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The Impacts of Supplier-Base Concentration on Bullwhip Effect: Evidence from Chinese Manufacturing Firms

Yize HU¹

Abstract

This paper empirically tests the influence of supplier-base concentration on the size of the bullwhip effect of enterprises. The study quantifies bullwhip effect of the enterprise by the ratio of fluctuations in production and the fluctuations in demand in each of the four quarters of each year. The study found that about half of the listed manufacturers in China have a bullwhip effect, and the size of the bullwhip effect of the enterprise is very heterogeneous. Empirical analysis found that after controlling the quarterly ratio of demand, the persistence of demand shock, the number of days of inventory holding, the gross profit margin, the size of the enterprise, and the lead time, the concentration of suppliers was significantly negatively correlated with the size of the bullwhip effect. This shows that the more concentrated the supplier of the enterprise, the closer the company and the supplier are in information sharing and production cooperation, and the shorter the company will be from receiving the order to delivering the goods to the customer. The rapid response of the company to customer demand reduces the distortion of demand and therefore reduces the bullwhip effect.

Keywords: supplier-base concentration, bullwhip effect; empirical research, China, cooperation.

Introduction

Forrester (1961) brings the concept of bullwhip effect, which means demand information magnify through downstream to the upstream of supply chain, bullwhip effect manifests invalid of supply chain management. Lee *et al.* (2004) uses a firm's purchasing and sales data, demonstrate that purchasing is not consistent with sales, and the fluctuation of purchasing is much bigger than the fluctuation of sales. Other evidences also support the existence of bullwhip effect, Procter & Gamble finds that the sales of diapers could not fully explain the fluctuation of purchasing; Hewlett-Packard also finds that the fluctuation of purchasing of printer dealers is much bigger than the actual demand. The bullwhip effect has a large

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impact on every link in the supply chain. As downstream purchase fluctuates more than actual demand fluctuations, upstream companies may be misled by increased demand, resulting in cost increases, inefficient production, and excessive inventory or out of stock, low equipment efficiency and high transportation. Kurt Salmon Associates (1993) point that bullwhip effect could lead to an increase of 12.5% to 25% of cost for the firm.

The existing studies explore the universality of bullwhip effect, the causes of bullwhip effect. This study is based on previous studies and examines the bullwhip effect of Chinese listed manufacturing firms. As bullwhip effect is a consequence of inefficient supply chain management, this study also explores the impacts of supplier-base concentration on bullwhip effect.

Literature Review

There are many studies in Economic and Management relates to bullwhip effect. Some case studies show that bullwhip effect exists in some companies, for example, Hammond (1994), Lai (2005) and Wong *et al.* (2007) use case studies and find that bullwhip effect exists in spaghetti firm, fast food firm, toy firm and retailer firm.

The existing studies also explain the existence of bullwhip effect. Kahn (1987) supposes that firms face first order auto regression demand, if the autoregressive coefficient is positive, then the demand is positive, and the fluctuation of production would be bigger than the fluctuation of demand, the increased demand would lead to increased anticipation of future demand, therefore purchasing would increase. Kahn (1987) points that under the best production behavior, the fluctuation of production would exceed the fluctuation of sales. The seminal study of Lee *et al.* (1997) discuss the amplification of demand through the supply chain, they point four causes of bullwhip effect: demand signal processing, rationing game, order batching, and price variations, they emphasize the importance of information sharing and mutual cooperation in the upstream and downstream of the supply chain.

The existing research on bullwhip effect is mainly theoretical research. Chen *et al.* (2000) expanded the study of Lee *et al.* (1997), they include demand forecast and lead time in their model, and also demonstrate that information sharing could ease but not eliminate bullwhip effect. Chen & Samroengraja (2004) expanded existing research in the ARIMA demand model. Watson and Zheng (2008) points that managers would overreact to demand. Sucky (2009) points that bullwhip effect is greater when the risk is aggregated.

Other theoretical research explores methods to mitigate bullwhip effect. Disney & Towill (2003) point that firms could use vendor managed inventory to mitigate bullwhip effect. Corporation with upstream manufacturers in demand forecasting

would mitigate bullwhip effect (Aviv, 2007; Wright & Yuan, 2008; Bayraktar *et al.* 2008).

