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تحلیل عددی زنجیره تامین(اثر شلاق چرمی) در بیمه عمر

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چکیده

مهمترین عنصر موفقیت در تجارت استمرار عملیات تولید و خدمات میباشد به همین دلیل اگر شرکتها خودشان را در جایگاه رسیدن به این هدف قرار ندهند یا نتوانند زیانهای خود را پس از حوادث جبران کنند به ورشکستگی خواهند رسید در این راستا صنعت بیمه نقش حیاتی در تجارت و استمرار مدیریت ریسک زنجیره تامین ایفا میکند

برای اولین بار در این مقاله دو بیمه نامه عمر در یک زنجیره تامین دو مرحله ای بمنظور بررسی اثر شلاق گاوی مورد بررسی قرار گرفت تقاضا در دو بیمه نامه وابسته و تحلیل عددی با روش پیش بینی هموار سازی نمایی و توزیع پواسون و سری زمانی بمنظور پیش بینی تقاضا در لید تایم محاسبه شد.

معادله اثر شلاق گاوی بمنظور کاهش اثر مخرب آن در صنعت بیمه ارائه شد نتایج نشان داد که اثر این پدیده در بیمه های عمر جامع بیشتر از بیمه های تمام عمر میباشد و عدم توجه به پدیده شلاق گاوی در این زنجیره موجب بر هم خوردن نظم زنجیره تامین صنعت بیمه خواهد شد

واژگان کلیدی: بیمه عمر ، مدیریت زنجیره تامین ، اثر شلاق گاوی، روشهای پیش بینی آماری.

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Numerical analysis on life assurance supply chain

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ABSTRACT
The critical element of success in business is maintaining continuous operations. If companies are not in a position to achieve that aim, or to finance their losses after an accident that can cause interruption, they certainly will fail. Insurance has a pivotal role in business and supply chain continuity risk management.
In this paper for the first time, a two-life insurance contract and a two-stage supply chain and bullwhip effect and is considered. Demands of the policies are correlated and analyzed by Poisson distribution and utilizes exponential smoothing forecast method to predict demand in lead-time period. An equation is derived for bullwhip effect measurement and some solutions are proposed for bullwhip effect reduction. The research showed that bullwhip effect of universal life insurance policy is greater than whole life insurance policy which can destroy more the harmony of insurance supply chain management.
Key words: life assurance, supply chain management, bullwhip effect, forecasting methods

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Introduction

So far, the bullwhip effect of life insurance in Iran's insurance industry has not been investigated so this is the first article, which investigates the bullwhip effect in insurance and namely in life insurance. A decade has passed since the publication of the two seminal papers by Lee, Padmanabhan and Whang (1997) that describes the "bullwhip effect" in supply chains and characterizes its underlying causes. The bullwhip phenomenon is observed in supply chains where the decisions at the subsequent stages of the supply chain are made greedily based on local information, rather than through coordination based on global information on the state of the whole chain. The first consequence of this information distortion is higher variance in purchasing quantities compared to sales quantities at a particular supply chain stage. The second consequence is increasingly higher variance in order quantities and inventory levels in the upstream stages compared to their downstream stages (lee,2018). In 2015 A.Sadeghi considered the bullwhip effect in a two product supply chain by moving average and exponential smoothing and showed that moving average creates less fluctuation than exponential pattern in Auto industry supply chain (Sadeghi,2015)

a) Insurance institutions are shaped by nature of the economic and social environment in which they grow and mature, there are at least four basic conditions necessary before the institution of private insurance can flourish.
   1- The economic system should basically be a system of private property.
   2- Society should be highly developed and industrialized.
   3- Legal relationships should be well organized, known to all and fairly enforced.
   4- There must be an ethical environment for insurance.
b) Supply chain consists of all entities involved, in fulfilling a customer need. A typical supply chain may involve a variety of stages. These supply chain stages include:
   - Customers
   - Retailers
   - Distributors
   - Manufacturers
   - Component suppliers

Each stage in supply chain connected through the flow of information, goods, and money. Supply chain coordination improves if all stages of the chain take actions that together increase total supply chain profits. Supply chain coordination requires each stage of the supply chain to take into account the impact its actions have on other stages. A lack of coordination occurs because different stages of the supply chain have conflicting objectives that conflict or because information flows, moving between stages delayed and distorted. Different stages of a supply chain may have conflicting objectives if each stage has a different owner. As a result, each stage endeavors to maximize its own profits, resulting in actions that often diminish total supply chain profits.
Dampening of demand is a major obstacle to achieve coordination and creation harmony within different stages of supply chains. Many companies have observed increasing fluctuation in orders while moving up from downstream sites to upstream sites. The result is a loss of supply chain profitability. After Forrester studies on demand amplification in 1958, many of researchers continue investigations on this phenomenon. In addition, a few case studies in various industries around the world (like P&G, HP, Barilla) and existence of demand dampening has been proved in their supply chains. Lee et al. (1997) introduced five main causes of this phenomenon i.e. demand forecast updating, order batching, price fluctuation, rationing and non-zero lead-time. Understanding these causes of the bullwhip effect can be useful for reduction of its influences.

