Effect of lead time statistical distribution on supply chain inventory system

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ABSTRACT

Selection of service providers in supply chain is a critical decision that affects future performance of the chain. In practice, there are several factors to be considered in selection of proper service providers such as quality of transport, price, trustworthiness, and lead time. One of the main factors in selection of service providers is the time. In this paper, we investigate the effect of statistical distribution of lead time on supply chain performance. First step of this study provides an insight into the effect of lead time statistical characteristics on supply chain. The next step, comparing two popular statistical distributions of lead time (uniform and normal distributions), presents some guidelines in selection of service providers.

Keywords: Supply chain management; Lead time; statistical distribution; performance; simulation; polynomial regression analysis

1. INTRODUCTION

Lead time (LT) is a very important factor in any supply chain (SC), being inseparable from SC. It usually has variations which lead to inconvenience of supply chain partners. Globalization leads to increase of physical distance of supply chain partners; which in turn, increases transportation lag. LT can be split into two parts: physical delays [1] and information delays [2]. Physical LT, itself, is composed of separate subparts that are affected by two main factors: performance of supply chain partner and environment uncertainties. For example, production LT can be categorized as physical LT because it directly delays physical material flow; furthermore, it is impressed by efficiency of supplier in rapid production. Efficiency in storage and retrieval of goods is another example of physical delays in supply chains, too. Transportation LT is a main part of physical LT that is affected by both performance of transportation service provider and environment uncertainty and, hence, causes probabilistic lead time.

Transportation LT is a significant part of total LT. On the other hand, transportation LT can be unstable because of environment uncertainty and complexity, especially in global businesses. Third party carriers have responsibility of good transition in supply chain. In the theory of supply chain, service providers are considered as an internal part of the chain. However, in practice, shipment services are sometimes outsourced to external carriers. Service provider selection is one of the strategic decisions in supply chain that can affect overall chain performance. Selecting transportation service provider is made based on several criteria, one of the main ones being time. Average of shipment time and also reliability of shipment time are two sensitive parameters for managers.

The aim of this study is to provide an insight into the relationship between SC performance and statistical features of the LT. A supply chain including four stages is simulated in two different conditions, one with uniform distribution of LT and the other with normal distribution. In each case, the supply chain is simulated for various combinations of LT mean and variance. Some SC performance measures are calculated for each LT distribution, and then are compared with each other. Time is one of the main parameters in transportation because it actively contributes to total lead time and increases both mean and variance of total lead time. Thus, one of the main applications of this study can be in the proper selection of carrier based on time factors.

In many researches, supply chain with uncertain lead time has been considered [3,4,5]. But these researches have only modeled supply chain in a specific situation and have not investigated the effects of lead time on supply chain performance; hence, they could not help the supply chain managers in deciding upon proper carrier selection. In this study, effect of lead time on supply chain performance has been evaluated by modeling the supply chain in various situations (i.e., mean, variance and distribution of lead time). Main contribution of this paper is in considering statistical distribution of lead times and its effect on supply chain performance measures. Consideration of statistical distribution of lead times are interesting for two reasons: (1) statistical distribution of each variable has advantageous information about the variable (2) extraction of statistical distribution of each carrier's lead time according to the historical data is possible and hence this study is feasible in practice.

The paper is organized as follows. Section 2 provides a brief review on LT-related researches. In section 3, research methodology is described. Results of simulation and regression analysis are drawn in section 4. Finally, in the section 5, discussion and future studies are described.

2. RELATED LITERATURE

Lead time is a critical factor that affects supply chain performance. Researches in the area of supply chain modeling and decision making have usually considered lead time. However, in some researches, deterministic lead times have been considered while in more realistic researches, lead times are allowed to have some degree of uncertainty. Lead time affects inventory system parameters; e.g., in order quantity/order point system, both order quantity and order point are affected by two main parameters, one of them being received order and the other one being replenishment lead time. Furthermore, lead time variation will disturb coordination through the supply chain [6].

