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Analysis of Bullwhip Effect Under Different Segmentation Conditions of Daily Used Chemical Enterprise–Take P&G and Unilever as Examples

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Abstract: The Fortune Global 500, which includes industrial, corporate and service companies, released its latest ranking on August 2nd, 2021. As the most famous and authoritative list to measure the world's largest companies, it provides the latest development trend of the world's largest enterprises. The companies on the list are all the best in every field. There is no doubt that these enterprises provide reference value to similar enterprises in marketing strategies, supply chain management, talent training and product orientation. This paper focuses on the products demand and supply chain management of daily used chemical enterprises, take Protect & Gamble (rank 128th in The Fortune Global 500, 2021) and Unilever (rank 175th in The Fortune Global 500, 2021) as examples and explore their products demand under different conditions. The STP strategy is applied to re-segment the market of the two companies. The data are collected and sorted from the three aspects of geographic regions, product categories and four quarters to obtain the volatility of each group of data under each segmentation condition. The data are combined and analyzed using the Bullwhip Effect to find out the largest and smallest fluctuations of combinations. According to the relevant results, the preventive measures and solutions to Bullwhip Effect are proposed for reference to reduce costs and improve efficiency.

Keywords: P&G; Unilever; Bullwhip Effect; Daily Used Chemical Enterprise

1. Introduction

Protect & Gamble (P&G), a multinational consumer chemicals company which was founded in 1837 in the United States. After more than 100 years of development, its products are sold in more than 180 countries and regions, and operates in about 70 countries and regions around the world. Nowadays, it owns many leading brands, such as Tide, Hushubao, Head & Shoulders and SK-II, that almost cover ten categories including beauty products, hair care products, home care products and food and beverage. According to a report by Fortune 500, P&G's operating revenue has reached $70,950 million in 2021, ranking first in the world's top 500 household and personal products industry.

The rank closely followed is Unilever. Founded in 1929, Unilever has become one of the world's largest consumer goods companies after 80 years of development, with 163,000 employees in 100 countries and regions. Its 14 categories and 400 brands sell well in more than 170 countries and regions around the world. It is one of the world's largest producers of ice cream, tea drinks, margarine and condiments, as well as one of the world's largest producers of washing, cleansing and hair care products. More than 160 million people around the world shop for Unilever products every day (Fan, 2022).

As two of the most famous fast-moving consumer goods companies (FMCG) in the world, P&G and Unilever both are the top companies in Fortune 500. There is no doubt that two of the excellent enterprises take proper strategies in localization communications and marketing (Zhang *et al.*, 2019). P&G chooses multi-brand strategy, while Unilever takes the route of brand extension (Huang, 2021). However, as FMCG companies, it's necessary for enterprises to know about when, where to provide the products and which products is easier to be sold, so that they can avoid the influence of the Bullwhip Effect (Zhao, 2021). In 1958, Forrester (1958), the

father of supply chain design, proposed the predecessor of Bullwhip Effect-Forrester effect, which was later defined as Bullwhip Effect by Lee *et al.* (1997). The main culprit of the Bullwhip Effect is the lack of supply chain coordination among the parties, which results from wrong and lack of information sharing. Blockchain technology has the main characteristic of distributed shared ledger that makes all parties in the supply chain network able to access data (Ghode *et al*., 2022).

To begin with, this paper will find out two companies' turnover in different re-segmentation conditions from 2012 to 2021 to calculate coefficient of variation (CV) for each variable. The CV on three different conditions is then multiplied obtain the volatility of data of each group under each segmentation condition. After that, the data is combined and analyzed using the Bullwhip Effect principle to find out the largest and smallest fluctuations of combinations. According to the relevant results, the preventive measures and solutions to Bullwhip Effect are proposed for reference to reduce costs and improve efficiency.

2. Re-segmenting the Market to Analyze the Changes of Product Demand

2.1. Re-segmented by Geographic Areas

Table 1 and Table 2 show P&G net sales and Unilever turnover on different areas from 2012 to 2021. P&G re-segments the world market by five different areas, which are North America, Europe, Asia, Latin America and Others while Unilever re-segments the world market by three areas, which are Asia/AMET/RUB, the Americas and Europe. We calculated the average number and standard deviation to obtain the CV. For P&G, it's clear to know the weakest volatility is in North America and strongest one is in others. For Unilever, however, the weakest volatility is in the Americas and the strongest one is in Europe.

