On the Relationship of Global Supply Chains and Product Design

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Abstract

The aim of the paper is to capture the principles of platform products and the structure of the supply chain on a firm's profitability. We model a firm with operations in two countries (termed as an international enterprise). Manufacturing and product design factors incorporated in the model include factory location, inventory, economies of scale, level of product attributes, and postponement. Marketing factors include product positioning and pricing. The framework also includes international factors such as the exchange rate and transportation cost. We model and compare eight operational options that the firm may adopt in this context. The first two options are based on the principles of platform products and are termed core product options. In these options, the international enterprise manufactures a "core product" in a single facility located in one of the countries. Under the first core product option, this facility also performs additional operations on the core product to develop custom-tailored products. Under the second core product option, customization of the core product takes place in facilities located in both countries. The other six options are characterized by standardization/customization of product and pricing policies as well as centralization/decentralization of the production function. The main result of the analysis is that under certain production-related conditions, the core product options dominate the other six manufacturing-marketing options. This result has significant managerial implications since it suggests that platform products implemented by the core product options exploit the best of both worlds; customized pricing and product policies as well as savings derived from economies of scale from the centralized production of the core product.

Keywords: Platform Products, International Issues, Manufacturing-Marketing Interface, Product Design, Postponement

1. Introduction

It is common to find companies that have operation in more than one country. These operations involve activities in manufacturing, marketing, distribution, new product development or combination of those. The nature and the extent of these operations performed in each country vary from company to company. This has lead to a typology of companies with operations in more than one country (Bartlett and Ghoshal, 1989). In order to facilitate the analysis and discussion in this paper, henceforth, we term as an *International Enterprise* (IE) a company that has operations (either manufacturing or marketing or both) in more than one country.

Management of IEs has to make decisions along a number of dimensions concerning its manufacturing and marketing functions (Yip, 1989). Manufacturing-related decisions include factory location, management of the global supply chain, inventory, and economies of scale, product design, and postponement. Marketing-related decisions include whether the IE should customize or standardize its products and pricing policies. The above decisions have to be made after taking into consideration such international factors as the exchange rate, transportation cost, and import taxes. Apparently, the complexity of the international business arena requires the above crucial decisions to be made by the company as a whole, with all business functions participating in the decision-making process.

The international facility location problem deals with the *configuration* and *coordination* of the value-added activities (Porter, 1990). Configuration refers to the degree of concentration and dispersion of activities in the value added chain. On the other hand, coordination of the activities around the globe deals with information sharing among the activities, the allocation of responsibility, and alignment of effort. The design of the network of facilities must also examine the impact of the network on the international supply chain, from the procurement of the raw materials, their transformation into intermediate products and subsequently into final products, their storing and their delivery to customers through a distribution system.

The marketing function of an IE must make the strategic choice whether the IE should offer a standardized or a customized product worldwide (Kumar and Hadjinicola, 2000). Levitt (1983) states that due to the emergence of global consumers and the homogenization of preferences, a global corporation "sells the same things in the same way everywhere." Other researchers though, challenge this view by arguing that substantial heterogeneity across countries prevents the adoption of standardized marketing programs (Douglas and Wind, 1987). In addition, the marketing function must decide whether to adopt standardized or customized marketing programs across countries such as pricing and promotional programs.

The purpose of this paper is to model and compare eight Manufacturing-Marketing (MM) options that an IE can adopt. These MM options emerge by considering factors from the manufacturing and marketing functions. Manufacturing factors include factory location, inventory, economies of scale, product design, and postponement, while marketing factors include product positioning and pricing (Hadjinicola and Kumar, 1997). The modeling framework also includes international factors such as the exchange rate, transportation cost and import taxes. The modeling framework is carried out for IEs that have operations in two countries. More specifically we address the question: Given a specific competitive environment characterized by a given number of competitors that can adopt any of the MM options presented in this paper, which MM option should an IE adopt to obtain maximum profits?

