Chapter 5
Existence and Causes of Bullwhip Effect: An Empirical Study on a Designer Footwear Supply Chain

Hau-Ling Chan, Tsan-Ming Choi, Shuyun Ren, Bin Shen and Wing-Yee Wong

1 Introduction

Bullwhip effect relates to "demand amplification" and "variance amplification" in which the order variance to the supplier is larger than that of the buyer and the distortion is amplified from the downstream to the upstream in the supply chain context (Lee et al. 1997). This phenomenon has been identified in many different supply chains, such as Procter and Gamble's Pampers, Campbell's chicken noodle soup, and Barilla's pasta which create operational instability (Wang and Disney 2016). The existence of Bullwhip effect increases supply chain costs and reduces supply chain efficiency (Bray and Mendelson 2012).

It is well-known that bullwhip effect exists, particularly in the high demand variance industry such as fashion. Fashion industry is very important in terms of its high

Part of this paper is based on the graduation thesis of Wing-Yee Wong. For the preparation of this paper, all authors have good contribution and the authorship is listed in an alphabetical order.

H.-L. Chan
Division of Business, Hong Kong Community College, The Hong Kong Polytechnic University, Kowloon, Hong Kong
e-mail: itcling@yahoo.com.hk

T.-M. Choi · W.-Y. Wong
Business Division, Institute of Textiles and Clothing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong
e-mail: bellawwy@gmail.com

S. Ren (✉)
School of Art and Design, Guangdong University of Technology, Guangzhou, China
e-mail: ShuYun_shara@live.cn

B. Shen
Glorious Sun School of Business and Management, Donghua University, Shanghai 210005, China
e-mail: binshen@dhu.edu.cn

B. Shen et al. (eds.), *Fashion Supply Chain Management in Asia: Concepts, Models, and Cases*, Springer Series in Fashion Business,
https://doi.org/10.1007/978-981-13-2294-5_5

volume and sales figures. Demand and variance amplification plays an important role as lead time, order batch, and product types are critical in the fashion industry. In the designer fashion industry, lead time of time-to-market is about four months (Kuksov and Wang 2013). The question is whether the lead time influences the demand amplification in the supply chain context. In addition, order batching is another practical rule in the fashion supply chain. The suppliers usually require a minimum order quantity to guarantee that the buyer will order a quantity that can ensure its minimum profit. This order batch may influence demand amplification. Last but not the least, fashionable products have a higher degree of demand uncertainty (Fisher 1997), which leads to a higher chance of demand amplification. High heel shoes are one kind of fashionable products in the fashion industry (Guéguen 2015). The higher-height shoes are usually more fashionable. A natural question is raised: Whether the heights of shoes affect the demand amplification. In this paper, we aim to evaluate the impact of lead time, order batch, and product types on the bullwhip effect in the fashion industry.

Motivated by the fact that the bullwhip effect may exist in different markets and the fashion company may overlook this problem, this paper is developed to statistically identify the existence of this effect and the internal causes of bullwhip effect by changing the inventory classification decision. To be specific, this paper examines the existence and the causes of the bullwhip effect in the designer fashion supply chain. The real POS data was collected from a famous real designer footwear brand, artificially named as Brand Z. To the best of our knowledge, it is the first paper to investigate the bullwhip effect in fashion industry. Our major findings are as follows. First, we find that in the designer fashion supply chain, minimum order quantity is not significantly related to the bullwhip effect. Second, the statistical result shows that a longer lead time implies a larger degree of bullwhip effect (i.e. larger variance of demand variability). Third, the heights of shoes are positively related to bullwhip effect between the manufacturer and the Brand Z only. This implies that more fashionable products have a higher degree of bullwhip effect.

This paper is organized as follows. In Sect. 1, we introduce our study. We then review the relevant literature and develop the corresponding hypotheses in Sect. 2. In Sect. 3, we indicate the sampling process and present the data analysis. In Sect. 4, we reveal our findings and statistical testing results. Finally, we draw the conclusion and highlight the implication in Sect. 5.