The empirical research on the bullwhip effect has begun to appear in recent years, mainly based on the empirical test of the existence of the bullwhip effect. Terwiesch *et al.* (2005) studied the bullwhip effect in the semiconductor supply chain. Cachon & Zhang (2007) used industry data to measure the bullwhip effect. They found that in US the bullwhip effect is not obvious in other industries outside wholesale industry, and that fluctuations in demand do not increase as they pass upstream to the supply chain. They also pointed out that seasonality may be the main reason for the smooth production of enterprises. Schmidt (2011) explored the measurement of the bullwhip effect of time aggregation. He found that the effects of time aggregation in different industries are not the same, indicating that volatility can be explained by the seasonality of production and sales.

Cachon & Zhang (2007) pointed out that some industries have no significant bullwhip effect as a whole, but some companies in the industry have, research should focus on the bullwhip effect at the enterprise level. Bray & Mendelson (2012) studied the bullwhip effect of US listed companies from 1974 to 2008. The study found that two-thirds of the companies in the sample had a bullwhip effect. On average, listed companies had more quarterly purchases than sales. In addition, the bullwhip effect of listed companies in the United States is extremely heterogeneous. Some enterprises have a particularly obvious bullwhip effect, but some companies do not have significant bullwhip effect. The standard deviation of the bullwhip effect of US listed companies is three times larger than the average.

Taking Chinese listed companies as a sample, Shan *et al.* (2014) examined the bullwhip effect of Chinese listed companies from 2002 to 2009. The study has similar results with the US study, where two-thirds of listed companies bullwhip. However, they also find that bullwhip effect of listed companies in China has been declining year by year, which may indicate that the company's supply chain management capabilities are improving. The authors also point out that bullwhip effect of the firm is related to the number of days of inventory holdings, the quarterly ratio of demand, and the persistence of demand shocks.

Isaksson & Seifert (2016) used a two-tier supply chain sample from the United States from 1976 to 2009. The study found that the bullwhip effect exists in most industries, such as minerals, manufacturing, wholesale, retail. On average, the fluctuation of upstream sales is 1.9 times than the fluctuation of downstream sales. Yao & Zhu (2011) examines whether the use of electronic trading will reduce the bullwhip effect in the supply chain. The authors found that when the customer industry uses electronic trading for procurement, bullwhip effect increases; when the supplier industry uses electronic trading, bullwhip effect decreases.

The existing research shows that some enterprises have the bullwhip effect. The theoretical model is used to explore the cause of the bullwhip effect and the factors affecting the bullwhip effect. The behavioral experiments are also used

to analyze the influence of human factors on the bullwhip effect. Taking the listed companies in the United States and China as samples, the existing research scientifically measures the degree of bullwhip effect of enterprises. The empirical test found that two-thirds of listed companies in the United States and China have significant bullwhip effects.

The existing research indicates that the size of the bullwhip effect of enterprises has obvious heterogeneity, and the degree of bullwhip effect of different enterprises is quite different. The existing research mainly explores the heterogeneity from the enterprise level, and draws the conclusion that the bullwhip effect of the enterprise is positively correlated with the days of inventory holding, negatively correlated with the quarterly ratio of demand, and positively correlated with the persistence of demand shock. As a manifestation of cooperation failure in the supply chain, it is important to analyze the heterogeneity of bullwhip effect from the perspective of supply chain. Therefore, controlling of inventory holding days, the quarterly ratio of demand, and the persistence of demand shock, this study empirically tests the correlation between supplier-base concentration and bullwhip effect.

Hypothesis development

The more concentrated the supplier-base of the enterprise, the closer the relationship between the enterprise and the supplier, and the degree of information sharing and cooperation may increase. Manufacturing production methods such as order-based production and just-in-time production require suppliers' rapid response. For example, Boeing reduced the number of suppliers from 3,600 to 1,200 after implementing the just-in-time production method (Nolan, Zhang, & Liu, 2008). Companies with high supplier-base concentration are more likely to adopt these production methods. For manufacturing companies, the increased cooperation between upstream and downstream brought by the concentration of suppliers enables companies to respond quickly to customer needs. A quick response to customer needs will greatly reduce the distortion of demand (Lee *et al.* 2004), so hypothesis 1 is proposed:

Hypothesis: Supplier-base concentration is negatively associated with bullwhip effect.

