

An explanation of the bullwhip effect in supply and demand



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The bullwhip effect rises due to the demand fluctuations and is clearly evident as an outcome of any increase or decrease in demand. The bullwhip effect describes how inaccurate information, non transparency in the supply chain and a disengaged production plan and real time information result in revenue, bad customer service, high inventory levels and unrealized profits.

The problem of this effect in supply chain management has always been a concern for many years. Due to its non industry specific nature, it has grabbed the attention of many professionals from diverse industries and business schools. Bullwhip effect as its name suggests is an oscillation in the chain or pipeline. In supply chain this effect occurs when there is a constant fluctuation in the demand. Incongruence in the information leads to its distortion thereby creating a bullwhip. As pointed out by Lee, Padmanabhan and Whang(1997 a, b) the expression “ Bullwhip Effect” was termed by executives of P&G, the company that manufactures Pamper brand of diapers. These executives observed that while the consumer demand for Pamper’s Diapers was fairly constant over time, the orders for diapers placed by retailers to their wholesalers or distributors were quite variable i. e., exhibited significant fluctuations over time. In addition, even larger variations in order quantities were observed in the orders that P&G received from its wholesalers. This increase in the variability of the orders seen by each stage in a supply chain was called the bullwhip effect. As per Simatupang and Sridharan this situation of misalignment can be termed as Asymmetric Information where different parties having different states of private information about demand conditions, products, and the chain operations. The problem of this asymmetry arises because participating

firms generally lack the knowledge required about each other's plans and intentions to adequately harmonize their services and activities. Supply chain members often do not wish to share their private information completely and faithfully with all others due to the profitability of that actual or perceived information. Thereby the whole supply chain suffers from suboptimal and opportunistic behavior. These decisions occur when the members do not have sufficient visibility to resolve various tradeoffs in decision making because lack of information causes decisions to be made in a narrow scope that cannot ensure that products flow properly to end customers. Moreover, with limited information sharing, members do not have consistent perceptions of market needs and visibility over performance at the other levels of the supply chain. As a consequence, decisions are made based on either the best estimation of the available data or an educated guess. Such decisions can be biased and prevent the individual member from attaining the optimal solution of the supply chain. For example, the manufacturer often uses incoming orders with larger variance and not sales data from the retailer as a signal about the future product demand.

Asymmetric information also produces 2 problems of vulnerability of opportunistic behavior. Specifically, adverse selection and moral hazard manifest themselves in the relationship among the supply chain members. The negative selection of adverse selection, for example, is that the member firms cannot optimize supply chain performance because they do not possess the required capability to meet the predetermined customer service level.

(Semchi levi, David, Philip Kaminsky and Edith Simichi Levi, Designing and Managing the Supply Chain, London: Mc Graw Hill, 1999, pp. 103-107)(Lee,

Hau L., V Padmanabhan and Seugjin Whang, " The Bullwhip Effect in Supply <https://assignbuster.com/an-explanation-of-the-bullwhip-effect-in-supply-and-demand/>

Chains,” Sloan Management Review, Vol. 38, No. 3 (1997), pp 93-102) To explain this effect a very simple example of two tier supply chain, a retailer and a manufacturer, can be taken into account. The retailer observes customer demand and places orders to the manufacturer. For determination of the order quantity to place with the manufacturer, retailer will use the observed demand data of customer and a demand forecasting technique. In the 2nd stage, the manufacturer plays his role of forecasting by observing the retailers demand to place order to his suppliers. In many supply chains, the manufacturer doesn't have access to customer's demand data thereby making him rely on the retailer's data to forecast. As the bullwhip effect implies (the orders placed by the retailer are significantly more variable than the customer demand observed by the retailer), the manufacturer's forecasting and inventory control problem will be much more difficult than the retailer's forecasting and inventory control problem. In addition, the increased variability will force the manufacturer to carry more safety stock or to maintain higher capacity than the retailer in order to meet the same service level as the retailer. A better explanation of this can be given by the example of beer game simulation created by the professors of MIT, Sloan School of Management. This simulation helps to understand the challenges faced by putting the participant in a real life supply chain situation. In the game students enact a four stage supply chain. The task is to produce and deliver units of beer: the factory produces and the other three stages deliver the beer units until it reaches the customer at the downstream end of the chain. The aim of the players is rather simple: each of the four groups has to fulfill incoming orders of beer by placing orders with the next upstream party. Communication and collaboration are not allowed between supply