2 Literature Review and Hypotheses Development

Bullwhip effect is no longer a new phenomenon. It has been well explored in the existing literature. The prior literature includes the existence, causes, and mitigation of the bullwhip effects. Sterman (1989) conducts an experiment called "Beer Distribution Game" to test the bullwhip effect phenomenon. The experiment is used to measure the change of order variances when it moves up in the supply chain. The result shows that the order variances are amplified when it moves up in the supply chain which is caused by the irrational decision making of the player. Another early article about the bullwhip effect is Lee et al. (1997). They use an analytical approach to identify that demand signaling, order batching, fluctuating prices, and shortage game are the four major causes of bullwhip effect. Wang and Disney (2016) conduct a comprehensive review in the bullwhip effect in supply chain. The bullwhip effect has been examined by empirical, analytical, and experimental approaches. In this paper, we use the empirical approach to identify the existence and causes of bullwhip effect in the designer shoe brand.

This effect affects a company's profitability since demand fluctuations could hinder demand forecasting and inventory management of the upstream supplier. In addition, it also jeopardizes the inventory service level in which the designer brand should maintain a high level to satisfy the customer. Therefore, supply chain members will try to increase the inventory quantity by keeping more safety stocks to ensure there is sufficient supply to deal with the customer demand. Higher manufacturing cost, storage cost, and delivery cost are then incurred (Zotteri 2013). As a result, identifying bullwhip effect is critically important.

2.1 Effect of Order Lead Time

Lead time is defined as the duration between the time an order is placed and the time the order is available for satisfying customer demands (Stevenson 2017). It consists of different components such as order preparation time, order transiting time to supplier, supplier lead time (i.e., length of time when the supplier receives the order and ready for shipping the products), items transiting time from the supplier, and preparation time for availability. However, lead time is an uncontrollable factor and it requires the firm to pay additional costs to shorten it (Hua et al. 2015).

Chen et al. (2000) find that lead time is directly related to variability amplification, which means that a longer lead time will induce a bigger bullwhip effect. Therefore, shortening the lead time could reduce the variability amplification as well as the quantity of safety stock needed. By reviewing the historical demand data, a more accurate demand forecast could be generated. Order decision could be made by considering the lead time required to produce and to deliver the merchandise so as to support the forecasted sales. On the other hand, Li and O'brien (1999) study the bullwhip effect on a multi-stage supply chain and propose that a long lead time at the upstream activities can increase bullwhip effect at the next stage. Oppositely, a long lead time at the downstream activities can alleviate the bullwhip effect. Chatfield et al. (2004) further study the effect of lead times under different information sharing policies on bullwhip effect. Based on the reviewed literature related to lead time and bullwhip effect, we present a hypothesis as below:

Hypothesis 1 A longer order lead time yield a higher level of bullwhip effect.

2.2 Effect of Minimum Order Quantity

Apart from lead time, order batching is another major cause of bullwhip effect (Lee et al. 1997). It refers to the situation that the downstream supply chain member places orders to upstream member in batches (Hussain and Drake 2011). Because of the high inventory holding costs and high backlog costs, companies prefer to place orders at a specific time point rather than when needed. In addition, Hussain and Drake (2011) also comment that order batching can help achieve economic order quantity and transportation economies. Economic order quantity refers to the production of a larger batch of merchandise where the manufacturer can enjoy the benefits of facility set-up cost reduction and manufacturing efficiency improvement. Transportation economies represent the optimization of transportation costs by fully utilizing the capacity in transportation. For example, retailers can attain a quantity discount from wholesaler and enjoy a full truck-load rate when they place in bigger lot sizes. From inventory managers' point of view, the order batching strategy can help meet the forecasted demand with minimal inventory, which in turns help them to achieve the sales target and gain profit.

