



# Product quality, incomplete contract and the product cycle<sup>☆</sup>



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## ARTICLE INFO

### JEL classification:

F12  
D23  
F23  
L22  
L33

### Keywords:

Product cycle  
Product quality  
Incomplete contract  
Firm boundaries  
Outsourcing

## ABSTRACT

According to the traditional theory of product cycle, firms in the North usually produce goods by themselves when the goods are relatively new, but later move production to the South after they become mature. But why do some firms choose intrafirm production transfer before arm's length transfer, while others choose to skip the stage of intrafirm transfer and go straight to arm's length transfer? By introducing product quality into the incomplete-contract framework of the product cycle, we show that more capable firms choose high-quality intermediate inputs, produce high-quality products, and choose intrafirm transfer before arm's length. Conversely, less capable firms choose the latter in the product cycle.

## 1. Introduction

In the spirit of Vernon's (1966) original notion of product cycles, Antràs (2005) provides an intriguing incomplete-contract framework that generates both endogenous organization and the product cycle with two equilibrium paths. In the first path, the production transfer to the South first takes place within the boundaries of the Northern firm (i.e. in a wholly/jointly owned foreign affiliate) and then later at arm's length (i.e. subcontracting to an independent supplier). In the second equilibrium path, the production transfer to the South goes straight to an arm's length arrangement without passing through the multinational stage.

These two patterns are observed in the product cycles of many firms in developed countries. According to Kotabe, Mol and Ketkar (2008), in the consumer electronics (CE) industry, most CE products of SONY follow the first equilibrium path. Specifically, in the early stage of the product cycle, SONY usually produces a CE product in Japan but later sets up a manufacturing subsidiary (or moves the production to an existing SONY subsidiary) in a low-wage country, followed by outsourcing to an independent manufacturer. Most CE products of Emerson, however, have followed the second equilibrium path: in the early stage of the product cycle Emerson usually produces a CE product in the U.S. but later goes straight to outsourcing to an independent manufacturer in a low-wage country. SONY

<sup>☆</sup> We are grateful to Bilgehan Karabay, Hong Ma and Zhihong Yu for the helpful comments. Thanks are also extended to the participants at the annual meetings of the Asian Pacific Trade Seminars (APTS), Australasian Trade Workshop (ATW) and the International Economics and Finance Society - China (IEFS-China). Huanlang He acknowledges financial support from the National Nature Sciences Foundation of China (No. 71403164).

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company, until very recently, was considered as one of the most innovative companies in the world (Burkitt, 2010). According to Steve Lohr (1983), “[Sony] was also a symbol - to Americans in particular - of the strengths of Japanese industry: Its ability to make high-quality, ingenious, affordable products, and, by inference, the weaknesses of many companies in the United States, which in recent years have been unable to do the same.” Why did some firms (e.g. SONY) follow the first equilibrium path in their product cycle whereas others followed the second?<sup>3</sup> How does product quality affect firm's decision in choosing one particular equilibrium path over the other in the product cycle? The purpose of this paper is to provide a simple analysis to shed light on these questions.

In this paper, we introduce product quality into the incomplete-contract framework of firm boundaries and the product cycle of Antràs (2005) for our analysis. To discuss product quality, it is important to analyze firm's optimal choice of product quality, which crucially depends on the specification for the determination of quality (or quality-cost specification). We follow the specification in Kugler and Verhoogen (2012), in which product quality is determined by both the quality of intermediate inputs and firm's capability. Since Kugler and Verhoogen (2012)'s specification has a nice property of complementarity between firm capability and input quality, we show that more capable firms will choose high-quality intermediate inputs and produce high-quality final goods. Furthermore, more capable firms that produce high-quality products will follow the first equilibrium path in the product cycle (i.e. intrafirm production transfer will take place before the arm's length transfer). Conversely, less capable firms will choose relatively low-quality intermediate inputs, produce relatively low-quality final goods, and only arm's length production transfer will take place in the product cycle. The result we obtain in this analysis provides an important cross-sectional implication and testable hypothesis. It predicts that the probability of a particular production transfer occurring within firm boundaries (i.e. intrafirm transfer) should be increasing in the firm's product quality at the time of transfer. This product quality should in turn be positively correlated with the firm's capability.