Researches on transportation mode selection have a close relation with this research. Selecting transportation mode has a direct effect on transportation lead time. Selection between two alternative transportation modes such that difference between their shipment times is equal to one period has been investigated [7]. That model has been developed such that difference between lead times could be any positive integer [8]. In both these mentioned models, only longer lead time has been compared to shorter lead time and uncertainty of lead time has not been considered; but in a real world, lead times are probabilistic and hence investigating changes on statistics of lead time such as mean and variance and -in a broader view-lead time statistical distribution will be much informative.

Some researches have discussed the existence of dual-sourced supply chains, with each source having individual transportation characteristics. Source selection in such researches is mainly based on trade-off between extra cost of rapid shipment and profitability of using such rapid shipment in reduction of safety stock and reorder point [9]. Adding product availability level in such models makes them close to the customer relationship management (CRM) concepts [10]. Nevertheless, considering performance measures of supply chain such as order variance, average of batch size, and stock-outs, which have an important role in such decision making, is not considered in the above mentioned studies.

In a new research [10], it has been shown that using slower transportation modes that increase lead time is economic for low-value items. Modeling a dual-sourced system (with one source being fast and another being slow) in the above mentioned study, it is shown that saving from lower safety stock level caused by utilizing the fast source is not always more than extra costs paid for using fast source. Also, portion of each placed order assigned to each transportation mode has been determined; thus, they have assumed that only a part of orders could be accelerated by spending extra cost.

To the best of our knowledge, there are many researches concerning transportation mode, supplier selection based on delivery factors, and carrier assessment that try to find optimal model in making decisions but none of them have answered questions such as: "Is there a specific statistical distribution of time for carrier services which is preferable to another distribution from certain points of view?" or particularly "is uniform distribution of shipment time preferable to normal distribution or vice versa, given that other conditions such as LT mean or variance are identical?". In this study, effect of lead time distribution on supply chain performance measures consisting of order sizes' average, order variance, holding inventory, and of stock-out size's average is evaluated by simulation and regression analysis. Regression analysis provides insight into the differences of theses two LT distributions in affecting supply chain performance.

3. RESEARCH METHODOLOGY

In this study, in the first step, a supply chain consisting of four stages is simulated under various conditions. In one simulation model, we assume that lead times are probabilistic and come from normal distribution while in another simulation model it is assumed that lead time come from uniform distribution. In these two different conditions, performance measures of supply chain for various combinations of LT mean and variance are estimated. In the second step, comprehensive regression analysis is done to discriminate differences between the two conditions in changing supply chain performance.

3.1. Supply chain model and simulation parameters

Investigated supply chain is a serial supply chain with four stages. In this model, each partner of the chain is customer of its upstream partner and supplier of its downstream. In each stage, only one actor exists. To measure the effect of lead time distribution on supply chain without any other intervener variables, we fixed other parameters and assumed that (1) end customer demand is fixed (2) ordering cost is negligible and therefore the effect of batch sizing arisen from ordering cost will not exist (3) data sharing mechanism enable supply chain partners to access the end customer demand information and therefore deviations caused by inaccurate forecasts are removed. In this model, the supply chain partners face a competitive market; therefore, if customer demand is not satisfied immediately, the order will be lost and customer will move to our competitors.

The supply chain partners' ordering strategy under theses assumption is simple. The only variable in ordering decision is lead time. Supply chain partners place their order based on forecasted lead time such that their orders cover lead time interval. Under this condition, supply chain in various combinations of mean and variance for two different statistical distributions of lead time are simulated. Supply chain performance measures consisting of mean order size, order variance, holding inventory per period, and stock-out size per period are calculated.

Supply chain actors in each simulation run work for 5000 periods. Lead times are generated randomly from each of uniform and normal distributions. All integers between 20 and 50 are tested for LT mean; and for each mean value, variance is varied from 0.5 to 20 (with interval 0.5); thus, for each LT mean, 40 various lead time variances are tested. For each combination of LT mean and variance, supply chain simulation is iterated 10 times and average of parameters are calculated. All these experiments are repeated for both uniform and normal LT distribution. Totally, supply chain is simulated 24000 times.