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Sucky (2009) divided researches on the bullwhip effect into six general categories papers aiming at a quantification of the bullwhip effect(e.g. Carlsson and Fuller, 2000; Chen et al., 2000a,b; Dejonckheere et al., 2003; Kahn, 1987; Lee et al. ,1997 a,b; Metters, 1997; Zhou and Disney, 2006), (ii) works focusing on analyzing and identifying the causes of the bullwhip effect (e.g. Geary et al., 2006; Lee et al., 1997 a,b; Metters, 1997; Nienhaus et al., 2006), (iii) studies observing the bullwhip effect in some industries or in numerous examples from individual products and companies (e.g. Cachon et al., 2005; Lee et al., 1997 a), (iv) papers addressing methods for reducing the bullwhip effect (e.g. Carlsson and Fuller, 2001; Chen et al., 2000a,b; Dejonckheereetal., 2003; Disney and Towill, 2003; Ingalls et al., 2005; Mason-Jones and Towill, 2000; Moyaux et al., 2007), (v) works focusing on simulating the system behavior (e.g. Disney and Towill, 2003; Ingalls et. al., 2005 Makajic-Nikolic et al., 2004; Nienhaus et al., 2006) and (vi) papers focusing on experimental validation of the bullwhip effect (e.g. Moyauxetal., 2003).

In the last decade, papers have provided issues for modeling and quantifying bullwhip effect and its solutions. In addition, investigations on the role of forecasting method, ordering policy, information sharing, lot sizing rules, and so on conducted in different statues. Chen et al. (2000a,b) quantified bullwhip effect in a single product supply chain and provided a measure for bullwhip ratio in case of moving average and exponential smoothing forecasting. Dejonckheere et al. (2003) proposed a control theory approach for measuring bullwhip effect and suggested a new general replenishment rule that can reduce variance amplification significantly. Disney and Towill (2003) introduced an ordering policy that results taming bullwhip effect. Zhang (2004) considered three forecasting methods for a simple inventory control system. The results showed that forecasting methods affect the bullwhip effect. He also presented three measures for bullwhip effect based on three forecasting methods. Kim et al. (2006) investigated stochastic instead of deterministic lead-time and investigated role of information sharing in bullwhip effect. Chandra and Grabis (2005) measured bullwhip effect when order size is calculating according to multiple step forecasts using autoregressive models.

Luong (2007) investigated effects of autoregressive coefficient and lead-time on bullwhip effect when MMSE forecasting method is used. Luong and Phien (2007) research was based on order of autoregressive demand pattern. They got an interesting result and found that bullwhip effect is not always an increasing function of lead-time. They showed that in some instances, bullwhip effect reduces when lead-time increases. Makui and Madadi (2007) utilized Lyapunov exponent and presented a measure for bullwhip effect. They provided useful results on the behavior of the bullwhip effect by investigating the mathematical relationships. Gaalman and Disney (2009) investigated behavior of the proportional order up to policy for ARMA (2,2) demand with arbitrary lead-time. They proposed a replenishment rule that accounts for the characteristics of the demand in a superior manner in order to compensate for possible weaknesses of the proportional OUT policy. Jaksic and Rusjan (2008) demonstrated that certain replenishment policies can be inducers of the bullwhip effect and suggested that through certain replenishment rules, the bullwhip effect can be avoided.

Chaharsooghi and Sadeghi (2009) considered a two-product supply chain and quantified bullwhip effect measure using statistical approach when moving average forecasting method is utilized by retailer. They concluded that there is no explicit expression for the bullwhip effect ratio, when statistical method used for quantifying of the bullwhip effect. Consequently, bullwhip effect measure calculates only limited cases.

Zhang and Burke (2011) investigated compound causes of the bullwhip effect by considering an inventory system with multiple price-sensitive demand streams. They studied two bullwhip effect measures, one for each demand stream individually and one for the aggregated demand. Nepal et al., (2012) presented an analysis of the bullwhip effect and net-stock amplification in a three-echelon supply chain considering step-changes in the production rates during a product's life-cycle demand.

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Using a simulation approach, the analysis focuses around highly complex and engineered products, which have relatively long production life cycles and require significant capital investment in manufacturing. Fazel Zarandi and Gamasaee (2013) investigated reducing of the bullwhip effect in fuzzy environments by means of type-2 fuzzy methodology. In order to reduce the bullwhip effect in a supply chain, they proposed a new method for demand forecasting.
Zotteri (2013) analyzed the empirical demand data for fast moving consumer goods to measure the bullwhip effect. The data consisted of the sell-in from a large manufacturer to the retailers and the sell-out from a retailer to the consumers. Findings showed that the bullwhip-effect could be substantial.
In this research, for the first time we consider life insurance contracts supply chain that consist broker , insured and insurer. Demand of two policies correlated. Ordering policy based on order up to policy and forecasting follows exponential smoothing method and data investigated by Poisson distribution. A measure for bullwhip effect and a numerical example for better analytical perception presented.