Product quality has been central to the “quality ladders” model of product cycle, where the product cycles occur mainly due to South's imitation (e.g. Grossman & Helpman, 1991; Yang and Maskus, 2001; Glass and Saggi, 2002). Empirical support of the quality ladders model has been found by many studies. For example, Feenstra and Rose (2000) find that developed countries export products to the U.S. earlier than to developing countries. Xiang (2007) also finds the evidence that the North's new products export to the US first. Subsequent studies have also focused on the North's initiatives in production transfer through licensing/outsourcing (e.g. Lu, 2007; Ma, 2015). For example, linking the South's market size to product quality in the dynamic product-cycle model, Ma (2015) demonstrates an endogenous quality upgrading just before the shift of production to the South. The most recent development in the theory of product cycle, however, focuses on firm boundaries (i.e. choice of different organizations under the incomplete contract) and the standardization process in the life cycle of goods production (Antràs, 2005). The contribution of this current paper is to introduce product quality into the incomplete-contract framework of firm boundaries and the product cycle (Antràs, 2005), and to shed light on why firms follow different equilibrium paths of organizational forms in the product cycle.<sup>4</sup>

The rest of the paper is organized as follows. Section 2 derives the equilibrium for each of the three organizational forms, with both exogenous and endogenous choice of product quality. Section 3 discusses the results of endogenous firm organizations for the two different equilibrium paths in the product cycle. Section 4 provides concluding remarks.

## 2. Product quality and firm capability

To formally discuss product quality, we need to specify consumption preference for high-quality goods and production cost of high-quality products. Suppose a representative consumer has the following utility function:

$$U = y_0 + \left[ \int_0^1 [q(i)y_q(i)]^\alpha di \right]^{\frac{1}{\alpha}}, \quad 0 < \alpha < 1 \tag{1}$$

where  $y_0$  is consumption of a homogeneous good and the second part of (1) is aggregate consumption of a continuum of differentiated products,  $y_q(i)$ ,  $i \in [0, 1]$ . Parameter  $q(i)$  is the strength of the representative consumer's taste for product/variety  $i$  (or product  $i$ 's quality index) in the constant-elasticity-of-substitution preference, and parameter  $\alpha$  is equal to  $(\sigma - 1)/\sigma$  with  $\sigma$  as the elasticity of substitution between any varieties.

The demand for firm  $i$ 's product, corresponding to (1), has the following isoelastic function:

$$y_q(i) = \lambda [q(i)]^{\alpha/(1-\alpha)} [p_q(i)]^{-1/(1-\alpha)} \tag{2}$$

where  $\lambda = \left[ \int_0^1 [q(i)y(i)]^\alpha di \right]^{\frac{1}{\alpha}}$  is taken as given by an individual firm. Following Antràs (2005), we focus on a Northern firm's decision in a *partial* equilibrium framework. Therefore, we drop index  $i$  and the demand facing the producer of good  $y$  becomes:

$$y_q = \lambda q^{\alpha/(1-\alpha)} [p_q]^{-1/(1-\alpha)}, \quad 0 < \alpha < 1 \tag{3}$$

Similar to Antràs (2005), we also assume that only firms in the North know how to produce the final good. Production of final good  $y$  takes place in the North and is given by the following Cobb-Douglas function:

<sup>3</sup> Although Antràs (2005) provides a mathematical condition that separates the two equilibrium paths, it is not discussed what scenarios could lead to the choice of one equilibrium path over the other.

<sup>4</sup> Although the “headquarter intensity” in Antràs (2005) could be an indication of product quality (e.g. Manova & Zhang, 2012; Verhoogen, 2008), the latter is determined by other important factors as well (e.g. choices of intermediate inputs, etc.). The purpose of this paper is to provide a formal analysis.

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