Graphical results of both uniform and normal LT distribution can be drawn. Graphical representation of results shows variations of SC performance measures against LT mean and variance. By using graphical representation of simulation results, comparison between two distributions of lead time will be possible but it is not sufficient. Regression analysis is used based on simulation results as input data, for measuring impact of each variable on supply chain performance and detecting difference of the two statistical LT distributions on supply chain performance quantitatively. In the next section, graphical diagrams, results of simulation, and regression analysis are described.

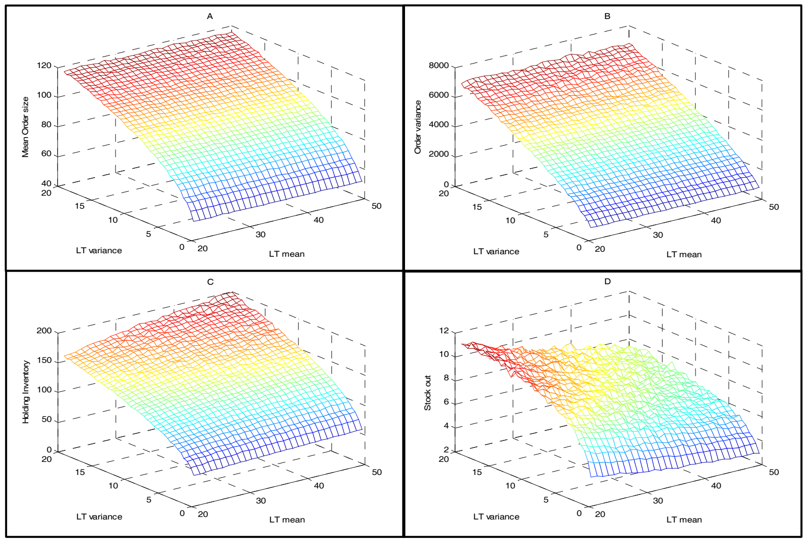

Figure 1. Performance measures' trends for various combinations of LT mean and variance in uniform distribution: (A) mean order size; (B) order variance; (C) holding inventory; (D) stock-outs

4. RESULTS

From four performance measures that are considered in this study, two measures (mean order size and order variance) are concerned about ordering system and the rest (holding inventory and stock-out size) are concerned about inventory system. Simulation shows that each of these measures vary according to changes of LT mean and variance. By investigating these variations and comparing difference between performance measures in two different LT distributions, effect of lead time distribution can be viewed in addition to creating insight into the quality of changes in performance indices.

Figure 1 and 2 show performance measures' trends for various combinations of LT mean and variance in uniform and normal distributions respectively.

Diagram (a) in both figures 1 and 2, are concerned about the trend of mean order size for various combinations of LT mean and variance. Both diagrams (1-a) and (2-a) show the logarithmic increase of mean order size against LT variance increase. According to theses diagrams, it seems that increasing LT mean at constant variance does not affect mean order size. Diagrams (1-B) and (2-B) show linear increase of order variance arising from LT variance increase in both LT distributions but it seems that increasing LT mean at constant variance has a little effect on order variance. Both diagrams (1-C) and (2-C) describe positive relation between holding inventory and both LT mean and variance; thus, maximum amount of holding inventory appear when both LT mean and variance have their maximum values. According to diagrams (1-D) and (2-D), positive relation between mean stock-out size and LT variance can be identified and reverse relation between mean stock-out size and LT mean is detected; thus, mean stock-out is maximized when LT mean is as small as possible and LT variance stands in its highest value. In the next section, more accurate and quantitative inference has been made using regression analysis. We use diagrams 1 and 2, to distinguish regression type. Based on these diagrams, polynomial regression seems to be appropriate. Furthermore, based on polynomial regression, it is tested whether two distributions (uniform and normal) are different in affecting supply chain performance or not?