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chain stages, so players invariably create the bullwhip in the pipeline or chain. Sterman (1950a) was the first one to actually test the beer game to experience the bullwhip effect to experiment the causes that result to it. He (Sterman) experienced (1) Inventory Rationing (2) order batching and (3) Price Fluctuations. He also provides evidence on bullwhip effect that occurs due to customer's tendency of underweighting the inventory in supply line. The customer does not keep in the account the unreceived inventory at the time of placing a new order. Due to this the orders in backlog are underweighed in the decision to order more. Peter et. al.(1940) identify 4 main causes behind building up of bull whip effect. These causes are:-

Demand Forecasting

Every company in a supply chain usually does a product forecasting for its production scheduling, capacity planning, inventory control and material requirement planning. This forecast is oftenly done on the basis of previous orders placed by the customers. A very common method of demand forecast is exponential smoothing in which future demands are continuously updated as the real demand data becomes available. The order placed reflects the amount needed to replenish the future demands aswell as safety stock. Due to long lead times the safety stock days surge resulting in greater order quantity fluctuations. Moving a level up, to the manufacturers stage if the method of forecasting is same i. e. exponential smoothing then the demand variability is even more, eventually creating a bullwhip.

Order Batching

In supply chain most of the organizations place orders with their upstream suppliers after the accumulating them. The frequency of these orders is weekly, biweekly or at times monthly depending on the product. There are several cost related and demand related reasons for this practice. This can be demystified by an example of a company that places an order once a month because of the nature of the product it deals in. The supplier faces a highly erratic stream of orders. There is a spike in demand at one time during the month, followed by no demands for the rest of the month. This variability is higher than the demands the company itself faces. This practice amplifies variability leading to bullwhip effect. Transportation economics also plays a major role in the frequency of order placements. If the truck load is not enough then the order is not released as the cost is same irrespective of the load. Therefore companies prefer to order only when accumulated requirements are enough for a truck load to fill. This period batching causes surges in demand at a particular time period, followed by the periods of time with no or little orders, and other time periods with huge demands.

Price Fluctuation

Price variation is a crucial factor that impacts the buying behavior of a person. The customer buys in quantities that do not reflect their immediate needs. They buy in bigger quantities and stock up when the prices are low and reduce the purchase when the prices are normal, thereby creating a forward buy pattern in the chain. As a result the customer's buying pattern doesn't reflect the consumption pattern and variation between the 2 grows which leads to the bullwhip effect.

Rationing and Shortage Gaming When the product demand exceeds its supply the manufacturer is forced to ration them to the customers. Knowing that manufacturer will ration the goods, customers exaggerate their real needs at the time of ordering. Later when the variation between demand and supply plummets down, orders suddenly start to fade and cancellations pour in. This overreaction of the customer is an outcome of anticipation due to lack of information and interaction between the relevant parties. As the customer doesn't get 100% delivery of the goods required, he exaggerates the demand in order to receive the desired amount of goods.

From the above information it is clear enough that all the factors or elements resulting in bullwhip effect originate from a common ground i. e. information sharing. It is evident enough that the lack of information and interaction between different stages evolve bullwhip in the system thereby plaguing the whole Supply Chain.

Collaborative Planning Forecast and Replenishment

CPFR is the most recent prolific management initiative that provides supply chain collaboration and visibility. It has lately emerged as a new paradigm for the organizations that further want to cut their operational cost and make their supply chain more agile and responsive. Supply chain collaboration involves close work relationship with upstream suppliers and downstream customers. Lambert et. al. (Lambert, Douglas M., Margaret A. Emmelhainz and John T. Gargner, " Building Successful Partnerships," Journal of Business Logistics, Vol. 20, No. 1 (1999), pp. 165-181). suggest a particular degree of relationship among chain members as means to share risks and rewards that result in higher business performance than would be achieved by the forms <https://assignbuster.com/an-explanation-of-the-bullwhip-effect-in-supply-and-demand/>

