The Industrial Dynamics of Order Rationing, Shortage Gaming, and Retail Promotions Demand Shock: A Discrete Event Simulation Experiment

Sara Liao-Troth, J. Whitney Bunting College of Business, Georgia College & State University, GCSU Campus Box 12, Milledgeville, GA 31061, sara.liao-troth@gcsu.edu

Within the domain of supply chain management, business systems are often modeled as a simplified vertical or serial supply chain with one member per echelon [7]. However, most supply chains have multiple members within a given echelon, and there exists differences in results and findings from supply chain models that incorporate multiple horizontal entities compared to those modeling single entities within an echelon [8]. Often, horizontal entities share a common supplier and/or customers and their relationships are competitive in nature [5]. Conflicts of interest are also present among the interdependent firms, as the optimal action for each firm in their inventory ordering may differ from what is optimal for other firms [6]. As a result, it is likely that the decisions and actions of each firm may impact not only the upstream supplier but may also negatively impact other firms in the echelon as well [1] through indirect linkages with the supplier. Unfortunately, the presence of competing horizontal firms and their linkages to a focal vertical supply chain are rarely considered despite the existence of interconnected information, material, and financial flows [5] [8] and impacts on the long-term performance of the industrial system [4]. There is a need to better understand the dynamics of competition for supply inventory among horizontally interconnected entities within business systems.

Two research questions—1. Does competition for supply inventory impact vertical industrial business systems and 2. How can supply inventory competition impact the inventory ordering and fulfillment process over time—are addressed through a discrete event simulation experiment based on a US major appliance supply chain. Interviews and publicly available industry data were used to construct a simulation model rooted in a real-world setting.

Competition for supply inventory among horizontal supply chain firms is operationalized via three variables: order rationing strategies, shortage gaming responses, and retail promotions demand shock. This research investigates their impact on the long-term system performance (demand variance, order fill rates, opportunity loss, and inventory carrying costs) of the inventory ordering and fulfillment process between 9 competing retailers and a shared upstream manufacturer.

Overall, the findings suggest that both vertical and horizontal entities within business systems are significantly impacted by each entity's actions within the inventory ordering and fulfillment feedback loop. Specifically, results from the simulation experiment indicate a strong impact from order rationing strategies and shortage gaming responses on long-term outcomes such as demand variance, order fill rates, opportunity loss, and inventory carrying cost. In contrast, a single retail promotions demand shock has limited long-term impact on system performance. Also, interactions between the three variables are complex, particularly when considered over time. There are both positive and negative impacts relative to each entity within the inventory ordering and fulfillment feedback loop.

Three contributions emerge from this research. First, results from this study fill a gap in the literature as it explicitly incorporates multiple horizontal entities and their impact on the more commonly researched vertical supply chain system. The findings complement vertically oriented supply chain management research by highlighting horizontally oriented inventory competition as an overlooked factor in supply chain management performance.

Second, this research expands knowledge about the long-term impact of various rationing strategies and shortage gaming responses. Three rationing strategies were identified from the literature and tested within the research. The findings both confirm and extend extant literature regarding the differential impact of each rationing strategy, e.g. [3], through exploration of their overlooked interactions with shortage gaming responses. Unlike prior studies which employ an analytical approach, a simulation experiment methodology was utilized which allowed for the detailed examination of the comprehensive set of interactions for these variables identified through literature and manager input. The results suggest that research models involving order rationing should explicitly account for competition among horizontal members of an echelon in order to capture a broader range of significant influences.

Finally, this research contributes to a greater understanding of the consequences of a single retail promotions demand shock. Research specific to the demand impact of retail promotions is limited despite the pervasive use of retail promotions to stimulate consumer demand [2]. However, demand shocks arising from retail promotions are generally considered detrimental in the supply chain management discipline. Interestingly, the results suggest that a single retail demand shock has a weak impact on system performance over time. Over the long-term (5 years) the system appears to recover from the demand shock, however over the short term the impact may be stronger in comparison. Therefore, an explicit identification of the time-period under study should be considered in research involving retail promotions demand shock. In addition, as this study investigated a single demand shock, it is possible that additional, overlapping demand shocks could produce negative outcomes congruent with beliefs expressed in literature. Thus, specification of the quantity of demand shocks under consideration should also be made in promotions research. Overall, the results regarding retail promotions demand shock suggests that additional research is required in order to understand the impact of retail promotions on supply chains.

REFERENCES

[1] Almadoss, W., Ho, T.-H., Krishna, A., Chen, K.-Y., Desai, P., Iyer, G., Jain, S., Lim, N., Morgan, J., Oprea, R. & Srivasatava, J. Experiments on strategic choices and markets. *Marketing Letters*, 2008, 19, 417-429.
[2] Blattberg, R.C, Briesch, R., & Fox, E.J. How promotions work. *Marketing Science,* 1995, 14(3), 122-132.
[3] Cachon, G.P. & Lariviere, M.A. An equilibrium analysis of linear, proportional and uniform allocation of scarce capacity. *IIE Transactions*, 1999, 31 (9), 835-849.
[4] Forrester, J.W. *Industrial Dynamics*. Cambridge, MA: The M.I.T. Press, 1961
[5] Li, L. Information sharing in a supply chain with horizontal competition. *Management Science,* 2002, 48 (9), 1196-1212.
[6] Moorthy, K.S. Using game theory to model competition. *Journal of Marketing Research*, 1985, 22 (August), 262-282.
[7] Morgan, C. Supply network performance measurement: future challenges? *The International Journal of Logistics Management*, 2007, 18 (2), 255-273.
[8] Wan, X. & Evers, P.T. Supply chain networks with multiple retailers: a test of the emerging theory on inventories, stock outs, and bullwhips. *Journal of Business Logistics*, 2011, 32 (1), 27-39.
[9] Wathne, K. H. & Heide, J.B. Relationship governance in a supply chain network. *Journal of Marketing*, 2004, 73-89.