4.1. Regression analysis

Regression analysis is a statistical methodology which uses the relationship between variables to predict value of a dependent variable by changing the independent variables [11]. In multiple

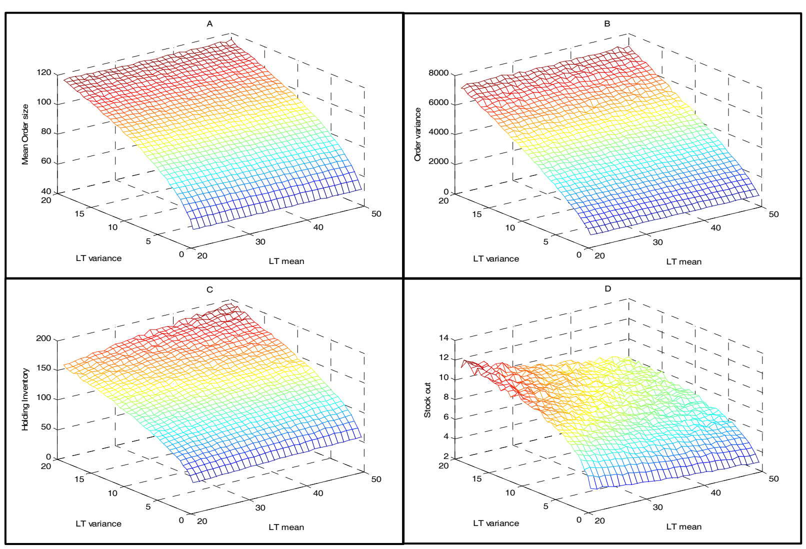

Figure 2. Performance measures' trends for various combinations of LT mean and variance in normal distribution: (A) mean order size; (B) order variance; (C) holding inventory; (D) stock-outs

regression analysis, one response variable and several independent variables exist. One of the most applied models of multiple regression models is polynomial regression. Generally, polynomial regression has been used in two basic cases [11]: (1) when response function is a polynomial function, and (2) when response function is unknown or complex but a polynomial function is an appropriate estimate of it. In this paper, according to figures 1 and 2, one can conclude that response function (concerned about each performance measure) can be estimated based on a polynomial function and therefore polynomial regression is used.

Our regression analysis has two main stages: (1) investigating the effects of LT mean and variance on each performance measure, both in uniform LT distribution and normal LT distribution, and (2) investigating the difference between two LT distributions in affecting each performance measure.

In the first stage, a second order polynomial regression (including interaction effects between independent variables) is used for investigating the effects of LT mean and variance on each SC performance measure. The general form of regression model is:

$$Y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_{11} x_{i1}^2 + \beta_{22} x_{i2}^2 + \beta_{12} x_{i1} x_{i2} + \varepsilon_i \quad (1)$$

Where x_{i1} and x_{i2} are predictor variables (LT mean and variance respectively) and Y_i is response variable that is one of the SC performance measures. Subscript i stands for i^{th} observation. Since four measures of SC performance are considered in this study, four regression models must be created for each of LT distributions (one performance measure has the role of response variable in each one). Table 1 shows the results of fitting regression models on simulation data after partial F-test..

As shown in table 1, each of eight regression models has five predictor variables including lead time mean (LTM), lead time variance (LTV), second order of lead time mean (LTM^2), second order of lead time variance (LTV^2), interaction effect between lead time mean and lead time variance (LTM*LTV). The five mentioned variables are correlated; thus, the model is run using centered predictor variables in order to reduce multicolinearity between independent variables [11] and coefficients are finally transformed to the original predictor variables after calculating regression parameters.

The exit of each predictor variable using partial F-test statistic at confidence level 95% is tested. If the exit of one predictor variable from each specific regression model is confirmed by partial F-test, then it is concluded that this independent variable is not a predictor variable in the formation of response function; in other words, effect of this independent variable on response variable is negligible. For example, when lead time comes from normal distribution, only LTM, LTV, and LTV^2 affect order variance but when lead time comes from uniform distribution, (LTM*LTV) affects order variance as well (see table 1).

Comparison of the two LT distributions is the second stage of our regression analysis and is presented in the following sections.

