD + \beta_4 I + \beta_5 Size \tag{16}$$

where *JIT Adopt* is a dichotomous variable that equals 0 when the firm does not adopt JIT and 1 when it does, *S* represents sales, *IT* is the inventory turnover, *VD* is the variability on demand, and *I* represents innovation (measured as research and development investment divided by pre JIT adoption sales) – again, Pre means the pre-JIT-adoption level of each variable. Two new factors are added here: variability on demand (*VD*), given that JIT system results less beneficial to firms with high volatility in sales and production, size (*S*) and innovation (*I*) because larger and more innovative firms are more inclined to adopt new technologies and systems such as JIT.

In the second stage of the self-selection analysis, a model that incorporates selectivity variables is included to explain determinants of changes in *ROA*. Here, selectivity variables are SV_A for JIT adopters and SV_{NA} for non-adopters. This second model has the following form:

$$\Delta ROA = \alpha_0 + \alpha_1 PreSales + \alpha_2 PreIT + \alpha_3 PreVD + \alpha_4 I + \alpha_5 Size + \alpha_6 SV_{A/NA} + \varepsilon \tag{17}$$

where $SV_{A/NA}$ is calculated using the density function f(•) by the distribution function F(•) on the normal distribution, and $\beta'Z$ is the value predicted by the first stage model:

$$SV_A = \frac{-f(\beta' Z)}{F(\beta' Z)} \tag{18}$$

$$SV_{NA} = \frac{f(\beta' Z)}{1 - F(\beta' Z)} \tag{19}$$

Selection bias is evaluated by analyzing the estimates of the α_5 coefficient on both equations: if it is negative on the two results, then we can conclude that the first stage results are overvaluing the impact of JIT on *ROA* performance.

Maiga and Jacobs (2008) add other independent variables such as earnings bonus to take into account the relationship between earnings-based bonus plans and a managers' JIT adoption decision, together with trade unions, because as suggested by Inman and Mehra (1989) labor unions may resist JIT adoption, both expressed as dichotomic variables (0 or 1). Another method to test the effect of JIT adoption on financial performance can be modeled following Hofer, Eroglu, and Hofer (2012), by defining the following selection model (Greene, 2017):

$$Z_i^* = \beta_{10} + \beta_{11} LPB_i + \varepsilon_{1i}, i = 1, \ldots, n \tag{20}$$

$$Z_i^* = \begin{cases} 1 \ if \ > 0 \\ 0 \ if \ \leq 0 \end{cases} \tag{21}$$

Equation 14 explains the relationship between lean production bundle (*LPB*) for each firm *i* and the probability of observing a firm's financial data (Z_i), which is a continuous latent variable. Financial data for firm *i* is observed when its Z_i parameter is positive. Lean production bundles are groups of practices that encompass all lean practices, such as JIT, total quality management and total productive maintenance (Shah and Ward, 2003) or conformance quality, delivery reliability, volume flexibility and low cost (White et al., 2010). These represent related and complementary approaches to improve the effectiveness, efficiency and financial performance of a firm (Kannan and Tan, 2005).

Now, if financial data are observed (Z=1), JIT effect on financial performance (FP_i) can be evaluated through the *LPB* parameter, along with inventory leanness (*IL*), sales volume (*SV*), sales growth (*SG*), and adding an industry fixed effect (*IFE*), as independent variables (Rumyantsev and Netessine, 2007). Error terms ε are described by a bivariate normal distribution, as described on equation 17.

$$FP_i = \beta_{20} + \beta_{21} \ln SV_i + \beta_{22} SG_i + \beta_{23} LPB_i + \beta_{24} IL_i + \beta_{25} IL_i^2 + IFE + \varepsilon_{2i}, \ \ i = 1, \ldots, n \tag{22}$$

$$\begin{pmatrix} \varepsilon_{1i} \\ \varepsilon_{2i} \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{pmatrix} \right] \tag{23}$$

By calculating the regression coefficients, the effect of each variable on financial performance can be evaluated (JIT adoption impact is measured by β_{23}). Along with regression analysis, a mediation test can be applied to explain how each independent variable affect the mediator variable – inventory leanness (*IL*) – and, therefore, what the individual impact on financial performance through their effect on inventories is.

4. Conclusions

Logistics contributes to the profitability of companies significantly, and for that, it is supported in quality, JIT and Six Sigma strategies. JIT contributes to the improvement of business processes by applying decision-making, operations research, and other topics models, all of them related to processes and actions. The relevance of JIT practice in companies relies on its contribution to improving the financial results of management, evaluated on a regular basis through performance financial indicators.

In financial statements, JIT is the result of a transactional approach, which comprises an exchange between entities that yields a debt. Several functions take JIT characteristics, financial statements dual aspect and monetary unit value transformation to computing company profit with the usual financial analysis. The obtained results of the conceptual approach in financial statements are linked to financial performance measures by several models that introduce pre-post changes, the relationships among sales, inventory, company size, JIT adoption and ROA changes, and also JIT explanation of financial data, along with other company and strategy data. By this operations, JIT strategy is included into financial statements logic.

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