Table 1 presents ten MM options that an IE can adopt. Under the first two options, termed *core product options*, the IE manufactures a "core product" in one of the two countries. In the first core product option, the facility in this country performs additional operations on the core product to develop custom-tailored products that meet the needs of the local and foreign markets. The final products are also shipped to the other country. Under the second core product option, the core product is shipped to the production facility in the second country to be customized. Customization of the core product can be additional machining, assembly processes, or simple attachment of components. The other eight options are characterized by the following three dimensions: (1) the IE offers a standardized or a customized product design; (2) the IE customizes its pricing policy or uses a uniform pricing policy; (3) the IE centralizes its production to a single facility in one country or decentralizes its production to facilities located in each country. The two MM options that deal with centralized or decentralized production and customized products that are sold at uniform prices are not considered as feasible. This is justified by the fact that customized products have different features leading to different production costs and eventually different pricing policies.

Table 1 Options for international enterprises defined by manufacturing, marketing, and product architecture elements

Manufacturing-marketing Options	Product	Price	Manufacturing
1	Core product-customized finished products	Customized	Centralized production of core product-centralized customization of finished products
2	Core product-customized finished products	Customized	Centralized production of core product-decentralized customization of finished products
3	Customized finished products	Customized	Decentralized production of finished products
4	Customized finished products	Customized	Centralized production of finished products
5	Standardized finished products	Customized	Centralized production of finished product
6	Standardized finished product	Customized	Decentralized production of finished product
7	Standardized finished product	Standardized	Centralized production of finished product
8	Standardized finished product	Standardized	Decentralized production of finished product
9 (not valid)	Customized finished products	Standardized	Decentralized production of finished products
10 (not valid)	Customized finished products	Standardized	Centralized production of finished products

2. Supply Chain Structures for International Enterprises

Details on the modelling aspect of the paper can be obtained from Hadjinicola and Kumar (2002).

2.1 Centralized Production of Core Product-Centralized Customization (Core-Centr)

Under the core-product approach, a uniform "central" product is designed that can accept a number of standard attachments, parts or components. The combination of attachments to the core product allows it to meet performance criteria and preferences of local consumers. Adaptations on the core product can vary from simple assembly operations to more complex machining operations. The core product is usually centrally produced in order to exploit savings from economies of scale. Additional operations on the core product may be performed in the same facility that the core product is produced, or in production/distribution facilities located in foreign markets. The core product is also referred to as platform product in the automobile industry (Robertson and Ulrich, 1998) or as a generic product in the electronics industry (Lee et al. 1993).

2.2 Centralized Production of Core Product-Decentralized Customization (Core-Decentr)

Under the *Core-Decentr* option, the core product is produced in country 1. The facility in country 1 is further responsible for adapting the core product into a customized product that meets the needs of consumers in country 1. In addition, the core product is shipped to the production facility of country 2 which adapts the core product into a customized product that meets the needs of consumers in this country. This option is adopted by HP for its Deskjets (Lee et al., 1993)

2.3 Decentralized Production-Customized Product-Customized Prices (Decentr-Cust-Cust)

The subsidiaries of an IE adopting this option are solely responsible for the production and development of the marketing programs for the country they serve. As such, products are customized to the needs of local consumers and their production takes place in facilities located in each country. Prices in each country are customized and are dependent on the product features and the income of the consumers in each country. This option is synonymous to a multinational corporation which follows a decentralized policy where local subsidiaries are given the autonomy to design and produce their own products as well as determine their pricing policies (Bartlett and Ghoshal, 1989).

2.4 Centralized Production-Customized Product-Customized Prices (Centr-Cust-Cust)

Under this option, the IE manufactures customized products for both countries it serves in a central facility located in country 1. The product targeted for country 2 is shipped from the facility in country 1 to country 2. The IE also follows a price customization policy.

2.5 Centralized Production-Standardized Product-Customized Prices (Centr-Stand-Cust)

Under the *Centr-Stand-Cust* option, the IE offers a standardized product across the two countries. The standardized product is produced in a facility located in country 1 and then shipped to country 2. This option requires centralized decision-making since the IE needs to design and produce a product with such features that yield the maximum total profits. Centralized decision making may be viewed as a measure of coordination and tighter control. Prices of the standardized product are customized for each country.

2.6 Decentralized Production-Standardized Product-Customized Prices (Decentr-Stand-Cust)

Under this option the IE offers a standardized product to the consumers of the two countries. The standardized product is manufactured in production facilities located in both countries. As a result, each production facility supplies the local market it serves with the standardized product. Prices of the standardized product are customized for each country.