4.1.1. Mean order size regression models comparison:

According to regression equation (see table 1) and also figure 1 and 2, relation between mean order size and lead time variance is much greater than relation between mean order size and lead time mean. Comparison of the two LT distributions is done using the same methodology for each of the four response measures. Below, regression model is used for the purpose of assessment of the difference between two lead time distributions:

$$\begin{aligned}(OrderMean)_i &= \beta_0 + \beta_1 X_i + \beta_2 (LTM)_i + \beta_3 (LTM)_i.X_i + \beta_4 (LTV)_i \\ &+ \beta_5 (LTV)_i.X_i + \beta_6 (LTM)_i^2 + \beta_7 (LTM)_i^2.X_i + \beta_8 (LTV)_i^2 \\ &+ \beta_9 (LTV)_i^2.X_i + \beta_{10} (LTM)_i (LTV)_i \\ &+ \beta_{11} (LTM)_i (LTV)_i.X_i + \varepsilon_i \end{aligned} \quad (2)$$

Where:

$$X_i = \begin{cases} 1 & \text{if observation } i \sim \text{Normal Distribution} \\ 0 & \text{if observation } i \sim \text{Uniform Distribution} \end{cases}$$

Thus, when lead times come from uniform distribution, the regression model will be:

$$\begin{aligned}(Order\ Mean)_i &= \beta_0 + \beta_2 (LTM)_i + \beta_4 (LTV)_i + \beta_6 (LTM)_i^2 \\ &+ \beta_8 (LTV)_i^2 + \beta_{10} (LTM)_i (LTV)_i + \varepsilon_i \end{aligned} \quad (3)$$

And when lead times come from normal distribution, the regression model will be:

$$\begin{aligned}(Order\ Mean)_i &= (\beta_0 + \beta_1) + (\beta_2 + \beta_3)(LTM)_i + (\beta_4 + \beta_5)(LTV)_i \\ &+ (\beta_6 + \beta_7)(LTM)_i^2 + (\beta_8 + \beta_9)(LTV)_i^2 \\ &+ (\beta_{10} + \beta_{11})(LTM)_i (LTV)_i + \varepsilon_i \end{aligned} \quad (4)$$

Table 1. Coefficients of fitted regression models on simulation data for both normal and uniform LT distribution

Normal Distribution							
Response Variable	**1**	**LTM**	**LTV**	**LTM^2**	**LTV^2**	**LTM* LTV**	**R^2(%)**
Order Mean	54.1	-0.0150	5.245	-	-0.112	-	99.3
Order Variance	760.7	-0.9214	418.64	-	-5.038	-	99.8
Holding Inventory	25.9	1.4353	8.223	-0.012	-0.201	0.040	99.2
Stock out	9.02	-0.2137	0.700	0.0019	-0.017	-0.002	96.7
Uniform Distribution							
Response Variable	**1**	**LTM**	**LTV**	**LTM^2**	**LTV^2**	**LTM* LTV**	**R^2(%)**
Order Mean	54.7	-0.0187	5.363	-	-0.117	-	99.3
Order Variance	745.3	-0.2423	416.71	-	-5.461	-0.114	99.8
Holding Inventory	23.6	1.5606	8.636	-0.014	-0.216	0.042	99.2
Stock out	9.38	-0.2268	0.653	0.0021	-0.016	-0.002	96.4

To assess whether the type of LT distribution affects response variable or not, two regression equations (3) and (4) must be compare with each other. If two regression models have a significant difference, then one can conclude that mean order size when lead times have normal distribution are statistically different from mean order size when lead times have uniform distribution. Hypothesis testing for such investigation is:

$$\begin{cases} H_0 : \beta_1, \beta_3, \beta_5, \beta_7, \beta_9, \beta_{11} = 0 \\ H_1 : \text{Not all } \beta_1, \beta_3, \beta_5, \beta_7, \beta_9, \beta_{11} = 0 \end{cases} \quad (5)$$

When H_0 has not been accepted then at least one coefficient is not equal to zero and therefore two models will be different. In other words, by not acceptance of H_0, two lead time

distributions will be different in affecting performance measures.
For testing the hypothesis (5) using partial F-test we have:

$$F^* = \frac{(SSE(Reduced\ Model) - SSE(Full\ Model))/(df_{Reduced\ Model} - df_{Full\ Model})}{SSE(Full\ Model)/df_{Full\ Model}}$$

$$= \frac{(5954.69 - 5286.53)/(2394 - 2388)}{5286.53/2388} = 50.303 \quad (6)$$

In equation (6), reduced model refers to model (2) under H_0 condition, while Full model is complete regression model of equation (2). Total number of observations is equal to 2400 thus full model's degree of freedom is equal to 2400-12=2388 and reduced model's degree of freedom is equal to 2400-12+6=2394.