1-Life assurance

The true wealth of nation lies not in its natural resources or its accumulated property, but in the inherent capabilities of its population and the way in which this population is employed. The preservation of human life is of basic inherent to all of us (Karen,1793)
A human life has value for many reasons. Many of these reasons are philosophical in nature , and would lead us into the realm of religion , esthetics , sociology , psychology and other behavioral sciences , of greatest interest here are economic value , there are four main perils that can destroy the economic value of human life : 1-premature death 2- loss of health 3- old age 4- unemployment (stalson, 1971)
Life insurance is a method of creating an estate of income –producing property. It is the only method of creating an immediate estate in case of premature death. It serves as a hedge against the possibility that the insured may not live to carry out property accumulation plans.
The chief purpose of life insurance in estate planning is to provide for dependents in case of death of the breadwinner. A secondary purpose is to save money of one's retirement.The major contracts of life insurance are of three types (Green, 1977):

1-term insurance:
a)level-term contract
b) decreasing-term contract

2-permanent life insurance:
a)whole life insurance
b)ordinary life insurance
c)limited-payment life contract
d)universal life insurance

3-endowment insurance:
a)limited-term
b)retirement income contract

Insurance cannot directly safeguard individuals and companies from accidents and subsequent disruptions but is the most important source of indemnification for losses when insured events materialize.

1-1Whole Life Insurance

Whole Life insurance is permanent life insurance coverage often chosen by individuals who want to lock in a fixed rate of premium for the rest of their life. Though whole life policies can be more

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expensive than some other types of life insurance, the long-term financial predictability of obtaining lifelong level premium is appealing to some. Whole life insurance carries cash value, which typically grows on a tax-deferred basis. These product features may make whole life a good choice for individuals with the larger budgets to work with. This type of coverage might be also good fit if you are concerned about your predisposition for illness or diseases based on your family history. This is because you will not be asked to complete additional medical exams once your policy is in place.

1-2Universal Life Insurance

Universal life insurance is a type of permanent life insurance coverage similar to whole life insurance that offers more flexibility in premiums than whole life coverage. Universal life carries interest earning cash value much like whole life insurance. However, universal life policies also have the added benefit of adjustable death benefits. This means that (in most cases) you can make changes to your policies death benefit as your needs may change. Because of this, universal life coverage may be a better fit for younger people looking for a permanent insurance option as well as those who are unsure of their future needs.

2- SUPPLY CHAIN

In this research, a measure for bullwhip effect in a two-stage supply chain with one broker and one insurer and insured is provided. Broker encounters market demand from insured and orders it to the insurer based on supply chain ordering policy. Therefore, service flow is from insurer to the broker then insured and demand information flow is from applicant or insured to broker toward insurer. There are two products in the supply chain and so broker and insurance applicant meet demand of two products. Figure 1 shows proposed supply chain.

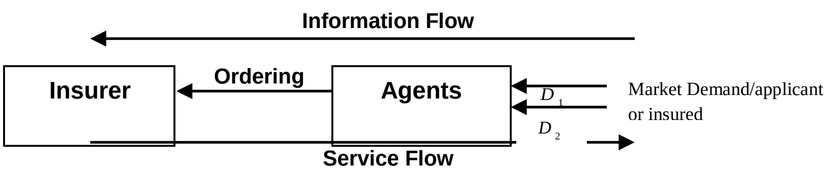

Figure 1: supply chain in life insurance industry

D_1 In addition, D_2 are demand values for whole life policy and universal life policy received by insurer. Demand of each product depends on demand of other product. Therefore, a suitable pattern for demand modeling must be considered that includes relationship between products. In the next section, proposed demand model is illustrated in detail. Poisson distribution is a discrete probability distribution that expresses the probability of a given number of events occurring in a fixed interval of time or space if these events occur with a known constant rate and independently of the time since the last event.

2.1Demand pattern

As mentioned before, demand of products are relevant to each other, so a first order vector autoregressive model (VAR (1)) is taken into consideration for demand modeling. AR (1) is a commonly used model for one-product supply chains and so, we consider vector model of AR (1) in this research, due to number of products in our supply chain. Dependence of two products in VAR (1) model is represented as follows: suppose that our supply chain produced product 1 and product 2 (P_1 =DANA whole life policy and P_2 =DANA universal life policy). Because these products can be used