Methodology

Data

This study uses a sample of all listed companies in China's Shenzhen Stock Exchange and Shanghai Stock Exchange. China's listed companies have voluntarily disclosed information on the top five major suppliers and customers since 2012. The data was collected manually from the listed company's annual report. Corporate

financial data comes from the China Stock Market and Accounting Research (CSMAR) database.

Variables

The dependent variable of this study is the bullwhip effect within the firm. The bullwhip effect is a phenomenon in which fluctuations in demand are increasing from the downstream to the upstream of the supply chain. Existing research, such as Cachon & Zhang (2007) and Shan *et al.* (2014), use the amplification of fluctuations in demand within the firm to define the bullwhip effect within the firm, the formula is as follows:

$$bullwhip_{it} = \frac{sd[Production_{it}]}{sd[Demand_{it}]}$$

The above formula shows that if the fluctuation of production is greater than the fluctuation of demand, then the value of the bullwhip effect is greater than 1, indicating that the enterprise has a bullwhip effect; if the fluctuation of production is less than the fluctuation of demand, then the value of the bullwhip effect is less than 1, then it does not exist bullwhip effect. The volatility is represented by the standard deviation of the sample. Based on the practices of the existing literature (eg: Cachon & Zhang, 2007), this paper uses COGS in the income statement as a proxy variable for demand. We use the following formula to calculate production:

$$production_t = COGS_t + Inv_t - Inv_{t-1}$$

It is worth noting that in the study of the bullwhip effect, it tends to use more frequent quarterly data rather than annual data, because the aggregation of annual data may mask the bullwhip effect to a certain extent. Therefore, in the calculation of the bullwhip effect variable, this study uses quarterly data to measure the value of the bullwhip effect in each quarter, and then obtains the bullwhip effect of the year by averaging the value of the bullwhip effect in four quarters of the year.

The most important independent variable in this study was supplier-base concentration. This study uses the Herfindahl-Hirschman Index (HHI) to construct a supplier-base concentration index, as follows:

$$sc_{it} = \sum_{j=1}^5 supplier_ratio_{ijt}^2,$$

supplier_ratio_{ijt} represents the proportion of the purchase amount of the enterprise *i* from the *j*th largest supplier in the total purchase amount in the year *t*, because the listed company discloses the purchase amount of the top five major

suppliers, so j is an integer from 1 to 5. sc_{it} is a number between 0 and 1, and the larger the value of sc_{it} , the higher the concentration of suppliers in the enterprise.

Similarly, the method of calculating customer-base concentration is:

$$sc_{it} = \sum_{j=1}^5 supplier_ratio_{ijt}^2,$$

$supplier_ratio_{ijt}$ represents the proportion of the sales of the enterprise i from the j^{th} largest customer in the total sales in the year t , because the listed company discloses the sales of the top five major customers, so j is an integer from 1 to 5. sc_{it} is a number between 0 and 1, and the larger the value of sc_{it} , the higher the concentration of customers in the enterprise.

This study also controls other related variables based on the existing research (eg: Cachon & Zhang, 2007; Shan *et al.* 2014). Control variables include the quarterly ratio of demand ($season$), demand shock ($demand_shock$), the size of the enterprise ($totalassets$), inventory holding days ($invdays$), the gross profit margin (gm), and the lead time ($daysap$).

Data Description

Table 1 lists descriptive statistics for the main variables. The average bullwhip effect of listed manufacturing companies in China is 1.191, with a median of 0.943, which indicates that more than half of the annual-enterprise observations have a bullwhip effect. In addition, the degree of bullwhip effect of some companies in the sample is very serious, far greater than 1. The quarterly ratio of demand ($season$) has an average of 0.524, indicating that quarterly fluctuations in the sample can explain about 50% of demand fluctuations on average. The average value of demand shock is -0.261, indicating that the demand of enterprises in the sample fluctuates greatly.

Table 2 lists the correlations between the variables. It can be seen that there is no multicollinearity problem between variables.