Minimum order quantity (MOQ) is a policy derived from the order batching practice, which is adopted due to the concern of economies of scale in the fashion industry (Chow et al. 2012). Most of the fashion companies use minimum order quantity policy to achieve the economies of scale in production and distribution. It has been proved that a small batch size could reduce the operational cost and enhance order stability (Wangphanich et al. 2010). The constraint of minimum order quantity could be applied to a particular item or a group of items, such as all colors of a particular style. The minimum order quantity may be contributed to the demand variation since it affects the accuracy of demand forecasting. Based on the above review related to order batching and bullwhip effect, a hypothesis is formulated below:

Hypothesis 2 A larger minimum order quantity leads to a higher level of bullwhip effect.

2.3 Effect of Product Types

The prior literature has examined the effects of product types on bullwhip effect in supply chains. Pastore et al. (2018) examine the bullwhip effect in automotive spare parts supply chain with more than 30,000 products, characterized by different technical characteristics, demand classes, and planning parameters. They find that bullwhip effect is more significant for fast moving products than slow movers. Duan et al. (2015) use daily and product level data to test the existence of bullwhip effect among substitutable products in supply chain. They find that the bullwhip effect is not only from the individual product, but also the substitutable ones. Raghunathan et al. (2017) analyze the bullwhip effect in multi-products by the analytical approach. They find that the various product types have different level of bullwhip effect.

In this paper, we use the data of a designer fashion brand's high heel shoes. The height of shoe heel can refer to the various product types. For example, 10 cm is high heel shoes, 65 mm is so-called middle heel shoes, and 10 mm is flat shoes. From the psychology perspective, high heel shoes increase women's attractiveness (Guéguen 2015). Because of the difficulty and the appearance of wearing, it is believed that high heel shoes are more fashionable products than flat ones (Graff et al. 2013; Johnson et al. 2014). Fashionable products have a higher degree of demand uncertainty (Fisher 1997; Selldin and Olhager 2007), which may lead to demand amplification because of enlarged demand variance. In this paper, we use product level data from designer shoe brand and evaluate the relationship between product types (i.e., different height of shoes) and bullwhip effect.

Hypothesis 3 Shoes with a higher height lead to a higher level of bullwhip effect.

3 Sampling and Data Analysis

3.1 Background of Brand Z

Brand Z is a British designer footwear brand selling luxury shoes, bags, and accessories all over the world. Apart from having direct sales to the final customers in the market, Brand Z is also a wholesaler selling products to various fashion retailers (e.g., department store). In this study, we consider the role of Brand Z as a wholesaler and focus on the shoe products to evaluate its bullwhip effect. The shoe products can be divided into two different types; they are flats and pumps. To be specific, the heel height of the flats is 10 mm while the heel height of the pumps ranges from 65 to 100 mm. On the other hand, the production time (as a result of the lead time) of each shoe type is different. It ranges from 4 to 8 months depending on the design complexity and the raw material availability. In real-world practice, minimum ordering quantity (MOQ) requirement is well observed in which the manufacturers impose the order quantity constraint on the downstream wholesaler. It is also the case in Brand Z in which some manufacturers have the MOQ requirement of 50, 75, 100, or even 200 units so as to guarantee their profits.

In this study, we consider a three-echelon supply chain which consists of a group of manufacturers, a wholesaler (Brand Z), and a retailer. Figure 1 presents the supply chain structure of Brand Z in Hong Kong. To be specific, the echelon at the downstream supply chain represents the Hong Kong fashion retailer who sells the shoe products to the final customers in the Hong Kong market. They can place an order to the wholesaler every month based on their market demand information. The middle echelon represents the Hong Kong wholesaler who receives and processes the orders from the fashion retailer and then makes an order request to the manufacturers according to the fashion retailer's order quantity as well as the manufacturer's MOQ