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instead of each other, we can suppose that demand of whole life in period *t* is relevant to demand of whole life in period *t*-1 as well as demand of universal policy in period *t*-1. This situation also exists for demand of universal life policy in each period. Suppose that D_t^i is demand of *i* th product in period *t* (*i*=1,2 and *t*=1,2,…). Hence VAR (1) process for demand of two products can be determined by:

$$\begin{cases} D_t^1 = \phi_{11} D_{t-1}^1 + \phi_{12} D_{t-1}^2 + a_t^1 \\ D_t^2 = \phi_{21} D_{t-1}^1 + \phi_{22} D_{t-1}^2 + a_t^2 \end{cases} \tag{1}$$

where a_t^i is forecast error of *i* th product for period *t* and is i.i.d. normally distributed with mean zero and variance σ_{ii}. Moreover covariance between a_t^i and a_t^j is represented by σ_{ij}. To simplify model, we assume that a_t^i for *i*=1,2 are uncorrelated (i.e. $\sigma_{12} = 0$) and a_t^i has a standard normal distribution (i.e. $\sigma_{11} = \sigma_{22} = 1$). The mentioned relationship for DANA whole life policy and DANA universal life is cleared in equation (1). In order to demand process to be stationary, or:

$$\begin{cases} Var(D_t^1) = Var(D_{t-1}^1) = Var(D_{t-2}^1) = \ldots = \gamma_{11} \\ Var(D_t^2) = Var(D_{t-1}^2) = Var(D_{t-2}^2) = \ldots = \gamma_{22} \end{cases}$$

we must have:

$$\left| \frac{(\phi_{11} + \phi_{22}) \pm \sqrt{(\phi_{11} - \phi_{22})^2 + 4\phi_{12}\phi_{21}}}{2} \right| \prec 1$$

Using time series models properties, it is proved that variance of each product (i.e. γ_{11}, γ_{22}) in a VAR (1) demand process can be derived by equation (2):

$$Var[D_i] = \gamma_{11} = \frac{((1-\phi_{11}\phi_{22})(1-\phi_{22}^2) - \phi_{12}\phi_{21}(1+\phi_{22}^2)) + +\phi_{12}^2(1-\phi_{12}\phi_{21}+\phi_{11}\phi_{22})}{1+(\phi_{11}\phi_{22}-\phi_{12}\phi_{21}-1)(\phi_{11}\phi_{22}+\phi_{12}\phi_{21}+\phi_{11}^2+\phi_{22}^2)+(\phi_{12}\phi_{21}-\phi_{11}\phi_{22})^3} \tag{2}$$

In which for product one, *i*=1 and *j*=2 and for product two, *i*=2 and *j*=1.In addition covariance between two products (i.e. γ_{12}) is expressed by equation (3):

$$Cov[D_1, D_2] = \gamma_{12} = \frac{\phi_{21}(\phi_{11}(1-\phi_{22}^2)+\phi_{12}\phi_{21}\phi_{22}) + \phi_{12}(\phi_{22}(1-\phi_{11}^2)+\phi_{11}\phi_{12}\phi_{21})}{1+(\phi_{11}\phi_{22}-\phi_{12}\phi_{21}-1)(\phi_{11}\phi_{22}+\phi_{12}\phi_{21}+\phi_{11}^2+\phi_{22}^2)+(\phi_{12}\phi_{21}-\phi_{11}\phi_{22})^3} \tag{3}$$

We need equation (2) and equation (3) to quantify bullwhip effect measure in the next parts.

2.2Ordering policy

In this research, following previous researchers such as, Chen et al. (2000 a,b), Zhang (2004), Hosoda and Disney (2006), Luong and Phien (2007) and Chaharsooghi. and Sadeghi (2009) we consider an order up to policy (OUT) for insurer inventory control system. OUT policy is easy to understand and is often utilized by companies to coordinate orders from suppliers where setup costs may be reasonably ignored (Su and Wong (2008)). In this system, level of inventory and facility is reviewed periodically and an order is placed to bring inventory position to a predefined level. In considered inventory control system, facility position is observed at the beginning of each period and in order to raise the inventory and other facility level to S_t, an order Q_t, is placed. After the order is placed, customer demand D_t occurs. Equation (4) shows the order quantity:

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$$Q_t = S_t - S_{t-1} + D_{t-1} \qquad (4)$$

If the base stock policy is employed the order-up-to level; S_t can be determined through lead-time demand by equation (5):

$$S_t = \hat{D}_t^L + z.\hat{\sigma}_t^L \qquad (5)$$

where $\hat{D}_t^L$ is forecast of lead-time demand and $\hat{\sigma}_t^L$ is standard deviation of lead-time demand forecast error. Moreover, *z* is normal *z* score and can be determined by normal table based on the favorable service level of the inventory system. According to Zipkin (2000), if holding and shortage costs are meaningful, then *z* will be calculated by equation (6):

$$z = \phi^{-1}\left(\frac{b}{h+b}\right) \qquad (6)$$

in which, *b* is shortage cost per unit and *h* is holding cost per unit and $\phi(.)$ is standard normal distribution function. Replacing equation (5) in equation (4) concludes equation (7) that is order quantity in period *t*:

$$Q_t = \hat{D}_t^L - \hat{D}_{t-1}^L + z(\hat{\sigma}_t^L - \hat{\sigma}_{t-1}^L) + D_{t-1} \qquad (7)$$

We suppose that each of products is ordered independently, so equation (7) can be used for both of them separately according to their parameters.

