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Linking Just in Time to Financial Statements Profitability Analysis Based on Duality Properties

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Abstract

The purpose of this paper is to analyze the impact of Just-in-time (JIT) strategy in profitability analysis by introducing the dual concept of monetary unit and a value transformation in financial statements items. A rational and analytical method was used; the analysis is based on a transaction concept, which applies to JIT and figures in financial statements, a monetary unit value change in financial statements and a computation of financial ratios/measures that include value transformation. Results show that value-creation computation in JIT methodology includes a Dirac function, a value-creation function and a kernel for the time of the offer-demand match. Based on the dual concept of monetary units a value transformation for the monetary units involved in profitability computation is included; it encompasses another kernel to find the new values of monetary units. The transformation applies to the computation of measures and ratios such as gross profit, operating profit, income, return on assets, return on equity, and return on investment; consequently, the computation of this measures/ratios changes when introducing the dual concept of monetary units.

Keywords: Just in time, financial statements, balance sheet, dual concept, profit, financial engineering.

INTRODUCTION.

Just in time strategy (JIT) is one of the most important for business operations contributing to competitiveness [1], it is also a popular philosophy in many industrial areas, especially in supply chain management [2]; an increasing number of companies from various industries are interested in adopting JIT philosophy to improve their productivity and competitiveness [3]. JIT demands to deliver the right goods and quantity at the right place and time [1, 2], at the right level of quality [2] and without carrying original inventory from one period to another [4]. It focuses on the elimination of waste and minimization of the need for raw materials, work-in-process, and finished goods inventory by reducing setup times [5], although that reduction may not be achieved in all industries [3].

JIT is attached to other components of lean manufacturing and logistics [6] including reverse logistics [2], milk-run material supply system, where a single depot serves an assembly line for both delivery and pickup simultaneously [6], cross-docking, as part of JIT for distribution logistics, which is aimed at producing continuous flow of products from suppliers to customers without any inventory [7] and production smoothing problem, that happens in JIT manufacturing [3]. It is also integrated with Optimized Production Technology and more traditional approaches, such as Economic Order Quantity [8].

The goals of the JIT are the followings: a) to decrease inventories of work in process, fluctuations in work process, failures and defects in production, and between-process demands in transition, and b) to improve inventory control, supervision and de-centralized control [1]. The benefits of JIT include both cost and efficiency, being cost the core issue along with speed, quality, and flexibility, as found in reverse logistics [2]. In retailer operations, many important KPIs are related to time, i.e. time between the arrival of a load-carrier and its pickup, along with time between load-carrier drop-off and its loading time, while other measures such as distribution lead time and amount of unprocessed loads provide a good indication of performance but within a whole distribution network [7].

Among other benefits of JIT, they are suggested that JIT improves communication, service, quality, competitiveness, forecasting, ordering and receiving procedures, long-term relationships with suppliers, sense of team spirit, provides quicker resolution of delivery problems, and reduces inventory, warehouse, supplier base, purchasing and administrative costs, carrying out, traffic time and prices [9], and cutting the production and distribution deadlines [1].

Regarding financial issues, JIT also has an impact on several financial measures. JIT contributes considerable to the profitability of enterprises [1], improving inventory turnover [9] giving a higher ratio of inventories to sales (faster rate of turnover), increasing profit and return on investment and reducing the requirement for current assets and small tools required [1]. Examining several financial accounting measures of profitability, it has been found that return on assets,

inventory turnover, labor utilization and return on sales showed positive and significant results when introducing JIT strategy, being inventory turnover and labor utilization the most relevant, while return on equity, asset turnover, and short-term liquidity showed to be not significant [10].

However, financial statements have complex properties and different logics operating within them [11-13]; one of their main characteristics is the dual concept of monetary unit which states that every monetary unit in financial statements is asset and claims on asset simultaneously, what results in that under this property assets are neither equal nor equivalent to claims on assets [14-20]. It was also shown that the dual property leads to a value transformation on one side of the accounting equation. [20-22]. Consequently, any computation must take into account these properties of the dual concept. That is the purpose of this paper.

The problem of representing the profitability impact of JIT in financial statements relates to several dual properties of financial statements and the fact that profitability analysis usually takes two or more items which are on different sheets. The dual properties are [15-18]: a) the dual concept of monetary units, b) the double-entry bookkeeping, c) dual aspects of accounting transactions, and d) the accounting equation. All of them represent that monetary units are simultaneously located in assets and claims on assets.

The duality of monetary units has been included in numerous theories and proposals about the foundations of accounting [see 23-31], which design every theoretical accounting system in such a way that it meets the requirement of having the same number of monetary units distributed in two different structures and still consider them to be equal. This assumption leads to the accounting equation in the form it is used and the idea that assets are equal to claims on assets, which is firmly rooted in accounting thought.