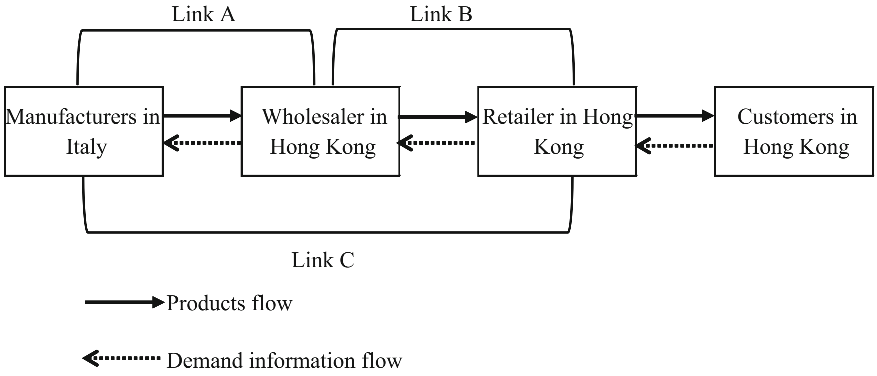

Fig. 1 Supply chain structure in this study

requirements. Finally, the echelon at the upstream supply chain is the manufacturers. There are totally four manufacturers and all of them are located in Italy. Each of them is responsible to produce the shoes with different styles and materials.

3.2 Methodology

3.2.1 Data Sets and Sampling

In this study, we collected the real order quantity data of each supply chain member in the period from June 2015–March 2016. To be specific, we collected (i) the order quantity of the retailer, (ii) the order quantity of the wholesaler (Brand Z), (iii) the production quantity of the manufacturers toward each shoe product. There are 25 shoe products in total. In addition, we also collected and specified the (iv) MOQ requirement, (v) lead time, and (vi) heel heights toward each shoe product. Overall, 825 data were collected. To provide a better explanation on various important parameters clearly, we have the following definition:

1. *Coefficient of variation (CV)*: Measured by the ratio of standard deviation of demand s to mean demand $\overline{x}$ (Fransoo and Wouters 2000; McCullen and Towill 2002), i.e., $CV = \frac{s}{\overline{x}}$.
2. *Bullwhip effect (BE)*: Determines the demand amplification level between two supply chain members and is quantified by the ratio of coefficient of variation of upstream echelon to downstream echelon. Specifically, BE at Link A, Link B, and Link C is denoted as $BE_A = \frac{CV_{Manufacturer}}{CV_{Wholesaler}}$, $BE_B = \frac{CV_{Wholesaler}}{CV_{Retailer}}$, and $BE_C = \frac{CV_{Manufacturer}}{CV_{Retailer}}$, respectively.
3. *Link A*: Consists of the manufacturer and the wholesaler.

4. *Link B*: Consists of the wholesaler and the fashion retailer.
5. *Link C*: Consists of the manufacturer and the fashion retailer.

3.3 Data Analysis

We first analyze the existence of the bullwhip effect of each shoe product according to the definitions. In addition, not all the manufacturers have imposed the MOQ requirement and we code the MOQ as "1" when there is no MOQ constraint imposed by the manufacturer. In other words, the manufacturer is willing to trade with the wholesaler when it orders at least one unit. Next, we conduct the statistical analysis using the SPSS software. A correlation test was employed to test the developed hypotheses.

4 Results

4.1 Analysis of the Bullwhip Effect

To determine the existence of bullwhip effect of each shoe product, we first measure the bullwhip effect at each link and of each shoe product. Table 1 summarizes the bullwhip effect, the MOQ requirement, the lead time and the heel heights of each shoe product.

4.2 Statistical Analysis of the Causes of Bullwhip Effect

Table 2 presents the correlation between MOQ, lead time, heel heights, and bullwhip effect at each link of each shoe product. First, we find that lead time is positively correlated with the heel heights with the p value <0.01. In addition, lead time is also positively correlated with the bullwhip effect with p value <0.05 with the Link A, p value <0.01 with the Link B and Link C. Therefore, H1 is supported and a longer order lead time yields a higher level of bullwhip effect.