2.3Forecasting method

Suppose that the lead-time *L* is the number of periods that elapse between the time an order is placed and the time that items are received in underwriting department. This lead-time could be due to order processing, underwriting flow time, transportation time or any other types of delays. Therefore, because of the existence of lead-time between placing order and receiving the policies and questionnaire into stock, we need to forecast demand. In the past researches especially in the case of single product supply chains, various forecasting methods such as moving average, exponential smoothing, minimum expected mean squares of error are utilized for forecasting of to forecast the lead-time demand and then a measure for bullwhip effect is derived for each situation. In case of multi-product supply chains, Chaharsooghi and Sadeghi (2009) considered a supply chain with two products in which retailer used moving average forecasting method for lead-time demand prediction. Here in this paper, we suppose that insurer uses exponential smoothing forecasting method to predict lead-time demand.
In exponential smoothing method, the forecasts are determined by equation (8) :

$$\hat{D}_t = \alpha D_{t-1} + (1-\alpha)\hat{D}_{t-1} \qquad (8)$$

in witch $\hat{D}_t$ is forecast for period *t* and α is the smoothing constant where $0 \prec \alpha \prec 1$. Equation (8) is equivalent to equation (9):

$$\hat{D}_t - \hat{D}_{t-1} = \alpha\left(D_{t-1} - \hat{D}_{t-1}\right) \qquad (9)$$

Therefore, lead-time demand estimation can be expressed as follows:

$$\hat{D}_t^L - \hat{D}_{t-1}^L = \alpha L\left(D_{t-1} - \hat{D}_{t-1}\right) \qquad (10)$$

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This expression is utilized for bullwhip effect measurement in the rest of paper. As we consider each product independent of the other one, equation (10) can be used for both of product based on the relevant parameters of two products.

3. Bullwhip effect

The bullwhip effect indicates the phenomenon where orders to the supplier tend to have larger variance than market demand to the retailer and broker. This demand distortion creates very problems in supply chain. Figure 2 shows the bullwhip effect in insurance service industry and figure 3 shows the flow of demand.

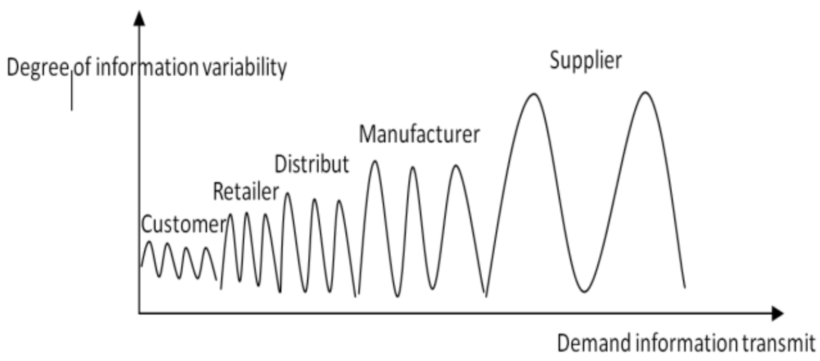

Figure 2: Bullwhip effect in insurance industry

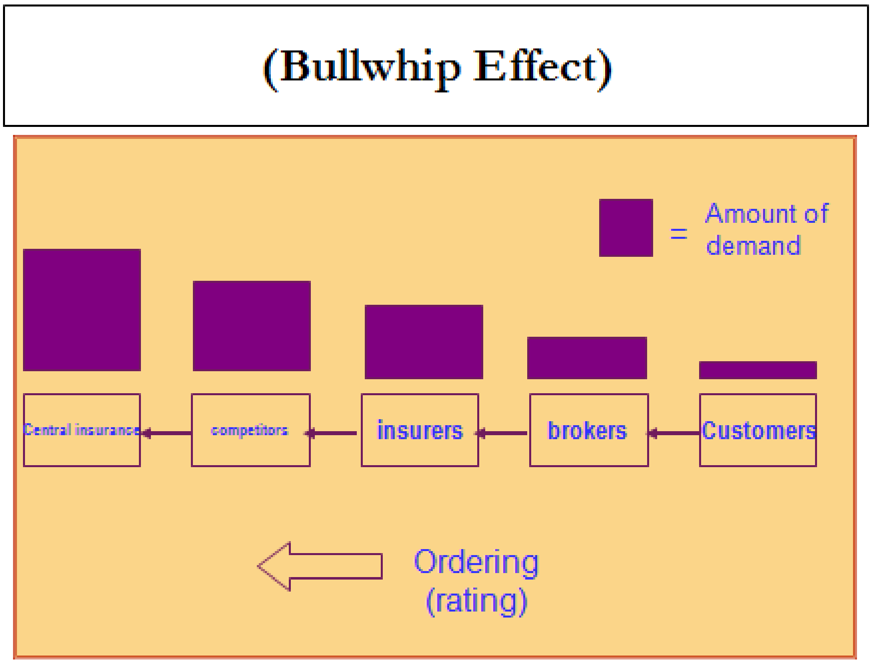

Figure 3: flow of demand in insurance industry

To show the existence of bullwhip effect in the proposed supply chain system, previous researchers defined it as ratio of variance of orders to variance of demand as is represented in equation (11):

