Book Review: Supply Chain's Flexibility - A Real Options Approach

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Abstract: This book contains of the investigation is about the process of decision making in supply chain management using a real options analysis framework. Specifically, the authors address issues regarding the optimal inventory level to hedge against demand uncertainties; the timing for equipment capacity implementation under market product mix complexity; the timing for workforce capacity reinforcement aiming market service requirements; and the decisions between integration and outsourcing in an uncertainty environment. Discrete and continuous time methodologies were used to identify the optimal value and timing of the options to adopt, when the demand is stochastic. Additionally, the effect of market requirements, such as product mix complexity and service level, were also taken into consideration. The demand is modeled under different stochastic processes; the impact of unexpected shocks is also explored, which enhances the generalization of the models to different business conditions. The applicability of the models enables the diversification and enrichment of the literature on the real options approach, within supply chain concept. Flexible inventory levels and the flexible capacity are supply chain features that can be used to deal with demand uncertainty.

Keywords: Flexibility, Supply chain, Supply chain management, SCM, Real Options

1. Introduction

The goal of this investigation is to study the effects of uncertainty in management enhancing the supply chains' flexibility. The purpose is to develop new models to support supply chain resources application; explore the effects of market uncertainty in the decision process; explore the effects of uncertainty in the supply chain performance; to perceive and quantify flexibility using options; and to test the applicability of proposed concepts and methodologies using illustrative examples.

In particular, this investigation presents solutions to minimize disruptions in fulfilling the uncertain market demand, caused by upstream problems, triggered by inadequate or unbalanced inventory buffers, lack of downstream technological or human capacity, or delays in running new operations. The use of different products' classifications allow a better understanding about the risk of the stocks; the use of product life evolution and sales performance, are important inputs for a new classification that appears to be both logic, useful and as far as we explored the literature we didn't find such any approach. The overstock concept, which represents an excess of stock value to hedge against future uncertainties in demand, and it is dependent on the uncertainty level evolution. The results showed that sales uncertainty has a positive impact on overstock (inventory) indicating that firms facing high demand uncertainty build up overstocks to avoid stock-outs.

However, the authors also noted that the overstock build-up declines as firms are more flexible regarding lead time, service level or capacity. The sequential approach to overstock decisions allow to have a better understanding, also as to value the influence of the demand uncertainty in the supply chain echelons, mainly in the upstream ones, where the uncertainty tends to have an intensified effect. On top of the uncertainty effect there can be also an information distortion among the decision makers (similar to a bullwhip effect). Also the lack of coordination causing the existence of non-optimal overstock values influences the global overstock value. Investments in capacity increase, due to volume or mix (innovation or customization) are influenced by future expected profits that depend on demand uncertainty evolution

International Journal of Supply Chain Management
IJSCM, ISSN: 2050-7399 (Online), 2051-3771 (Print)

also on the product mix strategy aiming the customers' evolution.

2. Review of the Book

All the chapters are within the topic of demand uncertainty. Chapter II contributes to the inventory mechanism in uncertain markets. In general, inventory control concerns balancing demand and supply where, in order to do that in a smooth fashion, some stocks are needed. Most often, buffers exist to profit from economies of scale and to protect from uncertainties in demand or in supply. Economies of scale dictate that because of existing fixed costs, the procurement or production orders should be dimensioned to some reasonable minimum batch sizes. Market demand uncertainty concerns both quantities and the timing. This give rise to stocks, an excess buffer to be kept to provide the adequate customer service requirements.

In this investigation the economies of scale will be ignored and our focus is the uncertainty element, specifically, the demand uncertainty. In chapter II, the authors propose the use of overstock as a new supply chain key performance indicator to define the optimal stock value, according to different demand uncertainty levels. To support this concept and for a better adaptation, regarding the models used to represent the demand, a new methodology to support the items' classification is presented; following the classification frame, different items should have different approaches regarding inventory management. They use a combination between the traditional ABC's adapted classification, considering the sales performance (fast movers, movers and slow movers); the market segmentation and the product's life cycle evolution. The results point out the relevance of three internal factors in the flexibility of the supply chain, which are the lead time, the phase-out activities and the subsequent obsolescence risk in items management, and the cost function related with warehousing activities and with the invested capital. The overstock model shows the link between demand uncertainty and supply chain inventory flexibility, for different item groups.

Based on the work of chapter II, the authors extended the contribution to the attribute of uncertain demand, considering the inventory sequential mechanism between different echelons in a chain. The extended research comprise five major scopes: (1) the effect of demand behavior on multi-echelon overstock value; (2) the influence of lead-time changes; (3) the influence of service level changes; (4) capital restrictions on inventory value and the (5) influence of non-optimal overstock values. An additional scope is related with the influence of the network design stocking points on overstock value. Simultaneously, we study the application of the model using an illustrative example.