individually. Bowersox (Bowersox, Donald J., “ The Strategic Benefits Of Logistics Alliance,” Harvard Business Review, Vol. 68, No. 4 (1990), pp. 36-43) reports that logistics alliances offer opportunities to dramatically improve customer service and at the same time lower distribution and storage operating costs. Narus and Anderson (Narus, James A. and James C. Anderson, “ Rethinking Distribution: Adaptive Channels, ” Harvard Business Review, Vol. 74, No. 4 (1996), pp. 112-120) define a collaborative supply chain as the cooperation among independent but related firms to share resources and capabilities to meet their customers’ most extraordinary needs. Collaboration, as per the most simple definition is nothing but a process which people, groups and organizations work together to achieve desired results. Therefore supply chain collaboration is a business practice wherein trading partners use IT and a standard set of business procedures to combine their intelligence in planning and fulfillment of customer demand (VICS, 2004). Collaboration and co-operation between producers and their customers is a key component of a modern successful supply chain. As per Tim Bennett, Former President of NFU, it is imperative that the organizations develop these relationships not only to drive improvements in efficiency but to respond more effectively to customer demands. As per Aviv, 2005; Schwarz, 2004) this initiative not only reduces the inventory but also increases sales for both sides i. e. retailers and suppliers. This also includes sharing of data and coming up with new and innovative ideas to attain a common objective. Supply chain collaboration is oftenly defined as 2 or more chain members working together to create a competitive through sharing information, making joint decisions, and sharing benefits which result from greater profitability of satisfying end customer needs than acting alone.

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(Simatupang & Sridharan, 2005; Whipple and Russell, 2007). CPFR (Collaborative Planning, Forecasting and Replenishment) is a new strategy to make the supply chain more effective and efficient keeping the customer at top priority. The complexity of new products, shrinking time to market, and capital intensity have led firms to collaborate to improve access to complementary abilities (Scott 2000) to help meet competitive challenges (Kanter 1994) and to address increasing competition due to market globalization, product diversity and technological breakthroughs (Simatupang, Wright and Sridharan 2002). A greater interconnectedness and trend of outsourcing have led to a greater need for supply chain professionals to work in alliance with firms possessing complementary skills and capabilities. Narus and Anderson (1996) define Supply Chain Collaboration as sharing knowledge and skills by independent but related firms to meet extraordinary demands of precious customers. The major reasons for companies to collaborate their supply chain with suppliers and/or customers as the case may be, is to reap a better competitive advantage and improve the overall operational efficiency with improved profit margins. As per Wernerfelt 1984 Resource based view shows how firms develop and utilize their resources. Moreover the ownership of scarce and firm specific resources is the reasoned behind its success. Collaboration in the past has very often been interchangeably used with cooperation. Every professional and expert defines it differently. There are several driving forces that for the exchange og reliable information in the supply chain industry. One of these driving forces is competition. Merchandise retailers such as Wal-Mart and K-Mart have expanded product offerings into food items in order to enhance the value of customer service offerings through one-stop shopping. A second <https://assignbuster.com/an-explanation-of-the-bullwhip-effect-in-supply-and-demand/>

driver is the innovative nature of products, or the length of the life cycle and the duration of retail trends in these industries. In the apparel industry, for example, the life cycle of some garments is 6 months or less. Yet, manufacturers typically require up-front commitments from retailers that may exceed 6 months making long term fashion forecasts risky. General merchandise retailers know this year's newest toy has a short product life cycle. It is imperative to get the latest trend in the consumer products to market quickly; otherwise, either tremendous lost revenues or markdown prices will be experienced. Long manufacturing lead times necessitate supply chain planning visibility. A third driving force is the longer, more complex supply chain given moves to offshore production. International sourcing for apparel and general merchandise has lengthened the supply chain and cycle time, and necessitating supply chain planning visibility. A fourth driving force behind CPFR is the nature of the supply chain cost structure. Global markets and more competitors are likely to move the supply chain system towards universal participation by all retailers in CPFR in an effort to cut costs (Raghunathan, 1999). All of these driving forces support the need to respond quickly to volatile demand and other market signals. These forces stimulate the development of supply chain visibility tools such as CPFR (Fisher 1997).