On the other hand, the statistical correlation analysis demonstrates that the MOQ does not have a significant correlation with the bullwhip effect at the 0.05 significance level. Therefore, H2 is rejected and we cannot reveal that a larger minimum order quantity leads to a higher level of bullwhip effect.

Table 1 Summary of the bullwhip effect, MOQ, lead time, and heel heights of each shoe product

Product	BE at Link A	BE at Link B	BE at Link C	MOQ (units)	Lead time (months)	Heel heights (mm)
1	1.1567	1.3273	1.5352	1	8	100
2	1.3901	1.4713	2.0452	1	8	85
3	0.8108	0.7568	0.6136	1	6	65
4	1.0417	1.0254	1.0682	150	8	85
5	1.0277	1.0023	1.0301	250	8	85
6	0.9226	0.9058	0.8357	100	4	65
7	1.0803	0.6026	0.6510	100	4	65
8	1.1199	1.0043	1.1247	100	6	85
9	0.9670	0.9183	0.8881	1	4	10
10	1.1459	1.0403	1.1921	100	6	85
11	0.9758	0.9184	0.8962	75	4	10
12	0.9652	0.9639	0.9304	200	4	10
13	0.9868	0.9726	0.9598	200	4	65
14	1.1247	1.1496	1.2930	1	6	85
15	1.0087	0.9993	1.0081	75	4	10
16	1.0279	1.0260	1.0547	1	6	100
17	0.9676	1.0417	1.0079	1	6	85
18	1.0591	0.9781	1.0358	1	6	85
19	0.9860	0.9741	0.9604	75	4	10
20	0.9706	0.9694	0.9408	50	4	10
21	1.0038	1.0184	1.0223	75	8	85
22	0.9988	0.9999	0.9988	100	4	10
23	0.7569	1.4201	1.0749	50	6	10
24	0.8981	0.9060	0.8137	1	4	10
25	1.0644	1.0928	1.1631	1	8	10

Finally, we find that the heel height and the bullwhip effect are positively correlated at Link A only with p value <0.05. However, there is no significant correlation between the MOQ and the bullwhip effect at Link B and at Link C. Therefore, H3 is partially supported and the shoes with a higher height lead to a higher level of bullwhip effect between the manufacturers and the wholesaler only.

Table 3 summarizes the statistical results for the proposed hypotheses.

Table 2 Correlation between MOQ, lead time, heel heights, and bullwhip effect at each link of each shoe product

	MOQ	Lead time	Heel height	BE at Link A	BE at Link B	BE at Link C
MOQ	1	−0.110	0.001	−0.076	−0.233	−0.224
Lead time	−0.110	1	0.608**	0.427*	0.537**	0.586**
Heel height	0.001	0.608**	1	0.484*	0.149	0.358
BE at Link A	−0.076	0.427*	0.484*	1	0.366	0.784**
BE at Link B	−0.233	0.537**	0.149	0.366	1	0.855**
BE at Link C	−0.224	0.586**	0.358	0.784**	0.855**	1

*Correlation is significant at the 0.05 level (two-tailed)
**Correlation is significant at the 0.01 level (two-tailed)

Table 3 Summary of the statistical test result

Hypothesis	Result
Hypothesis 1: A longer order lead time yields a higher level of bullwhip effect	Supported
Hypothesis 2: A larger minimum order quantity leads to a higher level of bullwhip effect	Rejected
Hypothesis 3: Shoes with a higher height lead to a higher level of bullwhip effect	Partially supported

5 Discussion

5.1 Causes of Bullwhip Effect

In this paper, we find that the order lead time and the height of the shoes have a significantly positive correlation with the bullwhip effect at all links and at Link A, respectively. Therefore, lead time and heel heights are critical causes of the bullwhip effect in the Brand Z supply chain.

5.1.1 Lead Time

According to the statistical result of H1, it shows that a longer order lead time leads to a higher level of bullwhip effect. Lead time, therefore, is a crucial factor which will affect the operations efficiency in a supply chain context because the upstream supply chain members are not able to keep track of the real demand at the downstream side with a long lead time (Liao and Shyu 1991).