Since calculated F-statistic is much greater than F-statistic *(F(0.95,6, ∞)=2.10)* thus H_0 is not accepted and therefore two models are statistically different. Furthermore, more detailed experiments are done to distinguish the differences of two models. In each new experiment, each of *X* variables' coefficients (i.e. $\beta_1, \beta_3, \beta_5, \beta_7, \beta_9, and\ \beta_{11}$) in general model (2) is tested one by one. Table 2 (see appendix) shows calculated regression coefficients and calculated F*.

As shown in table 2, more detailed experiments on each coefficient $\beta_1, \beta_3, \beta_5, \beta_7, \beta_9, and\ \beta_{11}$ is performed. At confidence level $\alpha = 95\%$, two coefficients β_1 and β_9 has a F* greater than *F(0.95,1, , ∞)=3.84* thus the two variables *X* and $LTV^2.X$ remain in the model. According to the remaining two variables in the model, difference of normal and uniform LT distribution on affecting mean order size is significant. According to negative sign of β_1, it is clear that offset from origin in regression model with normal LT distribution is lower in respect to the regression model with uniform LT distribution. But mean order size grows more rapidly in normal LT distribution than in uniform LT distribution (according to positive coefficient β_9).

4.1.2. Order variance regression models comparison:

To test the existence of difference in effects of two lead time distributions on order variance, a methodology like one used in section 4-1-1 is utilized. Calculated F-statistic *(F*=345.08)* is much greater than *(F(0.95,6, ∞)=2.10)* thus effects of two lead time distribution on order variance is different. More detailed partial F-tests on each coefficient shows that, in confidence level $\alpha = 95\%$, three coefficients $\beta_1, \beta_5, and\ \beta_9$ has a F* greater than *F(0.95,1, ∞)=3.84* thus the two variables *X,LTV.X* and $LTV^2.X$ remain in the model. According to remaining three variables in the model, difference of normal and uniform LT distributions on affecting order variance is significant. Table 3 (see appendix) shows calculated regression coefficients and calculated F*.

From table 3, one can conclude that difference of order variance between two investigated LT distributions is caused by lead time variance and not for the reason of lead time mean.

4.1.3. Holding inventory regression models comparison:

To test the difference between two LT distributions from holding inventory point of view, the same regression methodology like one used in section 4-1-1 is used. Calculated *F*=117.45* is much greater than critical value *(F(0.95,6, ∞)=2.10)*; thus, at $\alpha = 95\%$, two LT distributions are different in respect to the effect on holding inventory. More detailed tests show that $\beta_1, \beta_3, \beta_5, and\ \beta_9$ at confidence level 95% are non-zero and therefore variables *X*, *LTM.X*, *LTV.X*, and $LTV^2.X$ remain in the model; which causes the difference of normal and uniform LT distributions in affecting the holding inventory. Table 4 (see appendix) shows the regression coefficients and relevant F-statistic values.

As shown in table 4, sign of both β_3 and β_5 are negative; thus, by keeping theses two variable in the model, by increasing LT mean and variance in the normal distribution, average of holding inventory increases less than that of uniform LT distribution.

4.1.4. Stock-out size regression models comparison:

To assess the difference between two distributions of lead time in respect to stock-out size, the F-statistic of hypothesis (5) is calculated. Since *F*=97.475* is greater than *(F(0.95,6, ∞)=2.10)*, two LT distributions are different in affecting stock-out size. More detailed tests show that at $\alpha = 95\%$, both β_1 and β_5 are non-zero. Table 5 (see appendix) shows the regression coefficients and relevant F-statistic values.