However, using very different perspectives, such as axiomatic method, formal logic and set theory it was shown that the accounting equation does not hold and assets are not equal to claims on assets, i.e., their identical monetary units are not located in the same structures, so the consequence is that assets and claims on assets are not equal when matching by their identical monetary units [see 14-16]. It was also demonstrated that they are not equivalent, i.e., that the number of the monetary units is not the same in both structures when, again, identical monetary units are identified in their different structures [see 17, 18]. The latter result is even more surprising, having in mind that the accounting equation is focused on that. Finally, a mathematical approach led to inequality and the need for a value transformation in monetary units. Besides, another significant result is that there is no need to hold the equality restriction ([19-22]), although a small chance exists of holding the equality restriction it would involve changing the monetary units value and their number in the financial statements items.

Under this strong critic of some foundations of accounting, a consequence is that the standard ratio computations and measures obtained on financial statements require revisiting, as all of them assume the assets-claims on assets equality without any consideration of the conditions mentioned above. In that sense, the JIT measures and profitability analysis in financial statements require considering that the same monetary units are located in two different structures and for them to be equal a transformation value is needed.

Another consequence of the dual characteristics in financial statements is that measures and ratios have to take into account that the items in the computations are in two different sheets in financial statements. In the case of JIT profitability analysis, usually items are located on the balance sheet and income statements, and improvement in profitability is sometimes expressed by ratios. In this regard, financial ratios allow linking economic events with organization performance [32] and providing clarifications and insights to help in decision making [33].

JIT improves Return on Assets (ROA) by a better profit margin and asset turnover [34], ROI, profits and other measures [35]; ROI is improved when accounting management system work is coordinated with JIT [36]; however, there must be a trade-off between risk involved in JIT adoption and profitability measures, such as improvement in income before interest, taxes, and depreciation [37]. Other results indicate that no impact exists on financial performance, such as in sales, operating profit margin and return on investment (ROI) although it improves inventory turnover [38].

Given the considerations mentioned above, the purpose of this research is to analyze JIT profitability in financial statements based on the dual concept of monetary units.

METHODS.

A rational and analytical method was used; the analysis is based on a transaction concept which applies to JIT and figures in financial statements, a value change in monetary units in financial statements and a computation of financial ratios that include the value transformation. Results show that value-creation computation in JIT methodology includes a Dirac function, a value-creation function and a kernel for the time of the offer-demand match.

Based on the dual concept of monetary units a value transformation for the monetary units involved in the profitability computation is introduced; it includes another kernel to find the new values of monetary units. The transformation is introduced in the computation of measures and ratios such as gross profit, operating profit, income, return on assets, return on equity, and return on investment; consequently, the computation of this measures/ratios changes.

ANALYSIS AND FINDINGS.

JIT in Financial Statements.

As it was described [39, p. 9] JIT strategy is represented by 0-time inventory or the match

$$I(t) = O(0, t] - D(0, t] \quad (1)$$

where $O(0, t]$ = offer; $D(0, t]$ = demand; t = time. It can be $O \geq D$, at time t; however, ideally at the time when the asset is used the inventory time tend to 0, $t \to 0$ and $O(0, t] = D(0, t]$. Despite many JIT inventory management methods try to find the best conditions for suppliers and clients getting to it, this ideal framework is not easy to reach.

From the viewpoint of inventory costs, in every point of the manufacturing/service chain, there is an exchange where an asset is used to add value, create, and deliver a service or product. JIT produce goods or services without waste, selecting the processes that add value [40]. These are transactions comprising economic costs, which involves offer and demand to make sure the activities of the companies are performed. In this sense, a delta Dirac function represents the time at which *O-D* match (ideally it would be the time for a perfect match $O = D$) and the value creation v in every manufacturing/service chain point. Value creation is a time function, $f_o(t) = v$; where t is the time on which the transaction takes place. Then, the link between the delta Dirac function and value creation is

$$F_o = \int_{-\varepsilon}^{+\varepsilon} f_o(t)\delta(t)dt \quad (2)$$

where $t \pm \boldsymbol{\varepsilon}$: time interval where transaction is likely to happen. The area under delta Dirac function curve is 1 so every time a transaction is produced it results in v. However, the supplies could be available before, after or just in the time when it is needed; as far as time gets away of the time of use, resources are wasted somehow. Accordingly, every transaction creates a value v that depends on the supply arrival time; let us assume the time of arrival follows a probabilistic distribution and the longer the supplies arrival time is, the greater the possibility of resulting in a manufacturing/service chain stops. Then