Table 1. P&G's net sales on geographic areas.

	North America	Europe	Asia	Latin America	Others
2012	32,635	15,899	15,062	8,368	11,715
2013	32,825	15,150	15,150	8,417	12,625
2014	31,399	22,543	12,882	8,051	5,636
2015	30,512	19,833	12,205	7,628	6,102
2016	28,732	15,019	11,101	5,224	5,224
2017	29,276	14,963	11,060	5,205	4,554
2018	29,406	16,040	12,030	4,678	4,678
2019	30,458	15,567	12,860	4,061	4,738
2020	33,347	15,609	13,481	4,257	4,257
2021	35,775	16,746	14,462	4,567	4,567
CV	0.0701	0.1487	0.115	0.3026	0.4827

Data Sources: www.pg.com

Table 2. Unilever's turnover on geographic areas.

	Asia/AMET/RUB	The Americas	Europe
2012	20,530	16,937	13,857
2013	19,919	16,433	13,445
2014	19,859	15,500	13,078
2015	22,374	17,580	13,318
2016	22,139	17,395	13,178
2017	23,097	17,726	12,892
2018	22,942	15,804	12,236
2019	23,911	16,634	11,436
2020	23,333	16,232	11,159
2021	24,124	16,782	11,538
CV	0.0716	0.0442	0.0754

Data Sources: www.unilever.com

2.2. Re-segmented by Product Preference

Table 3 and Table 4 show P&G net sales and Unilever turnover on products preference from 2012 to 2021 respectively. P&G re-segments products preference by five types, which are Fabric & Home Care, Baby, Feminine & Family Care, Beauty, Health Care and Grooming while Unilever re-segments products preference by three types, which are Beauty & Personal Care, Food & Refreshment and Home Care. We calculated the average number and standard deviation to obtain the CV. For P&G, it's clear to know the weakest volatility is Baby, Feminine & Family Care and strongest one is Beauty. For Unilever, the weakest volatility is in Home Care and the strongest one is Food & Refreshment.

Table 3. P&G's net sales on products categories.

	Fabric & Home Care	Baby, Feminine & Family Care	Beauty	Health Care	Grooming
2012	26,778	15,899	20,083	12,552	8,368
2013	26,933	16,833	20,200	12,625	7,575
2014	25,763	20,128	19,322	7,246	8,051
2015	22,121	20,595	18,307	7,628	7,628
2016	20,896	18,284	11,754	7,183	7,183
2017	20,819	18,216	11,710	7,807	6,506
2018	21,386	18,045	12,698	8,020	6,683
2019	22,336	18,275	12,860	8,122	6,092
2020	23,414	18,447	13,481	9,224	6,386
2021	25,880	19,030	14,462	9,895	6,851
CV	0.1045	0.075	0.2298	0.2276	0.1059

Data Sources: www.pg.com

Table 4. Unilever's turnover on products categories.

	Beauty Personal Care	Food & Refreshment	Home Care
2012	17,963	24,122	9,238
2013	17,927	22,907	8,963
2014	17,921	21,312	9,203
2015	20,243	22,907	10,122
2016	20,031	22,667	10,015
2017	20,412	22,560	10,743
2018	20,393	20,393	10,196
2019	21,832	19,233	10,916
2020	21,304	19,275	10,145
2021	22,026	19,929	10,489
CV	0.0787	0.0806	0.0666

Data Sources: www.unilever.com

2.3. Re-segmented by Four Quarters

Table 5 and Table 6 show P&G net sales and Unilever turnover on four quarters. P&G re-segments four quarters from July, the four quarters including the second half of the first year and the first half of the second year while Unilever re-segments four quarters from January. We calculated the average number and standard deviation to obtain the CV. For P&G, it's clear to know the weakest volatility is from Apr. 1st to Jun. 30th and strongest one is Oct. 1st to Dec. 31st. For Unilever, the weakest volatility is in Q4 and the strongest one is in Q1.

Table 5. P&G's net sales on four quarters.

	Jul.1st-Sep.30th	Oct.1st-Dec.31st	Jan.1st-Mar.31st	Apr.1st-Jun.30th
2011-2012	21,530	21,744	20,194	20,212
2012-2013	20,739	22,175	20,598	20,655
2013-2014	20,174	21,099	19,641	19,596
2014-2015	20,186	20,161	18,142	17,790

Data Sources: www.pg.com

Table 5. P&G's net sales on four quarters (Continued).