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$$BE = \frac{Var(Q_t)}{Var(D)} \qquad (11)$$

in which $Var(Q_t)$ is variance of retailer orders and $Var(D)$ is variance of the customer demand. Therefore, to provide bullwhip effect measure, we must determine equations for two mentioned terms based on mathematical relationships. Moreover, it is possible to analyze impression of change in parameters such as exponential smoothing constant and lead-time on the bullwhip effect measure. Consequently, solutions for bullwhip effect reduction can be proposed based on scientific evidences analytically. Considering equation (11), to provide a measure for bullwhip effect, it is sufficient to determine variance of order and variance of demand.

3.1.Proposition

In case of exponential smoothing forecasting, variance (equivalently; standard deviation) of lead-time demand forecast error for each product does not depend on *t* and is constant during periods. It can be represented by equation (12):

$$(\hat{\sigma}_t^L)^2 = L\gamma\left(1+\left(\frac{\alpha L}{2-\alpha}\right)\right) + 2\sum_{i=1}^{L}(L-i)\gamma(i) + 2\alpha L\left[\left(\frac{L}{2-\alpha}\right)\sum_{i=1}^{\infty}(1-\alpha)^i\gamma(i) - \sum_{i=1}^{L}\gamma(i) - \sum_{i=1}^{L}\sum_{j=1}^{\infty}(1-\alpha)^j\gamma(i+j)\right] \qquad (12)$$

in equation (12), γ is variance of each insurance policy and $\gamma(i) = Cov(D_t, D_{t+i})$.

Because equation (12) implies that $\hat{\sigma}_t^L = \hat{\sigma}_{t-1}^L$, equation (7) can be summarized to equation (13):

$$Q_t = \hat{D}_t^L - \hat{D}_{t-1}^L + D_{t-1} \qquad (13)$$

Regarding equation (11) and equation (13), we can conclude that standard deviation of lead-time demand for each product does not impress bullwhip effect. Now we continue to determine two relationships for $Var(D)$ and $Var(Q_t)$ as numerator and denominator of bullwhip ratio. As mentioned before, equation (2) can be used as variance of market demand and to determine variance of orders, we follow our calculations based on equation (13) in next section.

3.2Variance of order quantity

To provide a measure for variance of order quantity, we must determine $Var(Q_t)$ using equation (13). If we substitute equation (10) in equation (13), we have:

$$Q_t = \alpha L\left(D_{t-1} - \hat{D}_{t-1}\right) + D_{t-1}$$

Alternatively: $Q_t = (1+\alpha L)D_{t-1} - \alpha L\hat{D}_{t-1}$ (14)

According to Zhang (2004), in exponential smoothing method, recursive relationship represented by equation (15) is equivalent to equation (8) and we use it in determination of variance of quantity:

$$\hat{D}_t = \alpha\sum_{i=0}^{\infty}(1-\alpha)^i D_{t-i-1} \qquad (15)$$

Replacing equation (15) in equation (14) yields equation (16):

$$Q_t = (1+\alpha L)D_{t-1} - \alpha^2 L\sum_{i=0}^{\infty}(1-\alpha)^i D_{t-i-2} \qquad (16)$$

Finally, summarizing relationships we concluded the following compact form variance of orders:

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$$Var(Q_t)=\left(\gamma\left((1+\alpha L)^2+\frac{\alpha^3L^2}{2-\alpha}\right)+\left(\frac{2\alpha^3L^2}{2-\alpha}\right)\left(\sum_{i=1}^{\infty}(1-\alpha)^i\gamma(i)\right)-2\alpha^2L(1+\alpha L)\sum_{i=0}^{\infty}(1-\alpha)^i\gamma(i+1)\right) \tag{17}$$

Equation (17) can be used for determination of variance of released orders for both of insurance life policies as products.