5.1.2 Heel Heights

From the statistical result of H3, it reveals that the shoes with a higher height lead to a higher level of bullwhip effect between the manufacturers and the wholesaler only. Our results show that the bullwhip effect due to the heel height exists in the linkage between the manufacturer and the wholesaler only. From Table 1, it indicates that a type of high heel shoes has a longer lead time between the manufacturer and the wholesaler. In addition, the high heel shoes are perceived as fashionable products with higher level of demand uncertainty (Fisher 1997; Selldin and Olhager 2007). Since the brand Z has its own physical stores in which it can also collect the demand information, this demand uncertainty of the fashionable shoe products can be reduced between downstream retailer and the wholesaler (brand Z).

5.2 Mitigate the Bullwhip Effect

5.2.1 Information Sharing

Information sharing between the downstream retailer and upstream supply chain members is an effective measure to mitigate the bullwhip effect in the supply chain context (Yang et al. 2011). According to Lee et al. (1997), information sharing includes sharing of inventory status, sales data, sales forecast, production quantity or even delivery schedule. For example, the downstream retailer possesess the market demand information in which it should be shared with the upstream manufactures for the production planning. Lee et al. (1997), Raghunathan (2001), Gaur et al. (2005) find that no one particular information sharing policy is perfect in all situations and they suggest to apply the hybrid policy for the information sharing. Despite the bullwhip effect cannot be fully eliminated through information sharing, it can help avoid the variance amplification at the upstream supply chain (Dejonckheere et al. 2004). In the exiting literature, it is stated that information sharing can significantly improve the supply chain efficiency as well as reduce the excess quantity of inventory (Bourland et al. 1996; Lee et al. 1997; Cachon 1999; Barut et al. 2002). By sharing the true demand information along the supply chain, it helps the retailer establish a relationship with upstream manufacturer. As Brand Z is a designer fashion brand in which they are famous for its craftsmanship, Brand Z should develop a long term strategic partnership with its manufacturers. In addition, it can help the supply chain members improve their operations management with a better inventory planning.

5.2.2 Quick Response Strategy

As suggested by Disney and Towill (2003), reducing the lead time can help mitigate the bullwhip effect in the supply chains. In fashion industry, quick response (QR) is a strategy that can shorten the lead time for the replenishment in response to the market changes (Choi and Sethi 2010). Under the QR strategy, the retailer can adjust the initial forecast quantity and then postpone the order decision closer to the selling season (Iyer and Bergen 1997). On the other hand, the retailer will conduct information updating by collecting the demand information of the correlated products to improve the forecasting accuracy (Choi et al. 2003, 2006, 2017, 2015). In the existing literature, it is found that both the supplier and the retailer are better off if an appropriate contract is adopted. To implement the QR strategy, Brand Z has to consider the degree of supplier and buyer relationship. This is because the supplier and buyer relationship will affect the quality of the information shared, the forecasting policy, the supply chain contract adopted, and the technology being used (Choi and Sethi 2010). Recently, many fashion retailers have adopted the radio frequency identification (RFID) technology for inventory management (Chan 2016; Chow et al. 2010). It can enhance the transparency of the inventory and achieve a quicker replenishment. It is an effective technology to handling the short shelf-life products (Karkkainen 2003) such as trendy fashionable products.

6 Conclusion Remarks

This study focuses on a targeted designer footwear brand and statistically examines the existence and the causes of the bullwhip effect in the designer fashion supply chain. We collected 825 data including the real order quantity of each supply chain member, MOQ requirement, lead time, and heel heights, and conducted the empirical tests. Our findings show that the degree of bullwhip effect in our targeted brand is significantly correlated with the lead time and the shoe height only but not the minimum order quantity requested by the manufacturers. In addition, we discuss the measures to mitigate the bullwhip effect in the Brand Z supply chain.