	Jul. 1st-Sep. 30th	Oct. 1st-Dec. 31st	Jan. 1st-Mar. 31st	Apr. 1st-Jun. 30th
2015-2016	16,527	16,915	15,755	16,102
2016-2017	16,518	16,856	15,605	16,079
2017-2018	16,653	17,395	16,281	16,503
2018-2019	16,690	17,438	16,462	17,094
CV	0.1187	0.1195	0.1164	0.1047

Data Sources: www.pg.com

Table 6. Unilever's turnover on four quarters.

	Q1	Q2	Q3	Q4
2012	12.1	13.3	13.4	12.6
2013	12.2	13.3	12.5	11.8
2014	11.4	12.7	12.2	12.1
2015	12.8	14.2	13.4	12.9
2016	12.5	13.7	13.4	13
2017	13.3	14.4	13.2	12.8
2018	12.6	13	12.5	12.2
2019	12.4	13.7	13.3	12.6
2020	12.4	13.3	12.9	12.1
2021	12.3	13.5	13.5	13.1
CV	0.0395	0.0381	0.0362	0.0355

Data Sources: www.unilever.com

3. Use Bullwhip Effect to Analyze the Fluctuation of Demand Under Different Conditions

3.1. Analysis of P&G CV on Different Conditions

For P&G, we got the CV for 5 regions, 4 categories and 4 quarters. We choose one from each set of data, multiply the three numbers, and try to get the maximum and minimum combination. Out of the 80, we find that the maximum is 0.013250. The result comes from G5*P3*Q2, which means the most volatile combination is from Oct. 1st to Dec. 31st, the selling of beauty products in other regions. The minimum number is 0.000551, which is from G1*P2*Q4. It means the most stable combination for P&G is from Apr. 1st to Jun. 30th, the selling of baby, feminine and family care products in North America.

Table 7. P&G's CV on different conditions.

Rank	Geographic Areas(G)	Products Preference(P)	Four Quarters(Q)
1	0.0701	0.1045	0.1187
2	0.1487	0.0750	0.1195
3	0.1150	0.2298	0.1164
4	0.3026	0.2276	0.1047
5	0.4827	-	-

Data Sources: Author's compilation

Table 8. P&G's CV combination.

Channels	Results	Channels	Results	Channels	Results	Channels	Results
G1*P1*Q1	0.000870	G1*P1*Q2	0.000875	G1*P1*Q3	0.000853	G1*P1*Q4	0.000853
G1*P2*Q1	0.000624	G1*P2*Q2	0.000629	G1*P2*Q3	0.000612	G1*P2*Q4	0.000551
G1*P3*Q1	0.001913	G1*P3*Q2	0.001926	G1*P3*Q3	0.001875	G1*P3*Q4	0.001688
G1*P4*Q1	0.001895	G1*P4*Q2	0.001858	G1*P4*Q3	0.001858	G1*P4*Q4	0.001672

Data Sources: Author's compilation

Table 8. P&G's CV combination (Continued).

Channels	Results	Channels	Results	Channels	Results	Channels	Results
G2*P1*Q1	0.001844	G2*P1*Q2	0.001856	G2*P1*Q3	0.001807	G2*P1*Q4	0.001626
G2*P2*Q1	0.001324	G2*P2*Q2	0.001332	G2*P2*Q3	0.001298	G2*P2*Q4	0.001168
G2*P3*Q1	0.004055	G2*P3*Q2	0.004082	G2*P3*Q3	0.003975	G2*P3*Q4	0.003578
G2*P4*Q1	0.004017	G2*P4*Q2	0.004043	G2*P4*Q3	0.003938	G2*P4*Q4	0.003544
G3*P1*Q1	0.001426	G3*P1*Q2	0.001436	G3*P1*Q3	0.001398	G3*P1*Q4	0.001258
G3*P2*Q1	0.001024	G3*P2*Q2	0.001031	G3*P2*Q3	0.001004	G3*P2*Q4	0.000904
G3*P3*Q1	0.003137	G3*P3*Q2	0.003158	G3*P3*Q3	0.003076	G3*P3*Q4	0.002768
G3*P4*Q1	0.003107	G3*P4*Q2	0.003128	G3*P4*Q3	0.003047	G3*P4*Q4	0.002742
G4*P1*Q1	0.003752	G4*P1*Q2	0.003777	G4*P1*Q3	0.003678	G4*P1*Q4	0.003310
G4*P2*Q1	0.002694	G4*P2*Q2	0.002712	G4*P2*Q3	0.002641	G4*P2*Q4	0.002377
G4*P3*Q1	0.008252	G4*P3*Q2	0.008306	G4*P3*Q3	0.008090	G4*P3*Q4	0.007281
G4*P4*Q1	0.008174	G4*P4*Q2	0.008228	G4*P4*Q3	0.008014	G4*P4*Q4	0.007213
G5*P1*Q1	0.005985	G5*P1*Q2	0.006024	G5*P1*Q3	0.005868	G5*P1*Q4	0.005281
G5*P2*Q1	0.004297	G5*P2*Q2	0.004325	G5*P2*Q3	0.004213	G5*P2*Q4	0.003791
G5*P3*Q1	0.013163	G5*P3*Q2	0.013250	G5*P3*Q3	0.012905	G5*P3*Q4	0.011614
G5*P4*Q1	0.013039	G5*P4*Q2	0.013125	G5*P4*Q3	0.012785	G5*P4*Q4	0.011505

