

Impact of demand changes and supply chain's level constraints on bullwhip effect

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ABSTRACT

During an aggravated economic situation many companies have to deal with various situations that present demand distortion and changes in production processes. As a result orders to suppliers fluctuate upstream of the supply chain in amplified form. This phenomenon is called the bullwhip effect, which is one of the more interesting and developing problems within supply chain management. This undesirable effect produces excess regarding inventory, problems during production planning and poor customer services. In this paper we experimented with two special cases in a simple four stage supply chain with the level constraints represented by the overall equipment effectiveness (*OEE*) level: Case 1 – stable demand with single 5 % change and ideal *OEE* level, and Case 2 – stable demand with single 5 % change and *OEE* level changes upstream of the supply chain. The results of spreadsheet simulation are shown in the tables and charts. The impact of slight demand distortion and level constraints within the supply chain on the bullwhip effect was evident. The comparison of the results showed that when deviations in production processes are present the higher bullwhip effect occur at different stages within the supply chain and depending on the situation do not have to occur at stages within the supply chain with the lowest *OEE* levels.

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References

- [1] Buchmeister, B., Friscic, D., Lalic, B., Palcic, I. (2012). Analysis of a three-stage supply chain with level constraints, *International Journal of Simulation Modelling*, Vol. 11, No. 4, 196-210, doi: 10.2507/IJSIMM11(4)3.212.
- [2] Trapero, J.R., Garcia, F.P., Kourentzes, N. (2014). Impact of demand nature on the bullwhip effect. Bridging the gap between theoretical and empirical research, In: *Proceedings of the 7th International Conference on Management Science and Engineering Management*, Springer Verlag, Berlin, 1127-1137 (in Press).
- [3] Fogarty, D.W., Blackstone, J.H., Hoffmann, T.R. (1991). *Production & inventory management*, South-Western, Cincinnati.
- [4] Buchmeister, B., Pavlinjek, J., Palcic, I., Polajnar, A. (2008). Bullwhip effect problem in supply chains, *Advances in Production Engineering & Management*, Vol. 3, No. 1, 45-55.
- [5] Buchmeister, B. (2008). Investigation of the bullwhip effect using spreadsheet simulation, *International Journal of Simulation Modelling*, Vol. 7, No. 1, 29-41, doi: 10.2507/IJSIMM07(1)3.093.
- [6] Forrester, J.W. (1961). *Industrial dynamics*, MIT Press, Cambridge.
- [7] Sterman, J. (1989). Modeling managerial behaviour: misperceptions of feedback in a dynamic decision making experiment, *Management Science*, Vol. 35, No. 3, 321-339, doi: 10.1287/mnsc.35.3.321.
- [8] Lee, H.L., Padmanabhan, V., Whang, S. (1997). Information distortion in a supply chain: the bullwhip effect, *Management Science*, Vol. 43, No. 4, 546-558, doi: 10.1287/mnsc.43.4.546.
- [9] Disney, S. Bullwhip effect in supply chains. *SciTopics*, from http://www.scitopics.com/Bullwhip_Effect_in_Supply_Chains.html, accessed December 13, 2011.

- [10] Ouyang, Y., Li, X. (2010). The bullwhip effect in supply chain networks, *European Journal of Operational Research*, Vol. 201, No. 3, 799-810, doi: 10.1016/j.ejor.2009.03.051.
- [11] Glatzel, C., Helmcke, S., Wine, J. (2009). Building a flexible supply chain for uncertain times, *The McKinsey Quarterly*, March Issue, 5 pages.
- [12] Cachon, G.P., Randall, T., Schmidt, G.M. (2007). In search of the bullwhip effect, *Manufacturing & Service Operations Management*, Vol. 9, No. 4, 457-479, doi: 10.1287/msom.1060.0149.
- [13] Chen, L., Lee, H.L. (2012). Bullwhip effect measurement and its implications, *Operations Research*, Vol. 60, No. 4, 771-784, doi: 10.1287/opre.1120.1074.
- [14] Duc, T.T.H., Luong, H.T., Kim, Y.-D. (2008). A measure of the bullwhip effect in supply chains with stochastic lead time, *International Journal of Advanced Manufacturing Technology*, Vol. 38, No. 11-12, 1201-1212, doi: 10.1007/s00170-007-1170-1.
- [15] Sucky, E. (2009). The bullwhip effect in supply chains – An overestimated problem?, *International Journal of Production Economics*, Vol. 118, No. 1, 311-322, doi: 10.1016/j.ijpe.2008.08.035.
- [16] Ouyang, Y., Daganzo, C. (2008). Robust tests for the bullwhip effect in supply chains with stochastic dynamics, *European Journal of Operational Research*, Vol. 185, No. 1, 340-353, doi: 10.1016/j.ejor.2006.10.046.
- [17] Shaikh, R., Khan, M.A. (2007). Quantifying bullwhip effect and reducing its impact, *South Asian Journal of Management Sciences*, Vol. 1, No. 1, 25-31.
- [18] Agrawal, S., Sengupta, R.N., Shanker, K. (2009). Impact of information sharing and lead time on bullwhip effect and on-hand inventory, *European Journal of Operational Research*, Vol. 192, No. 2, 576-593, doi: 10.1016/j.ejor.2007.09.015.
- [19] Bray, R.L., Mendelson, H. (2012). Information transmission and the bullwhip effect: An empirical investigation, *Management Science*, Vol. 58, No. 5, 860-875, doi: 10.1287/mnsc.1110.1467.
- [20] Oyatoye, E.O., Fabson, T.V.O. (2011). Information distortion in supply chain: A simulation approach to quantifying the bullwhip effect, *Journal of Emerging Trends in Economics and Management Sciences*, Vol. 2, No. 2, 131-141.
- [21] Kelepouris, T., Miliotis, P., Pramataris, K. (2008). The impact of replenishment parameters and information sharing on the bullwhip effect: A computational study, *Computers & Operations Research*, Vol. 35, No. 11, 3657-3670, doi: 10.1016/j.cor.2007.04.004.
- [22] Tominaga, H., Nishi, T., Konishi, M. (2008). Effects of inventory control on bullwhip in supply chain planning for multiple companies, *International Journal of Innovative Computing, Information and Control*, Vol. 4, No. 3, 513-529.
- [23] Csík, Á., Földesi, P. (2012). A bullwhip type of instability induced by time varying target inventory in production chains, *International Journal of Innovative Computing, Information and Control*, Vol. 8, No. 8, 5885-5897.
- [24] Nepal, B., Murat, A., Chinnam, R.B. (2012). The bullwhip effect in capacitated supply chains with consideration for product life-cycle aspects, *International Journal of Production Economics*, Vol. 136, No. 2, 318-331, doi: 10.1016/j.ijpe.2011.12.018.
- [25] Boute, R.N., Lambrecht, M.R. (2009). Exploring the bullwhip effect by means of spreadsheet simulation, *INFORMS Transactions on Education*, Vol. 10, No. 1, 1-9.