2.7 Centralized Production-Standardized Product-Standardized Prices (Centr-Stand-Stand)

One of the issues that arise in cases where the IE offers a standardized product is the standardization of prices across countries. Standardization of prices in the case where the IE offers dissimilar products across countries is not pursued since differences in product features result in differences in production costs and eventually prices. The *Centr-Stand-Cust* option, previously described, can adopt the standardized pricing policy.

2.8 Decentralized Production-Standardized Product-Standardized Prices (Decentr-Stand-Stand)

An IE which adopts the *Decentr-Stand-Cust* option may also employ a standardized pricing policy. Examples of companies following this option are companies dealing with commodities. Oil and cement companies are classic examples since their product is fairly standardized, with the prohibitive transportation cost forcing the companies to locate facilities around the globe.

3. Analysis and Discussion

Proposition 1 *The following hold true for the profit Π of any IE:*

(1) $\Pi^{\text{Core-Decentr}} \geq \Pi^{\text{Centr-Stand-Cust}} \geq \Pi^{\text{Centr-Stand-Stand}}$,

(2.1) $\Pi^{\text{Core-Decentr}} \geq \Pi^{\text{Decentr- Cust-Cust}}$, under certain conditions,

(2.2) $\Pi^{\text{Decentr- Cust- Cust}} \geq \Pi^{\text{Decentr- Stand-Cust}} \geq \Pi^{\text{Decentr- Stand- Stand}}$,

(3) $\Pi^{\text{Core-Centr}} \geq \Pi^{\text{Centr- Cust – Cust}}$, under certain conditions.

Proof of Proposition 1: Can be obtained from authors.

From parts (1) and (2.2) of Proposition 1, we see that $\Pi^{\text{Centr-Stand-Cust}} \geq \Pi^{\text{Centr-Stand-Stand}}$ and $\Pi^{\text{Decentr- Stand-Cust}} \geq \Pi^{\text{Decentr- Stand- Stand}}$. This shows that if an IE adopts the option of uniform pricing its standardized product, regardless of its production configuration, it would generate equal or less profits than when customizing the price of the standardized product across the two countries. The intuitive reason for this phenomenon is that price customisation enables the IE to exploit differences in the reservation prices and price sensitivity of consumers across countries. As such, the IE increases its profitability by exploiting local consumers' buying capability to the maximum possible degree.

From part (2.2) of the proposition we also see that $\Pi^{\text{Decentr- Cust- Cust}} \geq \Pi^{\text{Decentr- Stand-Cust}}$.The explanation for this result lies in two facts. First, decentralized production of a standardized product does not yield the maximum cost savings from economies of scale. Second, customized products, in any type of production environment, enhance the propensity of consumers to purchase the product, which further results in improved revenues. As a result, under the *Decentr-Cust-Cust*, the IE produces customized products in facilities located in the two countries. If the benefits derived from the improved sales of the customized products do not exceed the costs of customization, then the IE will be forced to decentrally produce a standardized product, thus adopting the *Decentr-Stand-Cust*

option. Note that the above comparison of the two options does not take into consideration the costs of designing the products. For example, options offering a standardized product may benefit from economies of design and thus allow for lower product prices. On the other hand, options offering customized products may be burdened by the cost of designing more products and the amortization of such cost may result in higher product prices.

Part (1) of the proposition shows that $\Pi^{\text{Core-Decentr}} \geq \Pi^{\text{Centr-Stand-Cust}}$. The key to understanding why the *Core-Decentr* option may yield equal or more profits than the *Centr-Stand-Cust* option, is the fact that the *Centr-Stand-Cust* option can be seen as a special case of the *Core-Decentr* option. We know that the core product's attribute levels are less than or equal to those of the customized products offered in the two countries. At the extreme case, the core product can be the product offered in one of the countries. Assume, without the loss of generality, that the core product is the same as the product offered in country 1, the country where it is manufactured. Then, this core product is shipped to country 2 to be custom-tailored. If the benefits derived from customizing the product in country 2 are less than the cost of customization, then the optimal product policy is to market the core product itself in country 2 which is equivalent to the *Centr-Stand-Cust* option. In other words, the minimum profits that the *Core-Decentr* option can generate are those of the *Centr-Stand-Cust* option.