Table 1. Descriptive Statistics

Variable	mean	sd	25%	50%	75%	95%	N
bullwhip	1.191	0.98	0.628	0.943	1.389	3.078	4938
sc	0.053	0.082	0.01	0.023	0.058	0.216	4938
cc	0.0450	0.076	0.006	0.016	0.0480	0.195	4938
season	0.524	0.26	0.316	0.524	0.741	0.93	4938
ρ	-0.261	0.273	-0.461	-0.283	-0.094	0.219	4938
invdays	144.2	133.0	64.71	104.0	173.5	394.9	4938
total assets	6454	15143	1475	2692	5209	21352	4938
gm	0.267	0.160	0.153	0.240	0.351	0.605	4938
daysap	88.64	63.89	44.73	75.67	114.0	209.4	4938

Regression Models and Results

This study uses the following regression to examine the association between supplier-base concentration and bullwhip effect:

$$bullwhip_{it} = \alpha + \beta_1 sc_{it} + \sum_{k=2}^K \beta_k X_{it}^k + \mu_i + \varphi_t + \varepsilon_{it} \quad (1)$$

β_1 is the interested coefficient. According to the hypothesis, is expected to be negative. The control variables of model (1) includes cc_{it} , $season_{it}$, $\log(invdays_{it})$, $\log(total_assets_{it})$, gm_{it} , $\log(daysap_{it})$, for variables $invdays$, $total_assets$ and $dayap$, I take logarithm of them to reduce the impact of outliers on regression results. μ_i is the controlled industry fixed effect, φ_t is the controlled year fixed effect, and ε_{it} is the error term for firm i in year t , which is assumed to follow the normal distribution.

Table 3 lists the results for the hypothesis. First, the bullwhip effect is separately regressed to the supplier-base concentration and customer-base concentration. Then adding other control variables, $season_{it}$, $\log(invdays_{it})$, $\log(total_assets_{it})$, gm_{it} , $\log(daysap_{it})$, bullwhip effect is regressed the supplier-base concentration and customer-base concentration.

Table 2. Pairwise Correlations of Variables

	bullwhip	sc	cc	season	ρ	log(inv-days)	log(total_assets)	gm	log(day-sap)
bullwhip	1								
sc	-0.02	1							
cc	-0.028**	0.212***	1						
season	-0.223***	-0.071***	-0.066***	1					
ρ	0.0200	0.028**	0.005	0.055***	1				
log(invdays)	0.061***	-0.122***	-0.034**	-0.007	-0.131***	1			
log(total_assets)	0.00300	-0.116***	-0.084***	0.024*	-0.0160	-0.156***	1		
gm	0.00700	-0.145***	-0.102***	0.082***	-0.064***	0.412***	-0.140***	1	
log(daysap)	-0.024*	-0.282***	0.051***	0.038***	-0.067***	0.366***	0.025*	0.247***	1

Note * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Model (1) Regression Results

	bullwhip	bullwhip
sc	-0.301*	-0.367*
	(0.181)	(0.188)
cc	-0.080	-0.308
	(0.192)	(0.191)
season		-0.760***
		(0.055)
ρ		0.153***
		(0.051)
log(invdays)		0.104***
		(0.021)
log(total_assets)		0.004
		(0.014)
gm		-0.075***
		(0.025)
log(daysap)		0.009
		(0.021)
year	Control	Control
industry	Control	Control
_cons	1.690***	1.531***
	(19.03)	(0.187)
N	4938	4872.000
R ²	0.046	0.092
Adjusted R ²	0.039	0.084

Note. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The coefficient of supplier-base concentration is significantly negative, indicating that the higher the supplier-base concentration, the lower the bullwhip effect, after controlling customer concentration, quarterly ratio of demand, demand shock, inventory holding days, firm size, gross profit margin, and lead time, which verifies the hypothesis. Specifically, the supplier concentration increased by one standard deviation, and the size of the bullwhip effect decreased by 0.03. The higher the concentration of suppliers, the shorter the preparation time from the receipt of orders to delivery, and the ability of companies to respond quickly to demand, so the possibility of distortion of demand is reduced and the bullwhip effect is reduced.

The coefficient of customer concentration is negative. In agreement with Ak & Patatoukas (2016) on the concentration of corporate customers, the more concentrated the company's customers, the closer the relationship between the company and the customer, the less uncertainty of demand. Decreased demand uncertainty will reduce the distortion of demand in the enterprise, so the size of the bullwhip effect declines. Specifically, for each additional standard deviation of customer concentration, the size of the bullwhip effect decreased by 0.022.

Consistent with the existing research, the quarterly ratio of demand has a significant negative correlation with the bullwhip effect, indicating that if the fluctuation of demand is mainly caused by quarterly, the enterprise can better predict the fluctuation of demand, so the bullwhip effect is lower. The persistence of demand shocks is significantly positively correlated with the bullwhip effect. The longer the demand keeps growing or stays falling, the easier it is for companies to distort demand and the bullwhip effect.

