Association for Information Systems
AIS Electronic Library (AISeL)

ICEB 2017 Proceedings

International Conference on Electronic Business

Winter 12-4-2017

The Impact of Product Variety and Product Diversification on Inventory Levels: From a Distributor Perspective

Hsin-Lu Chang
Department of MIS, National Chengchi University, hlchang@nccu.edu.tw

Yen-Chun Chou
National Chengchi University, Taiwan, yenchun@nccu.edu.tw

Hui-Ching Yang
National Chengchi University, Taiwan, 105356005@nccu.edu.tw

Follow this and additional works at: http://aisel.aisnet.org/iceb2017

The Impact of Product Variety and Product Diversification on Inventory Levels: From a Distributor Perspective
(Work in Progress)

Hsin-lu Chang, National Chengchi University, Taiwan, hlchang@nccu.edu.tw
Yen-Chun, Chou, National Chengchi University, Taiwan, yenchun@nccu.edu.tw
Hui-Ching Yang*, National Chengchi University, Taiwan, 105356005@nccu.edu.tw

ABSTRACT

We have been working with W company, one of the largest electronic component distributors in Asia, to improve their warehouse management. Our research examines how product variety, the number of items demanded by customer plants through time i in month t, and product diversification, the proportion of total orders each item carried by customer plants i in month t through time, influence inventory levels. We argue that product variety and product diversification are positively related with inventory cost. We also argue that the impacts of product variety and product diversification on inventory cost are negatively moderated by IT integration. W company's inventory records come from many customers' orders at plant level across months. We thus aim to use panel data analysis to examine W company's product strategies and resulting inventory performance at each customer-plant level over 6 months.

Keywords: Format instruction, ICEB, e-business, electronic commerce, headers and footers.

_____
*Corresponding author

INTRODUCTION

We have been working with W company, one of the largest electronic component distributors in Asia, to improve their warehouse management. W company is an intermediate trader between electronic components manufacturers and electronic devices manufacturers. As an electronic component distributor, W company mainly profits from serving its customers distinct categories of electronic items they need. To meet customers' demand, W company has to maintain high service level, and make sure that the number of electronic components in the customer hub is sufficient for customers to call off whenever they demand. Fully fulfilling customers' demands and avoiding stock-out are critical for their competitiveness against competitors.

W company has two ways of serving customers products, distributing items to customer hubs or delivering products directly to customers. The former way is an implementation of vendor-management inventory (VMI), which is a tool used to improve customer service, multi-firm supply chain efficiency and reduce inventory cost (Achabal *et al*., 2000; Kuk, 2004; Waller *et al*., 1999). Although VMI can reduce inventory cost, the uncertainty of actual demands makes it difficult to manage the warehouse, and results in tremendous storage costs. In most situations, customers place orders approximately once a month to W company, and the order quantities are usually unchanged. Even though the customers have placed orders, it does not mean that they will call off the exact quantity of items they ordered. They always call off less than the demand they gave to W company, with the remain items stored in the customer hub, causing considerable inventory costs. With the replenishment decision of W company, which is simply based on their experience and simple rules, the difference between the quantities supplied by W company and those called off by customers becomes even more larger. With high inventory levels, the management of warehouse becomes more important.

Ballou (Ballou, 1992) estimates that having inventories can cost between 20% and 40% of their value per year. Inventory cost is a severe problem for W company since inventory cost has a considerable effect on firm profitability. Moreover, product variety makes the inventory levels higher and the management of warehouse more complicated. Product variety has been proved to impact holding costs, service levels and delivery reliability (Closs, Nyaga & Voss, 2010). Prior research finds out that an increase in product variety increases inventory costs and decreases service levels (Closs, Nyaga & Voss, 2010). Furthermore, Graman and Magazine posit high levels of product variety require correspondingly higher levels of inventory (Graman & Magazine, 2002; Closs, Nyaga & Voss, 2010). According to previous research, product variety results in higher levels of inventory and inventory costs. However, product variety is essential to firm competitiveness and sales. To resolve the tradeoff, we are interested in examining the impact of product variety on inventory levels. In addition to product variety, we assume that product diversification, the proportion of total orders by a customer plant each item accounts for may influence inventory level and inventory cost. Prior research (Berg & Zijm, 1999) posits that reduced inventory levels not only reduce inventory costs, but also improve the efficiency of the order-picking operation within the warehouse. This paper examines how the product variety, product diversification influences the inventory level which is critical to warehouse management. We also simultaneously examine whether IT integration level moderates the relationship between product variety, diversification and the inventory level.