References

Barut, M., Faisst, W., & Kanet, J. J. (2002). Measuring supply chain coupling: An information system perspective. *European Journal of Purchasing & Supply Management, 8*(3), 161–171.

Bourland, K. E., Powell, S. G., & Pyke, D. F. (1996). Exploiting timely demand information to reduce inventories. *European Journal of Operational Research, 92*(2), 239–253.

Bray, R. L., & Mendelson, H. (2012). Information transmission and the bullwhip effect: An empirical investigation. *Management Science, 58*(5), 860–875.

Cachon, G. P. (1999). Managing supply chain demand variability with scheduled ordering policies. *Management Science, 45*(6), 843–856.

Chan, H. L. (2016). Using radiofrequency identification (RFID) technologies to improve decision-making in apparel supply chains. In T. M. Choi (Ed.), *Information systems for the fashion and apparel industry* (pp. 41–62). Duxford, UK: Woodhead Publishing.

Chan, H. L., Choi, T. M., Hui, C. L., & Ng, S. F. (2015). Quick response healthcare apparel supply chains: Value of RFID and coordination. *IEEE Transactions on Systems, Man, and Cybernetics: Systems, 45*(6), 887–900.

Chan, H. L., Shen, B., & Cai, Y. (2017). Quick response strategy with cleaner technology in a supply chain: coordination and win-win situation analysis. *International Journal of Production Research*, 1–12.

Chatfield, D. C., Kim, J. G., Harrison, T. P., & Hayya, J. C. (2004). The bullwhip effect—Impact of stochastic lead time, information quality, and information sharing: A simulation study. *Production and Operations Management, 13*(4), 340–353.

Chen, F., Drezner, Z., Ryan, J. K., & Simchi-Levi, D. (2000). Quantifying the bullwhip effect: The impact of forecasting, lead time and information. *Management Science, 46*(3), 436–443.

Choi, T. M. J., Li, D., & Yan, H. (2006). Quick response policy with Bayesian information updates. *European Journal of Operational Research, 170*(3), 788–808.

Choi, T. M., & Sethi, S. (2010). Innovative quick response programs: A review. *International Journal of Production Economics, 127*(1), 1–12.

Choi, T. M., Li, D., & Yan, H. (2003). Optimal two-stage ordering policy with Bayesian information updating. *Journal of the Operational Research Society, 54*(8), 846–859.

Chow PS, Choi TM, Cheng TCE. (2012). Impacts of minimum order quantity on a quick response supply chain. *IEEE Transactions on Systems, Man, and Cybernetics—Part A: Systems and Humans 42*(4), 868–79.

Chow, P. S., Choi, T. M., Cheng, T. C. E., & Liu, S. C. (2010). Quick response practices in the Hong Kong apparel industry. In *Innovative Quick Response Programs in Logistics and Supply Chain Management* (pp. 355–367). Springer, Berlin, Heidelberg.

Dejonckheere, J., Disney, S. M., Lambrecht, M. R., & Towill, D. R. (2004). The impact of information enrichment on the bullwhip effect in supply chains: A control engineering perspective. *European Journal of Operational Research, 153*(3), 727–750.

Disney, S. M., & Towill, D. R. (2003). The effect of vendor managed inventory (VMI) dynamics on the bullwhip effect in supply chains. *International Journal of Production Economics, 85*(2), 199–215.

Duan, Y., Yao, Y., & Huo, J. (2015). Bullwhip effect under substitute products. *Journal of Operations Management, 36*(2015), 75–89.

Fisher, M. (1997). What is the right supply chain for your product? *Harvard Business Review, 75*(2), 105–116.

Fransoo, J. C., & Wouters, M. J. (2000a). Measuring the bullwhip effect in the supply chain. *Supply Chain Management: An International Journal, 5*(2), 78–89.

Fransoo, J. C., & Wouters, M. J. (2000b). Measuring the bullwhip effect in the supply chain. *Supply Chain Management: An International Journal, 5*(2), 78–89.