From part (3) of the proposition we see that $\Pi^{\text{Core-Centr}} \geq \Pi^{\text{Centr- Cust – Cust}}$. The intuition behind this result lies in the fact that the differentiating factor among the two options is the production of the core product since both options offer customized products at customized prices. Both options customize their products in country 1 and subsequently, the customized product for country 2 is shipped to this country from country 1. Now, under the *Core-Centr* option, if the benefits derived from the production of the core product are not significant enough due to high production costs, the IE will not produce the core product but it will simply produce centrally the two customized products. This of course is equivalent to adopting the *Centr-Cust-Cust* option.

Part (2.1) shows that $\Pi^{\text{Core-Decentr}} \geq \Pi^{\text{Decentr- Cust-Cust}}$ under certain production-related conditions. The intuition behind this result is that at the extreme case, the *Core-Decentr* option will not ship from country 1 to country 2 any form of core product for further customization, i.e., the core product is vacuous. This may occur in environments where the savings derived from the centralized production of the core product are not sufficient to compensate for high transportation costs and import taxes of the core product. In this case, the subsidiary in country 2 will have to produce the customized product for country 2 from scratch since there is no core product. This is equivalent to the *Decentr-Cust-Cust* option. In other words, the minimum profits that the *Core-Decentr* option can generate are those of the *Decentr-Cust-Cust* option.

The results of Proposition 1 have significant implications on the choice of MM options adopted by an IE. The proposition for example, indicates that, under certain production-related conditions, two of the eight MM options considered generate higher or equal profits than the other six options, regardless of the number and nature of competitors. If the conditions are not met, the proposition indicates that the IE will have to structure itself in accordance to one of the following four options: *Core-Centr, Core-Decentr, Decentr-Cust-Cust, Centr-Cust-Cust*. Note that the above four "dominant" options deal with customized product and pricing policies. The choice will depend on the profitability comparison of the above four options in the specific environment that the IE operates.

In the analysis presented in this paper, we have assumed that the transportation cost and import taxes are the same whether the IE exports the core product or finished products. This may not be true since governments provide incentives to IEs to manufacture their products locally by reducing import taxes on raw materials and semi-finished goods. As a result, in such environments, the core product strategies may yield higher profits. In addition, the issue of the cost of product development is critical for an IE's profitability and must be taken into consideration when adopting an option. For example, customized product policies may require higher research and development costs than standardized product policies.

4. Conclusion

Companies with operations in more than one country, termed International Enterprises, have to make a number of decisions concerning their manufacturing and marketing functions. In this paper, we have considered a number of these factors in a single model in order to examine the profitability of eight options an international enterprise can adopt. The analysis is performed in a competitive environment for a two-country scenario. We identify the options that if adopted by IEs will result to higher profitability. In summary, options that adopt core or platform products as well as options adopting customized products lead to higher profitability.

References

Bartlett, C.A., Ghoshal, S. (1989), *Managing Across Borders: The Transnational Solution*, Harvard Business School Press, Boston.

Douglas, S.P., Wind, Y. (1987), "The myth of globalization," *Columbia Journal of World Business*, 22(4), 19-29.

Hadjinicola, G.C., Kumar, K.R. (1997), "Factors affecting international product design," *Journal of the Operational Research Society*, 48(11), 1131-1143.

Hadjinicola, G.C., Kumar, K.R., (2002), "Modelling manufacturing and marketing options in international operations," *International Journal of Production Economics*, 75, 287-304.

Kumar, K.R., Hadjinicola, G.C. (2000), "Product design for global markets," *Encyclopedia of Production and Manufacturing Management*, P. Swamidass (Ed.), Kluwer Academic Publishers, Boston, 559-563.

Lee, H.L. Billington, C., Carter, B. (1993), "Hewlett-Packard gains control of inventory and service through design for localization," *Interfaces*, 23(4), 1-11.

Levitt, T. (1983), "The globalization of markets," *Harvard Business Review*, 61(3), 92-102.

Porter, M.E. (1990), *The Competitive Advantage of Nations*, The Free Press, New York.
Yip, G.S. (1989), "Global strategy...in a world of nations?" *Sloan Management Review,* 31(1), 29-41.