This research examines the simultaneous effects of product variety and product diversification on inventory level in customer

plant. We clarify the effects of product variety and product diversification on inventory level into four categories: high product variety and high diversification, low product variety and low diversification, low product variety and high diversification, and low product variety and low diversification. We also consider the moderated effect of IT integration level on the relationship mentioned above. The above of classifications are further explored on two types of inventory management: customer direct and vendor-managed hub. Prior research mentions that if the computer manufacturer's channel is customer direct, then its strategy is differentiation, focusing on relatively small number of profitable or customized SKU's (Closs, Nyaga & Voss, 2010). If the computer manufacturer's channel is distributor, then its strategy focuses on cost leadership, focusing on relatively low margin profit but relatively high volumes. We aim to compare the two types of inventory management, and see any significant differences on product strategies, i.e., the four classifications above, applied and associated performances.

LITERATURE REVIEW

In the marketing literature, high product variety has been found to be essential for satisfying customer needs, and in turn increase the probability of completing a sale (Wan, Evers & Dresner, 2012). Companies routinely increase product variety in order to enhance competitiveness and grow sales. However, increasing product variety is known to have negative effects on operations, such as an increase in inventory levels (Wan, 2017). Higher product variety results in higher inventory levels due to large numbers of SKUs, which have their own lot sizes, safety stock, and order quantity levels (Zipkin, 2000). Product variety also increases the complexity and uncertainty in the operating environment. Graman and Magazine (2002) posit that greater product complexity requires correspondingly higher inventory levels. Thus, we argue that product variety might also increase the complexity and uncertainty in warehouse management, and in turn increase the inventory cost. Prior research (Wan, Evers & Dresner, 2012) finds out that increasing product variety may have positive impacts on sales, while increasing "too much" may have negative effects. Therefore, we suggest that product variety can satisfy customer demands and maintain competitiveness, but it might also increase complexity of warehouse management and increase inventory cost.

Prior research has mentioned the concept of international diversification, reflecting the number of different markets in which the firm operates and their importance to the firm. The level of international diversification is measured by the percentage of total sales represented by each market (Hitt, Hoskisson & Kim, 1997). Inspired by the concept of diversification indicator, which can show the importance of each market to the firm, we extend the concept to customer orders, called product diversification, which show the proportion of total orders each item carried by customer plant. Product diversification can reflect the importance of each item in total orders. The research (Hitt, Hoskisson & Kim, 1997) also suggests that unrelated product diversification spreads the risk across product markets, thereby reducing the probability of severe losses and increasing the probability of achieving a positive return. Hitt and colleagues (1995) argued that an integrated low-cost and differentiation strategy is often necessary to compete in international market. Firms focusing on specific market niches can provide both low-cost and differentiated product, thereby avoiding the competition. The entropy measure of product diversification(PDT) is defined as $PDT = \Sigma i [Pi \times \ln(l/Pi)]$, where Pi is the sales attributed to segment i and $\ln(l/Pi)$ is the weight given to each segment, or the natural logarithm of the inverse of its sales (Hitt, Hoskisson & Kim, 1997).

Prior research (Rai *et al*. 2006) indicated that a firm's information technology (IT)-based platform capabilities have a substantial effect on supply chain process integration. This capability is deeply embedded into the structure of interfirm operational processes, such as order management, inventory management, logistics, and distribution; and information processes, such as demand planning and forecasting. IT integration is an essential element in supply chain management (SCM), and have positive effects on firm performance. IT integration improves information sharing between customer and firm in supply chain; therefore, we suggest that IT integration level as a moderator in our research model.