Identified benefits of collaboration include: revenue enhancements, cost reductions, operational flexibility to cope with demand uncertainties (Fisher, 1997; Lee, Padmanabhan, and Whang, 1997; Simatupang et al., 2005); increased sales, improved forecasts, more accurate and timely information, reduced inventory, improved customer service, (Barratt and Oliveira, 2001;

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Whipple et al., 2007); division of labor, exchanges of knowledge about products and processes (Kotabe, Martin, & Domoto, 2003) and cost and/or problem avoidance (Whipple, 2007).

Companies like Wal mart , Procter and Gamble and Dell computers have evidently shown that an anticipatory business model is better able to increase sales revenues and deliver profit margins meeting the shareholder expectations. This model is successful only when there is a cooperation and collaboration amongst all the members, internal aswell as external of the entire supply chain. (Supply Chain Collaboration-How to implement CPFR ; Ronald K Ireland with Colleen Crum, pg2). As per Ronald K Ireland reducing the Bull Whip effect in supply chain is not a program or a monthly initiative. It is a continuous practice to maintain a balance and to keep it to minimal due the inevitable nature. About the collaboration Ronal shares one of his experiences at Wal mart where due to some wrong program installation in the systems, purchase orders used to get blocked that lead the point of sale data to zero. The actual break down of collaborative planning happened when no queries were raised regarding the drastic change in point of sale rate. It was only when a supplier requested a Wal mart analyst to verify the forecast. This incident moralizes that it takes a team approach to eliminate the bull whip in the supply chain. Trust plays a vital role in the whole collaborative setup. Without trust and reliability on partners, supply chain collaboration is of no use. It is very important to have trust and faith in the partners to create supply chain into a value chain. Longer the supply chain of a company more the impact of bullwhip effect can be observed. This also leads to increase in amount of the inventory across the chain. The rules of

ordering such as timing of order placement, the acceptance of or refusal of back orders, order quantities and lot sizes, and cancellation rights and penalties, can have an enormous impact on the total system inventory and the bullwhip effect.

The CPFR model created by Voluntary Interindustry Commerce Standards Association (VICS) is a promising mechanism for the forecast accuracy by having customers' and suppliers' participation in the forecasting process. A buyer and a seller work together as collaborators to satisfy the needs of the end customer thereby creating a win - win situation. VICS 2004 proposes a model that is applicable to almost all the industries. In case of any discrepancy the vendor and the buyer can come together and rectify it by deciding upon the replenishment quantity. This kind of association or professional acquaintance offers a great potential to drastically improve supply chain performance through collaborative demand planning, synchronized production scheduling, logistics planning and new product development. The VICS Association, CPFR provides templates for supply chain collaboration in 4 stages (VICS 2004): Planning Stage: At this phase the relationship between buyers and vendors is planned and updated. It leads to front end agreement and joint business plan. Variances, whether plan to plan or plan to actual, are also addressed.

Forecasting Stage: At this stage, demand(order)/supply(sales) forecast is created and exceptions or discrepancies are identified and resolved.

Forecast accuracy visibly improves by having customer and supplier involvement in the planning process and thereby making the goals compatible for both the parties.

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Execution: At this stage, the order is generated, shipments are prepared and delivered, products are received and stocked on retail shelves, sales transactions are recorded and payments are made.

Analysis: At this stage, monitor planning and execution activities for exceptional situations. If a discrepancy occurs, the two trading partners can get together and share insights and adjust plans to resolve such discrepancies.