In chapter III, we explore the concept of target setting in a multi-echelon supply chain, considering the demand uncertainty penetration through the different echelons. We use the overstock indicator to propose a balanced and integrated supply chain approach for each node. From the retail perspective, we suggest for a specific moment, the overstock to be targeted in upstream echelons, based on the demand uncertainty, existing stock level, lead time, agreed service level and cost function. With this methodology, managers can define their targets linked with down and upstream echelons and identify the most critical parameters to be monitored. The main results show the importance of the downstream stocks in the protection of the supply chain against the demand uncertainty effect, also as the link between echelons when non optimal values are considered. We propose a corrective factor that can be used in the target setting process, to close the gap between realistic targets under uncertain environments and performance evaluation.

In chapter IV, we employed a sequential decision frame applied to inventory management, considering the dynamic of supply chain nodes interaction. We base our reasoning in the right sequence and value of inventory in a multi-echelon supply chain. In each stage the management team decides the overstock level and, at the same time, they judge whether to exercise it or not. The decisions are optimized using a sequential approach. The analysis considers that the overstock value at one echelon depends heavily upon the overstock availability at other nodes. Only when the overstock goal of downstream echelon is defined, the overstock of the previous stage can be planned. But, on the other hand, in real terms, if the upstream overstock target is not achieved, it is not possible to increase stocks in the next stage, considering a capacity balanced supply chain. Based on the results, we support integration and alignment in inventories

decision process to protect the supply chain from the market uncertainty. We conclude that the overstock is more sensible to lead time and service level changes in the downstream echelons, where the changes are more expressive with higher implications. We use the concept of a multi-echelon overstock as a flexible inventory planning technique in uncertain environments. We extended the application for different stochastic processes.

In the same line of research on uncertainty impact in supply chain management, valuing the flexibility, we explore the capacity problems. First we incorporated capacity restrictions on the multi-echelon overstock model. Second we study options value on technology capacity. Our approach is close to value an investment decision regarding an asset acquisition. The novelty is the consideration of demand uncertainty together with a complex frame, including the product mix variety. Supply chain decisions should account for demand uncertainty on products' portfolio. The product mix is an actual problem for most of the companies operating in markets where the products life cycle is becoming shorter and the need of innovation is rising, corresponding to the customer needs, balancing quality and prices.

The chapter V investigates the manufacturing flexibility in the context of product mix strategy. We study the product mix strategy impact in the investment decisions process, especially by quantifying the investment decisions under demand uncertainty, examining the impact of different equipment features on investment flexibility value and incorporating product mix between standard and customized items. The motivation for this chapter is driven by firms' desire to satisfy customer specific needs yet respond to them quickly, under uncertain demand. Indeed, the challenge presented in this study is timely. Today's firms are constantly trying to figure out better ways to exploit economies of scale, while satisfying an increasing demand for highly customized products. Such an article, with a well sustained case study, might prove useful and inspirational to firms who are looking to implement such decision frameworks, in order to evaluate the opportunity to invest in flexibility enabling technology. Overall the study looks at standard and customized production systems and the decision to invest in a set of resources that will enable the choice.

Chapter VI is devoted to workforce capacity problem. A model is presented to support changes in workforce, considering a complex formulation covering most of the actual workforce planning issues. The novelty concerns to the incorporation of demand uncertainty and service level. In this paper we model the timing decision in adding labor shifts to respond to stochastic demand. A numerical experiment is provided to illustrate the proposed method. This study deals with the decision on creating or not a new work shift, which is a relevant decision point to the management of production systems. The authors consider that the introduction of a new work shift implies an investment that is not fully reversible and use real options theory to deduct the optimal time to implement the decision. They explore the link between the service level target and the variable decision for an additional shift. For the generality of the model, they used two stochastic processes to represent the demand behavior. The authors incorporated in the model many parameters used for planning purposes, such as overtime, but also with strategic concerns regarding the workforce composition. The service level improvement value concept as a flexibility measure to quantify the workforce shift changes, according to a service level target was also used.

Chapter VII is about supply chain network design, considering the option to integrate or outsource activities. There are a large number of studies on outsourcing, which consider the variability of the costs as the main hedging tool to deal with the market uncertainty, yet often penalizing the profit function of the company. The change from vertical integration to outsourcing creates a loss of direct access to information and integrated control throughout the entire supply chain. As a result, in the past at least, some of the expected gains from outsourcing have failed to materialize due to the lack of accurate and shared information. A flexible supply chain can respond efficiently to real-time changes in the cost, quantity, or mix of products that the market demands, only if there is accurate real-time information about supply and demand conditions. In this chapter, the authors explore the integration strategy, to help managers deciding to change from outsourcing to integration and defer commitment until future uncertainties are partially solved. The major concerns are related with the moment for the change, under demand uncertainty and considering the profit function

prior and after the decision, which can be full or partial. The change in the strategy can imply additional resources, for which a preparation stage is required, triggering irreversible costs.