3.3Bullwhip effect measure

Regarding equation (11), bullwhip measure is ratio of variance orders to variance of demand. Substituting variance of orders and variance of demand (i.e. γ) results:

$$BE=\frac{Var(Q_t)}{Var(D)}=\frac{\gamma\left((1+\alpha L)^2+\frac{\alpha^3L^2}{2-\alpha}\right)+\left(\frac{2\alpha^3L^2}{2-\alpha}\right)\left(\sum_{i=1}^{\infty}(1-\alpha)^i\gamma(i)\right)-2\alpha^2L(1+\alpha L)\sum_{i=0}^{\infty}(1-\alpha)^i\gamma(i+1)}{\gamma}$$

$$=(1+\alpha L)^2+\frac{\alpha^3L^2}{2-\alpha}+\frac{\left(\frac{2\alpha^3L^2}{2-\alpha}\right)\left(\sum_{i=1}^{\infty}(1-\alpha)^i\gamma(i)\right)-2\alpha^2L(1+\alpha L)\sum_{i=0}^{\infty}(1-\alpha)^i\gamma(i+1)}{\gamma} \tag{18}$$

If we consider γ_{jj} , L_j and α_j as variance, lead-time and exponential smoothing constant of product *j* (respectively), bullwhip effect measure will be provided for product *j* (*j*=1,2):

$$BE_j=(1+\alpha_jL_j)^2+\frac{\alpha_j^3L_j^2}{2-\alpha_j}+\frac{\left(\left(\frac{2\alpha_j^3L_j^2}{2-\alpha_j}\right)\left(\sum_{i=1}^{\infty}(1-\alpha_j)^i\gamma_{jj}(i)\right)-2\alpha_j^2L_j(1+\alpha_jL_j)\sum_{i=0}^{\infty}(1-\alpha_j)^i\gamma_{jj}(i+1)\right)}{\gamma_{jj}} \quad j=1,2 \tag{19}$$

It is clear that in equation (18) we need to $\gamma_{jj}(.)$. According to Chaharsooghi and Sadeghi (2009) we do not have an explicit expression for $\gamma_{jj}(.)$. Using their findings in determination of some limited cases of $\gamma_{jj}(.)$ and assuming that $(1-\alpha_j)^i\to 0$ when $i\to\infty$ we can summarize equation (19) to equation (20):

$$BE_j=(1+\alpha_jL_j)^2+\frac{\alpha_j^3L_j^2}{2-\alpha_j}+\frac{\left(\begin{array}{l}\left(\frac{2\alpha_j^3L_j^2}{2-\alpha_j}\right)\left(\begin{array}{l}(1-\alpha_j)\gamma_{jj}(1)+(1-\alpha_j)^2\gamma_{jj}(2)+(1-\alpha_j)^3\gamma_{jj}(3)\\+(1-\alpha_j)^4\gamma_{jj}(4)+(1-\alpha_j)^5\gamma_{jj}(5)\end{array}\right)\\-2\alpha_j^2L_j(1+\alpha_jL_j)\left(\begin{array}{l}\gamma_{jj}(1)+(1-\alpha_j)\gamma_{jj}(2)+(1-\alpha_j)^2\gamma_{jj}(3)\\+(1-\alpha_j)^3\gamma_{jj}(4)+(1-\alpha_j)^4\gamma_{jj}(5)\end{array}\right)\end{array}\right)}{\gamma_{jj}} \quad j=1,2 \tag{20}$$

4. NUMERICAL ANALYSIS

In this part, we analyze bullwhip effect measure via a numerical example. We supposed that market demand of products by Poisson distribution follows VAR (1) time series model with $\phi_1=\begin{bmatrix}0.9 & 0.8\\0.5 & 0.4\end{bmatrix}$

so demand process is as follows: $\begin{cases}D_t^1=0.9D_{t-1}^1+0.8D_{t-1}^2\\D_t^2=0.5D_{t-1}^1+0.4D_{t-1}^2\end{cases}$

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Due to the stationary condition, bullwhip effect measure for different values of *L* and limited measures of *p* (*p*=1,2,3,4,5) for two products.
Hypotheses: Provide bullwhip ratios in the case of exponential smoothing forecast

4.1Analyzing the bullwhip ratio for exponential smoothing forecast
Considering equation (20) for each product separately, we can measure bullwhip effect ratios for some values of α and *L* as mentioned in Table 1 and Table 2.

Table 1: Bullwhip effect ratios for whole life policy

		alpha1				
		0.2	0.4	0.6	0.8	1
L1	1	2.083	2.109	2.136	2.170	2.215
	2	2.182	2.261	2.354	2.475	2.644
	3	2.297	2.457	2.653	1.999	2.687
	4	2.429	2.696	2.034	2.692	3.146
	5	2.577	2.979	2.496	3.256	4.218
	6	2.742	2.305	4.340	5.152	6.506

Table 2: Bullwhip effect ratios for universal life policy

		alpha2				
		0.2	0.4	0.6	0.8	1
L2	1	2.144	2.251	1.375	2.528	2.731
	2	2.316	2.603	1.974	3.477	3.965
	3	2.518	2.055	2.797	3.848	6.384
	4	2.748	2.607	3.846	5.641	9.307
	5	2.006	3.259	5.118	7.856	12.986
	6	2.294	4.012	6.616	10.493	16.888

Table 3 presents bullwhip effect measures for equivalent α and *p* by exponential smoothing forecast method:

Table 3: Bullwhip effect ratios for $L_1 = 1$ & for $L_2 = 1$

BE1	alpha1	BE2	alpha2
2.123	0.33	2.298	0.33
2.196	0.4	2.932	0.4
2.182	0.5	2.325	0.5
2.104	0.67	2.425	0.67
2.235	1	2.731	1

For better analysis of bullwhip effect changes and study of its behavior based on α and *L* variation, we represent bullwhip effect values by curves in Figure 4 and Figure 5. Figure 4 depicts that bullwhip effect for product 1 increases when smoothing constant (α) and lead-time rises. The upper curves are derived for larger lead-time values. In addition, same condition is valid for the second product in Figure 5. Bullwhip effect measure is related to α and *L* lead-time directly. This relationship between bullwhip

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effect values and lead-time confirms by previous researchers like Chen et al. (2000b) and Zhang (2004) in case of single product supply chain.

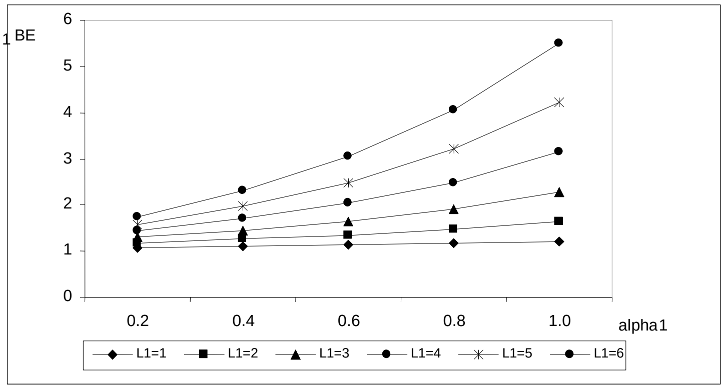

Figure 4: Bullwhip effect ratio for whole life with respect to α_1

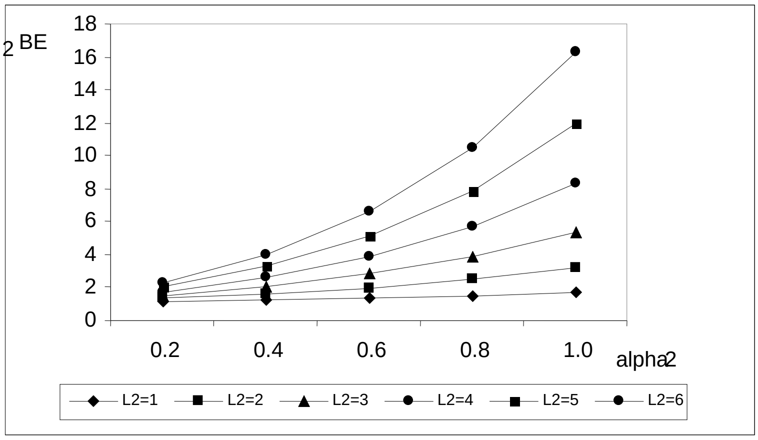

Figure 5: Bullwhip effect ratio for universal policy with respect to α_2

5. Discussion

In 2015, Sadeghi utilized exponential smoothing forecast to investigate the bullwhip effect in Toyota Auto industry. In 2014, Miri et al utilized an MCDM method to prioritize the branches of insurance company. The aim of this paper was to present the well-known absence of coordination in supply chain management causes the so-called bullwhip effect in which fluctuations in orders increase as they move up the chain.

THIS phenomenon occurs when companies significantly cut or add inventories. Economists call it bullwhip because even small increases in demand can cause a big snap in the need for parts and materials further down the supply chain.

We considered the supply chain management and bullwhip effect of two life insurance policies that were correlated. The flow of information was order-up stream. We supposed customers uses exponential smoothing forecast method. Market demand of products represented by a first order regressive pattern and a measure for bullwhip ratio provided and effect of lead-time and smoothing constant on the bullwhip effect values have been investigate. The bullwhip effect occurs when the demand order variability in the supply chain is amplified as they moved up the supply chain. Distorted information from one end of a supply chain to the other can lead to tremendous inefficiencies. Companies can effectively counteract the bullwhip effect by thoroughly understanding its underlying

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causes. Insurance industry leaders may implement innovative strategies that pose new challenges. Based on the results of this research we propose: 1-integrating new information system 2- defining new organizational relationships.3- Implementing new incentive and measurement system. Otherwise, they would face more excessive inventory investment, poor customer service, losing or decreasing revenue, misguided plans and programs, missing service schedules and inactive investment.

6-conclusion

Fluctuations of universal life policy forecasting demand could destroy the supply chain of insurance industry more than the fluctuations of whole life policy forecasting demand. Insurance companies should pay more attention on pricing, levels of supply chain, coordination and demand scheduling of universal life policy otherwise will face: a decrease in profit, service quality, customer satisfaction.

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