In terms of other control variables, the inventory holdings days was significantly positively correlated with the bullwhip effect. The high inventory holding period of the enterprise generally represents the poor forecasting ability of the enterprise, so the bullwhip effect is large. The coefficient of *total_assets* is not significant, indicating that the larger-scale enterprises in China's listed manufacturing enterprises have no significant advantage in managing the bullwhip effect. The coefficient of gross profit margin *gm* is significantly negative, the higher the gross profit margin of the enterprise, the lower the bullwhip effect. The coefficient of *daysap* is not significant.

It is worth noting that the model does not strongly explain the dependent variable bullwhip, only 9.1% of R^2 and 8.4% of the adjusted R^2 value. In similar studies, Cachon & Zhang (2007) used a US manufacturing listed company from 1992 to 2006 as a sample. The R^2 value of the model was 32%. Shan *et al.* (2014) used all of China's 2002-2009 listed company as a sample, and the R^2 value of the model is 11.2%. The regression model of this study adds supplier concentration and customer concentration on the basis of Shan *et al.* (2014), but takes the sample of China's manufacturing listed companies as sample, and the sample period becomes 2012-2019. The model with US companies as a sample is more powerful, which may be mainly because American companies use management information systems more and can predict the demand more scientifically, so the quarterly ratio of demand and the demand shocks are more powerful in explaining the size of the bullwhip effect. In the empirical results of China's sample, although these two variables are also statistically significant, the economic impact is small.

Robust Tests

In order to eliminate the influence of reverse causality, that is, the lower the bullwhip effect of the enterprise, indicating that the enterprise has better operational supply chain management capability, so the supplier concentration is higher. This study uses the next year's bullwhip effect to regress the supplier concentration and other control variables of the year. The model is as follows:

$$bullwhip_{it+1} = \alpha + \beta_1 sc_{it} + \sum_{k=2}^K \beta_k X_{it}^k + \mu_i + \varphi_t + \varepsilon_{it} \tag{2}$$

The regression results are shown in *Table 4*. The concentration of suppliers is negatively correlated with the size of the bullwhip effect of the company in the next year, indicating that the results of this study are robust. In addition, the impact of customer concentration on the bullwhip effect is more pronounced in this model.

Table 4. Model 2 Robust Tests

	bullwhip _{t+1}
sc	-0.156
	(0.194)
cc	-0.475**
	(0.202)
season	-0.794***
	(0.059)
ρ	0.137**
	(0.055)
log(invdays)	0.084***
	(0.022)
log(total_assets)	-0.006
	(0.015)
gm	-0.045*
	(0.025)
log(daysap)	0.024
	(0.023)
year	Control
industry	Control
_cons	1.554***
	(0.195)
N	3451.000

R ²	0.113
Adjusted R ²	0.103

Note. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Conclusion

The bullwhip effect is a phenomenon in which fluctuations in demand are continuously amplified from downstream to upstream. The existence of this phenomenon means inefficient production, excessive inventory or out of stock, low equipment use efficiency and high transportation costs, etc. The existing research finds that the bullwhip effect is widespread in various industries. For example, two-thirds of listed companies in the United States and China have a bullwhip effect, and the degree of bullwhip effect varies greatly among different enterprises. Therefore, it is an important research topic to explore the relevant reasons for the different degrees of bullwhip in enterprises.

The existing research finds that the degree of bullwhip effect of enterprises is related to the quarterly ratio of demand, the persistence of demand shock, inventory holding days, lead time, gross profit margin, and enterprise scale. Based on the existing research, this study proposes the influence of supplier concentration and customer concentration on the bullwhip effect. The higher the concentration of suppliers, the closer the relationship between the company and the supplier, the better the supplier can match the production and delivery, and the shorter the time from the receipt of the order to the delivery of the goods to the customer. The rapid response of enterprises to orders reduces the distortion of demand, so the degree of bullwhip effect declines. The higher the concentration of customers, the closer the relationship between the company and the customer, and the sharing of information with the customer enables the company to better predict the demand, so the bullwhip effect is reduced.

This study promotes the related research on the bullwhip effect, and further proves that the concentration of suppliers enables companies to benefit from the cooperation with suppliers and improve their operational capabilities. This study also has limitations. If data is available for the purchasing data, demand data and supplier data for each product in the company, the measure of bullwhip effect and supplier-base concentration would be more accurate.