At the end, the authors explore the design of business plans models, mainly referring to the number of planning periods. Companies need to plan their activities and to establish targets for their performance, for which a plan and a budget are required. Most of the times these revision periods represent important information arrival that can be used to correct or adjust forecasting models. The authors also want to reinforce the difference in the utility of such plan and budgeting periods considering the time that is being projected, from a short term approach to long term estimation. We use chapter VIII to develop a dynamic business plan model. A business plan guides the company profitability and helps managing the release of additional investments or resources. The more flexible a plan is in responding to future market changes, the more successful the business evolution is likely to be. The flexibility of a business plan is based on the extent of the milestones used to promote changes in the commitment of resources, considering the analysis of past results, but also the arrival of new valid information. For generality we contribute to the extension of plans analyses, informing the value of a dynamic business plan. We explore the marketing projects to support our reasoning about plans flexibility; nevertheless, the model can be extended to all situations regarding sequential investments or projects.

3. Discussion

The investigation is organized by chapters that support the application of the models, and consists of an introductory chapter (chapter I) and six trials on factors that enhance the use of supply chain flexibility measures in uncertainty environments and an extended chapter on the concept of flexibility to the evaluation of business plans.

The second chapter we present refers to the inventory value in a single echelon, as a measure of flexibility, subject to cost constraints. We introduce a new items' classification to support the indicator designated as overstock. In the third and fourth experiments we extend the concept of overstock, promoting the interaction and balance between supply chain echelons in order to improve overall performance. For a practical application of the approaches, we adapted the third chapter to the performance management, to support the establishment of coordinated and aligned goals, and used the fourth chapter to the coordination of supply chains, supporting the integrated and sequential inventory planning.

In the fifth chapter we analyze manufacturing technology features in connection with the company's product mix, exploring the concept of investment as a flexible measure to deal with uncertain demand volume and product range flexibility.

We dedicate the sixth chapter to the analysis of the input "workforce", exploring the economic conditions for increasing the number of work shifts and determining the critical point for decision making in uncertainty environments. In the chapter seven, we explore the concept of internalization of operations, focusing our analysis in the trigger moment that supports decision making in dynamic environments.

Finally, in the last chapter, we extend the concept of flexibility in uncertainty environments to the business plans analysis. Specifically, the authors explore the influence of the number of decision points in the flexibility of a plan in response to increasing market uncertainty. As an example, we use the mechanism of sequential budget to support the model. The increasing uncertainty in demand has promoted supply chains agility and flexibility, limiting the use of many of the traditional management techniques, because of their inability to incorporate the effects of uncertainty. Flexibility is clearly a competitive advantage that companies should have and therefore must be quantified. With the models developed and results that are presented, this thesis aims to demonstrate the usefulness of considering the uncertainty impact in management tools, using numerical examples to support the application of the models and the interpretation of the results, which clearly seek to bring the developments to the actual business practices.

4. Conclusion

The authors found a relevant link between manufacturing flexibility and uncertainty but also with the product mix strategy. They explored the influence

of partnerships between manufactures and their clients when they agree to share the risk of customization using a premium selling price. Workforce adjustments have been explored in the relation with market demand evolution or at a strategic level in relation to capacity expansions or automation projects. The findings support the influence of demand uncertainty on the decision regarding shifts expansion. However, this book introduced a new approach to allow the inclusion of the service level impact; we value not the historical service level, but the improvement on the current service level by setting challenging targets. They also found that integrating activities, despite the fixed visible costs due to the potential required capacity extensions, can also embed flexibility value, in opposition to an outsourcing current situation. This approach can be extended to support non quantified decisions that, because of strategic and market concerns withdraw any outsourcing alternative.

In this book, the authors found that companies using rolling approaches in their plans are more flexible than the ones with fixed and limited milestones. The extreme situation goes to the companies that guide their activities using a fixed annual budgeting period. These findings are in line with management reasoning that tends to split the resources allocation to minimize the potential risk. Generally, the findings imply that firms that are not constrained to adapt their stock, to adjust their capacity or change their network, tend to respond faster to demand shocks. The reason is that a less constrained firm has the means to purchase an extra unit of flexibility: overstock, equipment flexibility, hire labor quickly or outsource production over the business cycle. The business cycle monitoring can also contribute to the value of a company. Companies less constrained in the number of revisions of their plans or projects are more flexible to adapt to changes regarding the available options.

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Fernandes, Rui, Gouveia, Joaquim and Pinho, Carlos "Supply Chain's Flexibility – A Real Options Approach", Scholar's Press, AV Akademikerverlag GmbH & Co. KG , 2013, ISBN: 978-3-639-51357-8