



MIT SCALE RESEARCH REPORT

The MIT Global Supply Chain and Logistics Excellence (SCALE) Network is an international alliance of leading-edge research and education centers, dedicated to the development and dissemination of global innovation in supply chain and logistics.

The Global SCALE Network allows faculty, researchers, students, and affiliated companies from all six centers around the world to pool their expertise and collaborate on projects that will create supply chain and logistics innovations with global applications.

This reprint is intended to communicate research results of innovative supply chain research completed by faculty, researchers, and students of the Global SCALE Network, thereby contributing to the greater public knowledge about supply chains.

For more information, contact
MIT Global SCALE Network

Postal Address:

Massachusetts Institute of Technology 77
Massachusetts Avenue, Cambridge, MA 02139 (USA)

Location:

Building E40, Room 267
1 Amherst St.

Access:

Tel: +1 617-253-5320
Fax: +1 617-253-4560

Email: scale@mit.edu
Website: scale.mit.edu

Research Report: ZLC-2008-5

Cycle Inventories and the Value of the Firm: the Case of Two Firms

Andrés Eduardo de la Guardia Oteiza – José Manuel Garza Estrada

For Full Thesis Version Please Contact:

Marta Romero

ZLOG Director

Zaragoza Logistics Center (ZLC) Edificio

Náyade 5, C/Bari 55 – PLAZA 50197

Zaragoza, SPAIN

Email: mromero@zlc.edu.es

Telephone: +34 976 077 605

Cycle Inventories and the Value of the Firm: the Case of Two Firms

Andrés Eduardo de la Guardia Oteiza – José Manuel Garza Estrada

EXECUTIVE SUMMARY

Operations and Finance have historically been separate, both as academic fields and as functional departments within corporations. This situation naturally leads to a compartmentalized decision-making process. Two well-trained and well-intentioned managers can fail to see how their actions affect the complete picture, leading to missed opportunities or even counter-productive actions.

For example, typical operations management improvement concepts call for cost cutting. However, the real objective of a firm's management team is to increase the shareholders' value, which is a finance concept. Cost-cutting is an approximation for increasing the shareholders' value yet it has been shown that cutting costs too much can also cut the shareholders' value.

We studied one of these interactions between operations and finance as it applies to Supply Chain Management, where combining elements of both disciplines will improve our decision-making process and understanding. In particular, we focused on cycle inventories.

Cycle inventories are a natural phenomenon in supply chains whenever economies of scale in ordering or setup exist. If it is more cost-effective to make the products in batches, then a need for cycle inventories arises from the time the batch arrives or comes out of production until it is consumed. The eternal question that operations managers face is how much of these inventories to maintain by determining the optimal batch size. The "Economic Order Quantity" (EOQ) is the most popular model for establishing the size of cycle inventories, as it yields the ordering quantities that minimize the costs of holding and ordering stock.

Our research objective was to solve the cycle inventory problem, a traditional operations problem, through the lens of finance. We developed a model for determining the financial value of cycle inventories to the firm's shareholders, using the Capital Asset Pricing Model (CAPM) as our financial valuation tool. From that model, we determined what the "most valuable" inventory level is, as opposed to what the "least costly" inventory level is.

We also extended our results to a supply chain involving two inventory locations or "echelons" that can represent different firms and studied the effects of the most important parameters on the firms' ordering. We used the *Value Chain Explorer* software package from Jonova, our thesis sponsor, to validate our model; and we also developed our own software that implements our valuation model and finds the value-maximizing inventories

The key findings of our research are:

- The cost of capital of a firm is dependent on the size of the cycle inventories. They affect the expected cash flows of the company, which in turn can make the firm more or less exposed to random external shocks.
- The risk level that the firm is exposed to has an impact on its optimal order quantity. It is an inversely proportional relationship: the higher the risk a firm is subject to, the lower its optimal ordering quantity should be.
- Any parameter that can affect the firm's cash flows can affect the optimal cycle inventories. This finding is important because it brings into our analysis factors like the selling price that were previously ignored by cost-minimizing models like the EOQ. For example a higher selling price, *ceteris paribus*, generates more cash flows, which lowers the proportion of the random part of the cash flows. This in turn, reduces the risk profile of the company and allows it to have higher order quantities.
- We compared our optimal results with those of the EOQ and found that when a firm faces low levels of risk, the optimal ordering quantities are very similar. Only when the risk is high, the EOQ diverges from the optimal quantity provided by our model.
- When we extended our valuation model for a two-firm supply chain, we found that taxes can have an impact on the ordering quantities between two firms. The location with the higher tax would tend to have higher inventories when compared with a case where taxes are equal.
- Taxation can also influence the impact of changing the wholesale or transfer pricing between the echelons. This is particularly important, as it changes the way we must compute quantity discounts in a supply chain. It is better to keep the transfer price lower when the retailer has the higher taxes. Our model basically tries to steer taxable revenues away from, and taxable costs into, the higher tax echelon.

We believe our research will be very valuable to:

- Enterprises that need to carry high levels of inventory as a proportion of their total assets.
- Supply chains that are highly exposed to risk or that have large risk imbalances between their links.
- Academics who want to study interactions between operations and finance.
- Governments who wish to analyze the impact of taxation policies on the operations of the firms in their jurisdiction.

Finally, we leave pointers for further research in the area of trade credit between firms. Lending and borrowing within the supply chain has a natural advantage over lending through third parties like banks. Lending between suppliers and buyers therefore generates lots of opportunities for value creation in supply chains.