According to table 5 (see appendix), sign of β_5 (coefficient of *LTV.X*) is positive; thus, by increasing lead time variance, increase of stock-outs in normal LT distribution is greater than that of uniform LT distribution.

5. DISCUSSION

Lead time is one of the main factors that affect performance of each supply chain partner. By effective management of lead time, it is possible to reduce its harmful effects. In this study, at first stage, effects of lead time mean and variance on supply chain performance has been identified by simulating the supply chain. Results of this stage have been summarized as follows:

- Both mean order size and order variance are affected by lead time variance more than by lead time mean.
- Average of holding inventory has positive relation with both LT mean and variance.
- Investigation about stock-out size shows that by increasing lead time mean, stock-outs decrease but lead time variance and stock-outs have a direct relation.

Also, by using a methodology based on polynomial regression analysis, difference between normal and uniform LT distributions is assessed based on the change they cause in SC performance measures. Main findings of this stage shows that lead time with normal distribution is different from lead time with uniform distribution, as the distribution type affects all performance measures including mean order size, order variance, holding inventory, and stock-out amounts.

Finally, regarding the business conditions, relative importance of each performance measure, and desired behavior of each performance measure, managers can decide about carrier selection based on carrier characteristics about transportation or production lead time; or one can decide about investment on changing the lead time characteristics. In this paper, only the effects of lead time are considered. These effects can be changed if interaction with other variables such as customer demand, data sharing level and so on, has been added to the model; it can be viewed as future study.

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Appendix

Calculated regression coefficients and relevant F-statistic values.

Table 2. Regression coefficients and F-statistic values (response variable=mean order size)

	1	**X**	**LTM**	**LTM.X**	**LTV**	**LTV.X**	**LTM^2**	**LTM^2.X**	**LTV^2**	**LTV^2.X**	**LTM*LTV**	**LTM* LTV.X**
Coefficient	96.744	-1.190	-0.018	0.003	2.960	-0.020	0.0002	-0.00008	-0.117	0.0047	-0.0014	0.0004
F* statistic	-	**109.572**	-	0.2769	-	3.633	-	0.00718	-	**5.4244**	-	0.1582
Overall X coefficients F*= 50.30298267												

Table 3. Regression coefficients and F-statistic values (response variable=order variance)

	1	**X**	**LTM**	**LTM.X**	**LTV**	**LTV.X**	**LTM^2**	**LTM^2.X**	**LTV^2**	**LTV^2.X**	**LTM*LTV**	**LTM* LTV.X**
Coefficient	4389.7	99.3192	-1.41	0.4936	300.6	14.656	0.0391	-0.0294	-5.4614	0.4226	-0.1144	0.0574
F* statistic	-	**295.542**	-	1.9202	-	**751.79**	-	0.4101	-	**16.6321**	-	0.8661
Overall X coefficients F*= 345.0856348												

Table 4. Regression coefficients and F-statistic values (response variable=Holding inventory)

	1	**X**	**LTM**	**LTM.X**	**LTV**	**LTV.X**	**LTM^2**	**LTM^2.X**	**LTV^2**	**LTV^2.X**	**LTM*LTV**	**LTM* LTV.X**
Coefficient	142.43	-3.7985	0.985	-0.043	5.721	-0.183	-0.0143	0.0014	-0.2162	0.0144	0.0427	-0.0018
F* statistic	-	**246.235**	-	**8.2905**	-	**67.401**	-	0.5711	-	**11.0305**	-	0.5473
Overall X coefficients F*= 117.4517657												

Table 5. Regression coefficients and F-statistic values (response variable=stock-outs size)

	1	**X**	**LTM**	**LTM.X**	**LTV**	**LTV.X**	**LTM^2**	**LTM^2.X**	**LTV^2**	**LTV^2.X**	**LTM*LTV**	**LTM* LTV.X**
Coefficient	7.9652	0.299	-0.10	0.0025	0.215	0.0294	0.0021	-0.00014	-0.0165	-0.00072	-0.0028	-0.00006
F* statistic	-	**149.578**	-	2.7512	-	**169.23**	-	0.5329	-	2.6812	-	0.0426
Overall X coefficients F*= 97.47508088												