$$F_v = \int_{-\varepsilon}^{+\varepsilon} F_o k(d, t)dt \quad (3)$$

where $t \pm \boldsymbol{\varepsilon}$: interval time when supplies arrival and offer-demand can happen and t the time at which it ideally should happen; d: real time at which the offer-demand exchange happens; k: kernel transform, with $k(d, \cdot)$: $[0, \infty) \to \mathbb{R}_+$, $\int_0^\infty k(d,t)dt = 1$; $\int_0^\infty tk(d,t)\,dt = E(d)$; which is the expected predicted time under JIT assumptions; $t \in [0, \infty)$ and $d > 0$. In the interval $t \pm \boldsymbol{\varepsilon}$ in the supply arrival time, it is created a cost, not allowing continuing the company operations when the supplies are later than t, or by holding an inventory when supplies arrives earlier than t.

Each transaction aggregates value, so the management/service chain results in the total value creation by adding all the unitary values

$$F_T = K \int_a^b \int_{-\varepsilon}^{+\varepsilon} F_v k(d, t)dt \quad (4)$$

where a-b denotes the manufacturing/services cycle, with K cycles per year. Companies keep track of every operation activity, and they assign a cost to each one of them; consequently, they have n number of transactions involving offers and demands in the operation chain, so the associated monetary capital is $\sum_{i=1}^{n} U_i$, where U_I is the monetary capital value in each operation chain point, which includes inventory as a penalization. This monetary capital is allocated to: a) items in financial statements; its value depends on the type of vendor-client JIT inventory coordination model, and b) gross profit, operating profit, and net profit/income in financial statements; the result of operation chain is the product/service sold/delivered at price p.

Figures in financial statements are economic transactions in the form of costs $C_i = (X_i, Y_i, A_i, t)$ [29, 30], where C_i = transaction cost, X_i, Y_i = entities (or company agents) in the transaction, A_i = resource subset in the exchange, and t = transaction time. Transactions are such that X_i owes Y_i or Y_i owes X_i, and debt is associated to cost, in a scale D_c [29, 30] $C_i \to D_c$.

As it was expressed in previous research, monetary units in financial statements do not have to be discrete and finite, so an injective function f: $D_c \to \mathbb{R}_+$ maps D_c into the real numbers set $\mathbb{R}_+$, and debts are in a continuous-infinite scale representing monetary units [19-22, 41]); several analyses were made based on this assumption [see 19-22]. Other authors indicate the possibility of using different but equivalent scales [42].

According to what was previously mentioned, company profit P is the result of all the offer-demand transactions which have a cost C_i, in which an A_i resource exchange between X_i and Y_i happens at time t [41] and have an associated D_i (Debt); that is

$$P = \sum_{k=1}^{n} \boldsymbol{D_i} \quad (5)$$

Every monetary unit in financial statements is both assets and claims on assets simultaneously, what is called the dual concept of monetary units; it means that be them equity or liabilities they are located on the asset side too, and there is no direct equality-equivalence relationship between assets and claims on assets, but it requires a value transformation [19-22]; besides, there is a transform kernel giving the probability of every possible result [21-22]), in this case, for profit.

As it was expressed [see 41] some asset items, A_is, have the same monetary units as profit P_i, with P_i adding to E_i (Equity). Assets A_is are profit-makers, and their corresponding debts D_A are measured in monetary units located in an equity E_i items.

Another transform kernel $k(d, u)$ gives the probability density function to transforming the monetary units u_i [21-22]

$$F_u = \int_0^\infty f_u(l)\, k(u,l)\, dl \qquad (6)$$

where $k(u, \cdot)$: $[0, \infty) \rightarrow \mathbb{R}_+$; $\int_0^\infty k(u,l)dl = 1$; $\int_0^\infty lk(u,l)\, dl = E(u)$, which is the expected value of monetary unit such as it accomplishes the requirement of the measure or ratio computation; $l \in [0, \infty)$ and $u > 0$. Despite the similarity between (3)-(4) and equation (6), the latter is the transformation to be made on financial statements monetary units while (3) and (4) are the transformation to be made on value production, which depends of the JIT efficacy. The type of kernel introduced in (3), (4) and (6) are not so clearly identified and can adopt several forms; some suggestions for transformation in (6) are linear transformation and other computations from chaos and catastrophe theory [see 21, 22]).

The usual computations for profit in financial statements are:

a) gross profit = sales minus costs of goods sold,
b) operating profit = gross profit minus operating expenses (usually it includes depreciation and amortization),
c) profit/income = operating profit minus taxes and interest,
d) *ROA* (Return of Assets) = Net Income / Total Assets,
e) *ROE*(Return on Equity) = Net Income / Equity,
f) *ROI*(Return on Investment) = (Net Income – Investment) / Investment.

