Economic Modelling 33 (2013) 398–406

Contents lists available at SciVerse ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

An optimal production method for penetrating foreign markets: Standardization, localization, and flexible technology

Chul-Woo Kwon *

Kyungpook National University, 1370 Sankyuk-dong, Buk-gu, Daegu 702-701, Republic of Korea

ARTICLE INFO

Article history:
Accepted 17 April 2013

JEL classification:
F10
F12
F19

Keywords:
Flexible technology
Taste difference
Standardization
Localization

ABSTRACT

This paper examines firms' production strategies for supplying products tailored to the target country's local taste: developing a new localized variety and modifying an existing variety to fit the local taste. Adopting the concept of the flexible technology in industrial organization theory, the paper develops a simple theoretical model to examine when and why exporters or multinationals adopt flexible technologies to serve multiple markets. The results suggest that firms with basic varieties that are considerably different from the variety demanded by the local country are likely to develop localized varieties to serve the country, whereas those with basic varieties that are considerably similar to the demanded variety are likely to modify their existing varieties. In some circumstances, even when foreign production has an intrinsic cost advantage over exporting before the application of a flexible technology, firms may choose to be exporters by adopting the technology. In addition, the results indicate a possible industry equilibrium: Firms with basic varieties that are considerably similar to the variety demanded by the local country are likely to modify them and become multinationals, whereas those with basic varieties that are considerably different from the demanded variety are likely to develop new localized products and become multinationals. Otherwise, firms are likely to modify their existing platforms and become exporters.

1. Introduction

Since the seminal work of Krugman (1980), theoretical progress in international trade has relied mainly on product differentiation and the taste of variety. Existing trade theories incorporate differentiated products into monopolistic competition and successfully explain intra-industry trade. However, noteworthy is that, despite the general use of product differentiation and product varieties, no study has provided a systemic analysis of technologies for developing and producing differentiated varieties in international trade. In addition, although a country's demand for product varieties is driven by local consumers' specific taste as well as their preference for the love of variety,[1] most trade theories based on product differentiation ignore the difference in the taste between countries.

Because consumers' tastes vary across countries, many multinationals and exporters supply differentiated products that are tailored to local tastes. For examples, Microsoft offers its software products in various languages, and Samsung's mobile phones have different specifications and functions across countries. Many multinationals in China add Chinese herbs to their products to fit local taste in China.[2] In addition, there are two major strategies for producing products that satisfy the local taste: producing newly developed localized products and producing a variant of existing products that is modified to fit the local taste. Honda, a Japanese automaker, sells different versions of Accord in North America and Japan. The two versions are basically the same, but their shapes and specifications are slightly different. However, Nissan's Altima, one of the best-selling cars in North America, is unique to that market. That is, no equivalent model is sold in Japan. For another example, McDonald's makes several variants of Big Mac or country-specific menu to fit country-specific tastes.[3] According to a survey of foreign affiliates in the manufacturing sector in Korea conducted by the Korea Institute for Industrial Economics and Trade (KIET), 63.3% of the foreign affiliates produced standardized but locally modifiable products; 22.8% produced fully localized products tailed to the Korean market; and 8% produced standardized products (Kang et al., 2004, Table 1). These results are consistent with those of KIET's (2008) survey of Korean multinationals in the manufacturing sector: 54.9% of Korean multinationals produced standardized but locally modifiable products; 25.4% produced fully localized products; and 19.7% produced standardized products (Table 1).

Therefore, modifiable products and related technologies are widely observed in the real economy, but they have received little attention from international economists. However, they have received some

* Tel.: +82 53 950 7428; fax: +82 53 950 5407.
E-mail address: cwkwon@knu.ac.kr.

[1] Lancaster (1979, 1990).

[2] Beijing Review, No. 11.

[3] In India, Big Mac is renamed Maharaja Mac and is made with lamb instead of beef. Apart from selling international McDonald's product, McDonald's sells various vegetarian products for the Indian market.

0264-9993/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.econmod.2013.04.036

Table 1
Types of products produced by Korean and foreign multinationals.

	Standardized	Standardized but locally modifiable	Localized
Korean multinationals (2004)[a]	19.7	54.9	25.4
Foreign multinationals (2008)[b]	13.9	63.3	22.8

"Foreign Direct Investment from Korea in Manufacturing Industry 2004," D. Y. Kang, S. Y. Lee, W. B. Lee, S. H. Ahn, *KIET Issue Paper 2004-162*, 2004.
"Foreign Direct Investment into Korea in Manufacturing Industry 2008," KIET, *Policy Reference 2008-86*, 2008.
[a] Products supplied in foreign markets.
[b] Products supplied in the Korean market.

attention from industrial organization economists and are known as the *flexible technology* (Boyer and Moreaux, 1997; Chang, 1993, 1998; Eaton and Schmitt, 1994; Norman, 2002; Norman and Thisse, 1999). Although there is no widely accepted definition of the flexible technology, it generally refers to the technology used for producing multiple variants of products by modifying basic ones (in this paper, "platforms"). By adopting the flexible technology, firms with multiple products can reduce the cost of developing new ones and thus enjoy the benefit of *economies of scope*.[4] Because multinationals and exporters that supply products tailored to local tastes are essentially multi-product firms, they are motivated to adopt flexible technologies to pursue this benefit.