Intensive competition in the market place has forced companies to respond more quickly to customer needs through faster product development and shorter delivery time. Increasing customer awareness and preferences have lead to companies that are able to deliver products with excellent quality, and on time. However the demand of customers for product variety, especially in the case of short life-cycle products such as food, apparel, toys and computers, makes it difficult for manufacturers and retailers to predict which particular variety of the products the markets will accept. To be effective in matching demand with supply, manufacturers and retailers need to collaborate in the supply chain. Each form of collaboration varies in its focus and objectives. Regardless of the collaborative approach taken, however, Simatupang and Sridharan(2003) suggest that the requirements for effective collaboration are mutual objectives, integrated policies, appropriate performance measures, a decision domain, information sharing and incentive alignment. These requirements demonstrate a need for significant planning and communication to occur between partners, and can require significant resource commitment. Additional studies (Derocher and Kilpatrick, 2000; Mentzer et al., 2000) have affirmed that strong relationships <https://assignbuster.com/an-explanation-of-the-bullwhip-effect-in-supply-and-demand/>

increase the likelihood that firms will exchange critical information as required to collaboratively plan and implement new supply chain strategies. In order for this sharing of critical information to occur, a high degree of trust must exist among the collaborating partners (Frankel et al., 2002). Trust refers to the extent to which supply chain partners perceive each other as credible and benevolent (Ganesan, 1994; Doney and Cannon, 1997). Credibility reflects the extent to which a firm believes their relationship partner has intentions and motives that will benefit the relationship (Ganesan, 1994). One important aspect of information sharing as it relates to collaboration is the delineation of the kind of knowledge, explicit or tacit, that results from the exchange of information. Collaborative arrangements involve knowledge transfer that is both explicit (e. g. transactional) and tacit, which resides in “ social interactions” (Lang, 2004). More specifically, explicit knowledge is defined by Lang (2004) and referred to here as knowledge that can be “ articulated and codified” in order to be “ transmitted easily.” Hoover et. al., (2001) identify the benefits of collaboration only when it is done on a larger scale. Therefore they conclude that collaboration cannot be just a solution between close [partners, but needs to be implemented with a larger number of business partners. The end goal should be solutions that enable mass collaboration. Andraski (1994) reports that CPFR engages the manufacturer and the retailer into exchanging marketplace information in order to come up with a customer specific plan that can substantially reduce inventory. There are various cases or examples of CPFR implementation that prove its success. Various types of partnerships (collaborations) have been tried. Wal-Mart and Warner Lambert embarked on the first CPFR pilot, involving Listerine products. In their pilot scheme, Wal Mart and Warner

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Lambert used special CPFR software to exchange forecasts. Supportive data, such as past sales trends, promotion plans and even the weather, were frequently transferred in an iterative fashion to allow them to converge on a single forecast should their original forecasts differ. The pilot scheme was very successful resulting in a tremendous increase in sales, better fill rates and in a reduction of inventory investment (Cooke, 1998; Hill, 1999). Other examples of CPFR pilots include Sara Lee's Hanes and Wal-Mart, involving 50 SKUs of underwear supplied to almost 2500 Wal-Mart stores (Hill, 1999; Parks, 1999, 2001; Songini, 2001). In 1996, Heineken USA employed CPFR to cut its order cycle time and is currently providing Collaborative planning and replenishment software to its top 100 distributors (Aviv, 2001). Procter and Gamble has several active CPFR pilots underway (Schachtman, 2000). Levi Strauss and Co. incorporates certain aspects of the CPFR business process into its retail replenishment service (e.g. by creating joint business plans and identifying exceptions) (Aviv, 2001). Additionally, in the ECR report entitled "European CPFR Insights" several CPFR pilots are described including: Unilever - Sainsbury's GNX, Condis-Henkel-Cartisa, Kraft-Sainsbury's GNX, Carton Scholler, Vandemoortele-Delhaize (ECR Europe, 2002). (Andraski and Haedicke, 2003) cited a major gap of misunderstanding, misuse of greater bargaining power and undue expectations in a collaborative relationship. Such gaps can be avoided if mutual agreements on extensive and timely information sharing were put in place to more precisely predict potential problems of matching supply and demand. At the same time these arrangements call for an effective governance structure to address potential economic incentive problems

between contracting parties, thereby leading to more cooperation across firm level boundaries.

Era of 1990's saw the emergence of collaboration in the form of JIT II when the famous American audio system manufacturer, BOSE gave its key suppliers authority to work as an integral part of the material and purchasing systems. This not only replaced the traditional supply chain methods, by giving procurement personnel time to conduct value added activities but also gave the "in - plant" supplier representatives, opportunity to understand the changing needs of the customer.