RESEARCH FRAMEWORK

Our research examines how product variety, the number of items demanded by customer plants through time i in month t, and product diversification, the proportion of total orders each item carried by customer plants i in month t through time, influence inventory levels. Our research model is shown in figure 1. Low product variety means that the order demand in the customer hub is composed of small number of items; low product diversification presents that only small number of items account for most of total order quantities in customer hub. On the contrary, high product variety means that there are many kinds of items demanded in customer hub, and high product diversification means that the proportion each item accounts for in the total order in the customer hub is with slight difference.

According to prior research (Wan, 2017), increase in product variety has negative impacts on operations, increase the complexity and uncertainty in the operating environment. Higher product variety results in higher inventory levels due to large numbers of SKUs (Zipkin, 2000). Graman and Magazine (2002) posit that greater product complexity requires correspondingly higher inventory levels. They all suggest that increasing in product variety results in higher inventory level. Therefore, we argue that product variety is positively related with inventory cost.
H1 Product variety is positively related with inventory cost.

Product diversification, the proportion of total orders each item carried by customer plants i in month t through time, can show the importance of each item to the orders by customer plant. We suggest that with higher product diversification, most items in the orders are important to the customer plant, in turn making it more difficult and complicated to manage inventory, resulting in

higher inventory cost. Therefore, we argue that Product diversification is positively related with inventory cost.
H2 Product diversification is positively related with inventory cost.

Prior research (Rai, Patnayakuni & Seth, 2006) suggests that IT integration for SCM enables supply chain process integration, which yields sustained gains in firm performance. IT integration is an essential element in SCM, and have positive effects on firm performance. Therefore, we argue that IT integration level negatively moderates the impact of product variety and product diversification on inventory costs.
H3 The impact of product variety on inventory cost is negatively moderated by IT integration.
H4 The impact of product diversification on inventory cost is negatively moderated by IT integration.
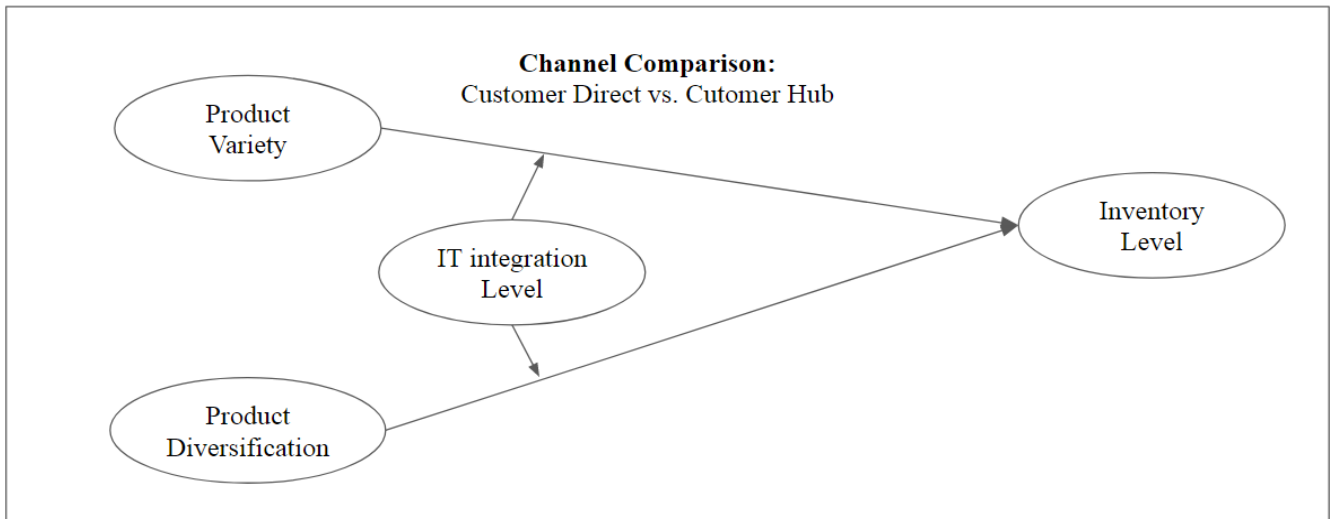

Figure 1: model for product variety, product diversification, inventory level, and IT integration level

RESEARCH PLAN
The data that we collect from the W company includes item list, stock report, customer hub, item call off, IT integration level, and item available data.
Item List
The item short name, item number, item brand, category and item attribute, single or common.