In this regard, the present paper develops a simple theoretical model to examine when and why exporters or multinationals adopt flexible technologies to serve multiple markets. In addition, the study employs the developed model to examine firms' choice between exporting and foreign production. The results suggest that firms may choose to be exporters by adopting a flexible technology even when foreign production has an intrinsic cost advantage over exporting before the application of the technology. In addition, the results indicate a possible industry equilibrium: Firms with platforms that are considerably similar to the variety demanded by the local country are likely to modify them and become multinationals, whereas those with platforms that are considerably different from the demanded variety are likely to develop new localized products and become multinationals. Otherwise, firms are likely to modify their existing platforms and become exporters.

The rest of this paper is organized as follows: Section 2 defines the flexible technology and develops a theoretical model for analyzing firms' choice of production strategies. Section 3 discusses an optimal production method for firms and the possible industry equilibrium in a monopolistically competitive industry, and Section 4 concludes with a summary of results.

2. Model

2.1. Demand and technology

Assume that a representative consumer in country M has a standard CES utility function over varieties of differentiated products in the Θ sector. In particular, the demand function for a variety indexed by θ_j^M in the Θ sector in country M in a given period takes the following standard CES form:

$$y_i = A \cdot p^{-\varepsilon}, \varepsilon > 1, \quad \text{if} \quad \theta_j^M \in \Theta_M, \tag{1}$$

where Θ_M is a set of demanded varieties in sector Θ in country M and $A > 0$. Differentiated products can be supplied by either domestic or foreign firms located in countries other than M. Assume that consumers' tastes are country-specific and that demanded varieties in M differ from those in other countries. That is, $\Theta_{i \in C} \cap \Theta_M = \varnothing, i \neq M$, where Θ_i is a set of demanded varieties in country i and C is a set of countries.

Assume that firms can adopt flexible technologies to exploit economies of scope. In particular, following the notion of the flexible technology introduced by MacLeod et al. (1988) and Eaton and Schmitt (1994), suppose that if a firm decides to adopt a flexible technology, then the firm first develops a (standardized) platform and then produces different varieties to serve multiple markets by modifying the costly the platform costly.[5] Here the platform is the final or half-finished product that is modifiable.[6] Formally,

Definition 1.

1. A flexible technology is a function $g(\omega_i)$ such that $g : \omega_i \rightarrow \theta_j$ for $\forall\ \omega_i \in \Omega, \forall\ \theta_j \in \Theta$, and $\omega_i \neq \theta_j$, where Ω and Θ are sets of modifiable and final products, respectively.
2. ω_i is the platform.

That is, a flexible technology is a technology that can transform a modifiable final or half-finished product into a (different) final product. A platform is the final or half-finished product before the application of the flexible technology. Assume that the modification process incurs some additional cost: the additional fixed modification cost of developing a variant or switch the production process from a platform to a final variant and the per-unit modification cost that depends on the difference between the platform and the final variant (Eaton and Schmitt, 1994). Assume that the total cost of producing n different variants from a platform is given by the following expression:

$$\begin{cases} fr_i + n \cdot fm_i + \sum_{j=1}^{n} q_i^j \cdot h\left(mc_0, \theta_i^j; \omega_i\right) & \text{if the platform is a half} - \text{finished product} \\ fr_i + (n-1) fm_i + \sum_{j=1}^{n} q_i^j \cdot h\left(mc_0, \theta_i^j; \omega_i\right) & \text{if the platform is a final product} \end{cases}.$$

The fixed cost fr_i is the R&D cost of developing a platform, and the additional fixed cost fm_i is for developing a variant or switching the process from a platform to a final variant. In addition, q_i^j is the quantity of variant θ_i^j. Note that the necessary condition for economies of scope for the flexible technology is $fr_i > fm_i$. For analytic simplicity, assume that $fr_i > fm_i = 0$. Finally, $h(\cdot)$ is the per-unit production cost (i.e. marginal cost) of producing a final variant and consists of the marginal cost mc_0 of producing a platform and the per-unit modification cost of switching from platform ω_i to final variant θ_i^j. Throughout this paper, consider the following specific marginal cost of producing a variant:

$$h\left(mc_0, \eta^{ij}\right) = \frac{mc_0}{\eta^{ij}}, \tag{2}$$

where $\eta^{ij} \in [0,1]$ is the measurement of the *attribute similarity* between platform ω_i and final variant θ_i^j.[7] Clearly, $\partial\, h(\cdot)/\partial\, mc_0 > 0$, $\partial\, h(\cdot)/\partial\, \eta^{ij} > 0$, and $\partial\, ^2h(\cdot)/(\partial\, \eta^{ij})^2 > 0$. Here the higher the η^{ij}, the greater the similarity between the final variant and the platform. Therefore,

[4] "The essence of flexible manufacturing (technology) is economies of scope in the production of differentiated products" (Eaton and Schmitt, 1994).

[5] Here the flexible technology refers to that in Eaton and Schmitt (1994), who define a flexible technology as a technology that firms can use to produce many final variants from basic products at some cost and employ it to examine firms' entry, preemption, and merger strategies in markets with evenly distributed consumer preferences. Their basic product is identical to the present paper's platform. Norman and Thisse (1999) use the Eaton–Schmitt model to analyze entry and preemption strategies by allowing for a flexible technology. Norman (2002) adopts the Eaton–Schmitt model to discuss firms' choice of the level of the flexible technology and the location of base products in various submarkets. In addition, some economists refer to flexible technologies as platform technologies (Muffatto, 1999).

[6] For example, if an automaker decides to share a car body and an engine in more than two variants of cars, then the platform consists of the car body and the engine.

[7] Eaton and Schmitt (1994) use the following linear cost structure: $fr_i + (n-1)fm_i + \sum_{j=1}^{n} q_i^j \left(mc_0 + r\left|\theta_i - \theta_i^j\right|\right)$, where r is a nonnegative parameter.