Although other indicators have been described [see 41], to show the application of the previous formulations this paper only uses those mentioned. Table 1 shows the transformations that apply to every profit measure. As that table shows, the transformation F_u applies only to monetary units located on one side of balance sheet.

Table 1: Transformations for computing profit-related measures and ratios.

Measure/ratio	Transformation
Gross profit = sales minus costs of goods sold	F_T (Sales) - F_u (costs of goods sold)
Operating profit = gross profit minus operating expenses	F_T (gross profit) - F_u (operating expenses)
Profit/income = operating profit minus taxes and interest	F_T (operating profit) - F_u (taxes and interest)
ROA (Return of Assets) = Net Income / Total Assets	F_T (Net Income) / F_u (Total Assets)
ROE(Return on Equity) = Net Income / Equity	F_T (Net Income) / F_u (Equity)
ROI(Return on Investment) = (Net Income – Investment) / Investment	F_T (Net Income) – F_u (Investment) / F_u (Investment)

Several types of kernels apply to transformations, but selecting one of them is a matter of describing priorities and assigning weights to delays and monetary unit distribution; chances are normal, uniform, triangular, Epanechnikov, Dirac, and others. As mentioned it is by assigning weights to distributions how the companies define value in production and monetary units.

DISCUSSION

In this paper, a different approach to identifying the value creation and representation in financial statements linked to JIT has been described. Regarding financial statements, the company assets are used in value creation, which in turns produces a profit; that profit is allocated to equity. This cycle describes how financial statements items are connected. Usual measures of profit, or any other financial indicator, take into account neither the fact that financial statements are recurrent nor their dual nature. However, when doing any financial computation, the fact that some monetary units are located on the items involved in the computation, while others are not, is relevant. Relations between company areas or operations should not duplicate monetary values but to describe unbiased relationships.

As findings in previous researches show [14-22], the whole set of assets is neither equal nor equivalent to the whole set of claims on assets, which includes equity. In this regard, one of the main findings of this research is to provide the link between equity, as the final allocation of profit, and assets by a series of transform function. The dual concept of monetary unit is easy to understand from the viewpoint of the balance sheet. It is also easy to journalize accounting transactions when the accounting equation is considered at the beginning of practice [43] as it is the basis of accounting [44]. However, it is more complicated to identify it through company operations; this paper shows how to introduce it into operation perspective.

Value creation, in this occasion by JIT strategy, is the way of providing a connection between company operations and financial operations, and the computations to obtaining financial measures of profitability. Once this is done, the extension to other strategies or company activities is easier to conceptualize. Several approaches describe financial statements figures as economic transactions [29, 30, 42]; however, they do not link these transactions with the real transactions of company operations. Connecting operation companies with financial accounting by gross profit is part of management accounting [45], and there is a need for conciliating several topics in financial statements [see 46, 47]. In this paper this link is provided; however, it still demands to show its application with real data of companies, what will be done in future research.

Another central issue in this paper is the use of integral transforms to identifying the value created by company

operations and that of transformed monetary units. Despite part of it was presented in another paper [see 41], a complete computation through company operation cycle and some changes in that computations are described here. Moreover, transformations are explicitly included in profit computations, what gives an idea of its application possibilities, Determining the type of transform or kernel, to be used is related to business strategy and other principles guiding the costs/debts (transactions) valuation, in the case of company operations, or computing assets/claims on assets monetary unit value.

Despite that more general approach to computing monetary unit transformation, based on strategy principles or operation valuation, the specific kernel used also gives the expected value of differences between assets and claims on assets, which is a more practical and less complicated approach. The former provides a global view of the company, the latter a practical computation. In this sense, some distributions introduced in cross-sectional studies of financial ratios were the mixture of normal distributions, lognormal distribution, and gamma distribution, with the non-normal stable Paretian distribution drawing better results [48].

Finally, the use and interpretations of financial ratios are substantial in understanding the financial position of a company [49, 50], and ranking companies [50], so it is crucial to go deeper into its complex relationships.

CONCLUSION

The contribution of JIT to performance and profitability of companies has been pointed out frequently. It is usually understood as some figures, ratios, and indicators in financial statements. However, new conceptualizations about the principles guiding financial statements lead to a better comprehension of the real possibilities that JIT and other financial ratios based methodology have.

To that, several models need to be introduced; they comprise a concept of a transaction, a model for value-creation based on the offer-demand match, a time-dependent value transformation, and a dual-concept value transformation of monetary units in financial statements. After these concepts and changes enter the computation, the results and interpretation of the financial indicators provide a better decision-making process.

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