Gaur, V., Giloni, A., & Seshadri, S. (2005). Information sharing in a supply chain under ARMA demand. *Management Science, 51*(6), 961–969.

Graff, K. A., Murnen, S. K., & Krause, A. K. (2013). Low-cut shirts and high-heeled shoes: Increased sexualization across time in magazine depictions of girls. *Sex Roles, 69*(11–12), 571–582.

Guéguen, N. (2015). High heels increase women's attractiveness. *Archives of Sexual Behavior, 44*(8), 2227–2235.

Hua, G., Wang, S., & Cheung, T. C. E. (2015). Price and lead time decisions in dual-channel supply chains. *European Journal of Operational Research, 205*(1), 113–126.

Hussain, M., & Drake, P. R. (2011). Analysis of the bullwhip effect with order batching in multi-echelon supply chains. *International Journal of Physical Distribution & Logistics Management, 41*(10), 972–990.

Iyer, A. V., & Bergen, M. E. (1997). Quick response in manufacturer-retailer channels. *Management Science, 43*(4), 559–570.

Johnson, K., Lennon, S. J., & Rudd, N. (2014). Dress, body and self: Research in the social psychology of dress. *Fashion and Textiles, 1*(1), 1–24.

Karkkainen, M. (2003). Increasing efficiency in the supply chain for short shelf life goods using RFID tagging. *International Journal of Retail and Distribution Management, 31,* 529–536.

Kuksov, D., & Wang, K. (2013). A model of the 'It' products in fashion. *Marketing Science, 32*(1), 51–69.

Lee, H. L., Padmanabhan, V., & Whang, S. (1997). Information distortion in a supply chain: The bullwhip effect. *Management Science, 43*(4), 546–558.
Li, D., & O'brien, C. (1999). Integrated decision modelling of supply chain efficiency. *International Journal of Production Economics, 59*(1–3), 147–157.
Liao, C. J., & Shyu, C. H. (1991). An analytical determination of lead time with normal demand. *International Journal of Operations & Production Management, 11*(9), 72–78.
McCullen, P., & Towill, D. (2002). Diagnosis and reduction of bullwhip in supply chains. *Supply Chain Management: An International Journal, 7*(3), 164–179.
Pastore, E., Alfieri, A., & Zotter, G. (2018). An empirical investigation on the antecedents of the bullwhip effect: Evidence from the spare parts industry. *International Journal of Production Economics.* (In Press).
Raghunathan, S. (2001). Information sharing in a supply chain: A note on its value when demand is nonstationary. *Management Science, 47*(4), 605–610.
Raghunathan, S., Tang, C. S., & Yue, X. (2017). Analysis of the bullwhip effect in a multiproduct setting with interdependent demands. *Operations Research, 65*(2), 424–432.
Selldin, E., & Olhager, J. (2007). Linking products with supply chains: Testing Fisher's model. *Supply Chain Management: An International Journal, 12*(1), 42–51.
Sterman, J. D. (1989). Modelling managerial behaviour: Misperceptions of feedback in a dynamic decision making experiment. *Management Science, 35*(3), 321–339.
Stevenson, W. J. (2017). Operations management (13 ed). McGraw-Hill Education.
Wang, X., & Disney, S. M. (2016). The bullwhip effect: Progress, trends and directions. *European Journal of Operational Research, 250*(2016), 691–701.
Wangphanich, P., Kara, S., & Kayis, B. (2010). Analysis of the bullwhip effect in multi-product, multi-stage supply chain systems—A simulation approach. *International Journal of Production Research, 48*(15), 4501–4517.
Yang, D., Choi, T. M., Xiao, T., & Cheng, T. C. E. (2011). Coordinating a two-supplier and one-retailer supply chain with forecast updating. *Automatica, 47*(7), 1317–1329.
Zotteri, G. (2013). An empirical investigation on causes and effects of the Bullwhip-effect: Evidence from the personal care sector. *International Journal of Production Economics, 143*(2), 489–498.