Stock Report
The data contains data of items' stock status and the actual average week usage of every customer by week. We collect 24 weeks of stock report from W company.

Item Call Off
The data contains item number, item short name, transaction date, hub call off or customer direct, which customer plant, and the quantity.

IT Integration Level
IT integration level data describes how each customer transmit information with W company. There are three ways to inform forecasting information: email, web crawling, AP-AP. With regard to PO, there are web crawling and AP-AP

Item Available Data
It includes the item number, of the item, item category, average usage, item number on hand, item number on order, and available stock.

W company's inventory records come from many customers' orders at plant level across months. We thus aim to use panel data analysis to examine W company's product strategies and resulting inventory performance at each customer-plant level over 6 months.

EXPECTED CONTRIBUTION
By analyzing data collected from W company, an electronic component distributor, we hope our results can give W company some management implications, like whether they should increase or decrease product variety or diversification to improve its inventory efficiency and warehouse management. There are few studies including the concept of product diversification when discussing warehouse management and inventory management; thereby, our research can give electronic component distributor

new management approaches. Also, theoretically, one of key influence/role of IT is to improve information sharing. Given the industry context where electronic manufacturers can reschedule or cancel orders from W company, it is interesting to empirically examine the effect of IT integration on the relationship between product variety, product diversification, and inventory costs.

REFERENCES

[1] Achabal, D.D., McIntyre, S.H., Smith, S.A., & Kalyanam, K. (2000). A decision support system for vendor managed inventory. *Journal of Retailing*, *76*(4), 430-454.

[2] Kuk, G. (2004). Effectiveness of vendor-managed inventory in the electronics industry: determinants and outcomes. *Information & Management*, 41(5), 645-654.

[3] Waller, M., Johnson, M.E., & Davis, T. (1999). Vendor-managed inventory in the retail supply chain. *Journal of Business Logistics*, *20*(1), 183.

[4] Ballou, R.H. (1992). *Business Logistics Management* (3rd ed.). Englewood Cliffs, NJ: Prentice-Hall.

[5] Closs, D.J., Nyaga, G.N., & Voss, M.D. (2010). The differential impact of product complexity, inventory level, and configuration capacity on unit and order fill rate performance. *Journal of Operations Management*, *28*(1), 47-57.

[6] Graman, G.A., & Magazine, M.J. (2002). A numerical analysis of capacitated postponement. *Production and Operations Management*, *11*(3), 340-357.

[7] van den Berg, J.P., & Zijm, W.H.M. (1999). Models for warehouse management: Classification and examples. *International Journal of Production Economics*, *59*(1), 519-528.

[8] Rai, A., Patnayakuni, R., & Seth, N. (2006). Firm performance impacts of digitally enabled supply chain integration capabilities. *MIS Quarterly, 30*(2), 225-246.

[9] Wan, X., & Sanders, N.R. (2017). The negative impact of product variety: Forecast bias, inventory levels, and the role of vertical integration. *International Journal of Production Economics*, *186*, 123-131.

[10] Wan, X., Evers, P.T., & Dresner, M.E. (2012). Too much of a good thing: The impact of product variety on operations and sales performance. *Journal of Operations Management*, *30*(4), 316-324.

[11] Hitt, M.A., Hoskisson, R.E., & Kim, H. (1997). International diversification: Effects on innovation and firm performance in product-diversified firms. *Academy of Management Journal*, *40*(4), 767-798.