Data Sources: Author's compilation

3.2. Analysis of Unilever CV on Different Conditions

For Unilever, we got the CV for 3 regions, 3 categories and 4 quarters. We choose one from each set of data, multiply the three numbers, and try to get the maximum and minimum combination. Out of the 36, we find that the maximum is 0.000240. The result comes from G3*P2*Q1, which means the most volatile combination for Unilever is in Q1, the selling of food and refreshment products in Europe. The minimum number is 0.000104, which is from G2*P3*Q4. It means the most stable combination for Unilever is in Q4, the selling of home care products in the Americas.

Table 9. Unilever's CV on different conditions.

Rank	Geographic Areas(G)	Products Preference(P)	Four Quarters(Q)
1	0.0715	0.0787	0.0395
2	0.0442	0.0806	0.0381
3	0.0754	0.0665	0.0361
4	-	-	0.0354

Data Sources: Author's compilation

Table 10. Unilever's CV combination.

Channels	Results	Channels	Results	Channels	Results	Channels	Results
G1*P1*Q1	0.000222	G1*P1*Q2	0.000214	G1*P1*Q3	0.000203	G1*P1*Q4	0.000199
G1*P2*Q1	0.000228	G1*P2*Q2	0.000220	G1*P2*Q3	0.000208	G1*P2*Q4	0.000204
G1*P3*Q1	0.000188	G1*P3*Q2	0.000181	G1*P3*Q3	0.000172	G1*P3*Q4	0.000169

Data Sources: Author's compilation

Table 10. Unilever's CV combination (Continued).

Channels	Results	Channels	Results	Channels	Results	Channels	Results
G2*P1*Q1	0.000137	G2*P1*Q2	0.000132	G2*P1*Q3	0.000125	G2*P1*Q4	0.000123
G2*P2*Q1	0.000140	G2*P2*Q2	0.000136	G2*P2*Q3	0.000129	G2*P2*Q4	0.000126
G2*P3*Q1	0.000116	G2*P3*Q2	0.000112	G2*P3*Q3	0.000106	G2*P3*Q4	0.000104
G3*P1*Q1	0.000234	G3*P1*Q2	0.000226	G3*P1*Q3	0.000214	G3*P1*Q4	0.000210
G3*P2*Q1	0.000240	G3*P2*Q2	0.000232	G3*P2*Q3	0.000220	G3*P2*Q4	0.000215
G3*P3*Q1	0.000198	G3*P3*Q2	0.000191	G3*P3*Q3	0.000181	G3*P3*Q4	0.000178

Data Sources: Author's compilation

4. Conclusion

From the calculation results above, it's clear to know where, when is easier to sell the products and what to sold. The maximum number shows it has the highest volatility, so the enterprises should be careful in this way. For P&G, the selling of beauty products in other regions from Oct 1st to Dec.31st is worth to be careful. For Unilever, the way is in Q1, the selling of food and refreshment products in Europe. On the contrary, the minimum number is always the safest way to go. For P&G, it is in North America, the selling of baby, feminine & family care products from Apr. 1st to Jun. 30th. It is true for Unilever that the safest way is in Q4, the selling of home care products in the Americas.