References

- Ak, B.K., & Patatoukas, P. N. (2016). Customer-Base Concentration and Inventory Efficiencies: Evidence from the Manufacturing Sector. *Production and Operations Management*, 25(2), 258-272.
- Aviv, Y. (2007). On the Benefits of Collaborative Forecasting Partnerships between Retailers and Manufacturers. *Management Science*, 53(5), 777-794.
- Bayraktar, E., Koh, L.S.C., Gunasekaran, A., Sari, K., & Tatoglu, E. (2008). The role of forecasting on bullwhip effect for E-SCM applications. *International Journal of Production Economics*, 113(1), 193-204.
- Bray, R., & Mendelson, H. (2012). Information Transmission and the Bullwhip Effect: An Empirical Investigation. *Management Science*, 58(5), 860-875.
- Cachon, G., & Zhang, F. (2007). Obtaining Fast Service in a Queueing System via Performance-Based Allocation of Demand. *Management Science*, 53(3), 408-420.
- Chen, F., & Samroengraja, R. (2004). Order Volatility and Supply Chain Costs. *Operations Research*, 52(5), 707-722.
- Chen, F., Drezner, Z., Ryan, J.K., & Simchi-Levi, D. (2000). Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact of Forecasting, Lead Times, and Information. *Management Science*, 46(3), 436-443.
- 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.
- Forrester, J.W. (1961). *Industrial Dynamics*. MIT Press and John Wiley & Sons Inc., New York.
- Hammond, J.H. (1994). *Barilla SpA (A)*. HBS Case 9-694-046, Harvard Business School, Boston.
- Isaksson, O.H.D., & Seifert, R.W. (2016). Quantifying the bullwhip effect using two-echelon data: A cross-industry empirical investigation. *International Journal of Production Economics*, 171(P3), 311-320.
- Kahn, J.A. (1987). Inventories and the Volatility of Production. *The American Economic Review*, 77(4), 667-679.
- Kurt Salmon Associates. (1993). *Efficient Consumer Response: Enhancing Consumer Value in the Grocery Industry*. The Joint Industry Project on Efficient Consumer Response, Washington, D.C.
- Lai, R.K. (2005). Bullwhip in a Spanish shop. *Harvard NOM Research Paper 06-06*, Harvard Business School, Boston.
- Lee, H. L., Padmanabhan, V., & Whang, S. (1997). Information Distortion in a Supply Chain: The Bullwhip Effect. *Management Science*, 50(4), 1875-1886.
- Lee, H. L., Padmanabhan, V., & Whang, S. (2004). Information Distortion in a Supply Chain: The Bullwhip Effect. *Management Science*, 50(12_supplement), 1875-1886.
- Nolan, P., Zhang, J., & Liu, C. (2008). The global business revolution, the cascade effect, and the challenge for firms from developing countries. *Cambridge Journal of Economics*, 32(1), 29-47.
- Shan, J., Yang, S., Yang, S., & Zhang, J. (2014). An Empirical Study of the Bullwhip Effect in China. *Production & Operations Management*, 23(4), 537-551.
- Sucky, E. (2009). The bullwhip effect in supply chains - An overestimated problem? *International Journal of Production Economics*, 118(1), 311-322.

- Terwiesch, C., Ren, Z.J., Ho, T.H., & Cohen, M.A. (2005). An Empirical Analysis of Forecast Sharing in the Semiconductor Equipment Supply Chain. *Management Science*, 51(2), 208-220.
- Watson, N., & Zheng, Y.S. (2008). *Over-reaction to Demand Changes Due to Subjective and Quantitative Forecasting*, Harvard Business School.
- Wong, C.Y., El-Beheiry, M.M., Johansen, J., & Hvolby, H. (2007). The implications of information sharing on bullwhip effects in a toy supply chain. *International Journal of Risk Assessment and Management*, 7(1), 4-18.
- Wright, D., & Yuan, X. (2008). Mitigating the bullwhip effect by ordering policies and forecasting methods. *International Journal of Production Economics*, 113(2), 587-597.
- Yao, Y., & Zhu, K.X. (2012). Research Note - Do Electronic Linkages Reduce the Bullwhip Effect? An Empirical Analysis of the U.S. Manufacturing Supply Chains. *Information Systems Research*, 23(3), 1042-1055.