5. Suggestions

5.1. Creating Vendor Managed Inventory Mode

Vendor Managed Inventory (VMI) is a cooperative strategy between supply and demand to reduce the total inventory cost in the supply chain through cooperation. Such as the "manufacturer-retailer" VMI model. Manufacturers establish VMI warehouses between manufacturers and multiple retailers. Manufacturers are the upstream enterprises of the supply chain and the leading enterprises, responsible for the supervision and replenishment of retailers' inventory (Chen, 2021).

This mode breaks the traditional inventory management mode of independent administration and poor information. Its core theory is that the upstream enterprises share the existing inventory and actual sales data of the downstream enterprises, and carry out scientific replenishment according to the actual sales model, sales trend and replenishment strategy. Therefore, both sides of the transaction have changed the traditional independent prediction model, avoiding and reducing the operation cost of logistics, business flow and information flow caused by their respective prediction and non-cooperative sharing as much as possible, thus reducing the total cost of the supply chain (Zhang, 2022).

5.2. Realizing Information Sharing

Through the establishment of the Internet of Things, centralized demand information and stock data sharing can be achieved to achieve real information sharing. Based on the platform of Internet of Things, downstream enterprises can choose suitable suppliers by knowing the production capacity, inventory and price of upstream enterprises. Through the Internet of Things platform, upstream enterprises can understand the demand level of the consumer market and the inventory level of downstream enterprises and predict their weekly and monthly production and inventory level to achieve the purpose of reducing costs.

5.3. Shortening the Lead Line

Enterprises reduce the cost through economic order quantity, and order lead time has a relatively large impact on inventory-related costs. The key to reduce the Bullwhip Effect caused by bulk order is to shorten the order lead time. Shortening order lead time puts forward two requirements for the management of supply chain. First, the demander increases the order times and delivers the order quantity to the supplier quickly with the lowest order cost. On the premise that supply chain is a stable strategic alliance, EDI (electronic data interchange)

technology, Kanban technology[1] or ERP can be used to achieve it. Second, the logistics and distribution of distributors' small-batch goods demand is completed through low cost, which can only be realized through the third-party logistics distribution optimization system. Through the timely and efficient distribution system of the supply chain, the third-party logistics enterprise enables the intermediate enterprises in the supply chain to realize the lowest inventory and reduce the storage cost of the warehouse.

5.4. Adding Multiple Suppliers

In some cases, as a result of the limitation of supplier production capacity, the market will appear the situation of demand is less than the supply, lead to products distribution game problem. Multiple suppliers can reduce supplier pressure and impact because lack of production process, downstream enterprises will be relatively reasonable playing order, reduce the impact the demand variation amplification, and weaken the Bullwhip Effect. It can not only eliminate the supply of stable high demand for downstream enterprises expectations among out of stock and the stock up demand, but also eliminate the derived due to stock up false demand. The product supply stability can avoid the shortage of the "game", meet the demand of each node enterprise order, envoy point enterprise order to market demand, eliminate the shortage of game, and weaken the Bullwhip Effect.

5.5. Reducing Node Enterprises

The more intermediate enterprises in the supply chain, the closer the location of core enterprises to the upstream, the more times the demand order information is revised, and the more obvious the demand amplification phenomenon. By reducing the number of intermediate enterprises in the supply chain, the core enterprises in the supply chain can be as close to the downstream as possible. The time of demand order information being revised will be correspondingly reduced, thus weakening the Bullwhip Effect. E-commerce technology can effectively reduce the redundant distributors, retailers, regional agents and other links in the supply chain, shorten the chain length of the supply chain, and also effectively weaken the Bullwhip Effect.

5.6. Building Dual Channels

A two-level supply chain network consisting of a manufacturer and a two-channel retailer can be constructed based on the consumer's price reference behavior under the condition of price information symmetry. The price reference effect may restrain the Bullwhip Effect of dual-channel supply chain, but it cannot eliminate the Bullwhip Effect (Wang & Gao, 2021). Goods with high price autoregressive degree in dual-channel supply chain might have smaller Bullwhip Effect. When the price fluctuation of online market is relatively large, the smaller (larger) the price reference coefficient of online (lower) market, the smaller the Bullwhip Effect of dual-channel supply chain.

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[1] Kanban method has been gaining popularity in corporations and businesses around the world to easily manage work. It works practically by drawing a comparison between the planning of the work and the amount of execution taking place in the workplace. If any disturbances are found during the process, Kanban helps in overcoming that issue in the production.

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