



## Global outsourcing or foreign direct investment: Why apple chose outsourcing for the iPod

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### ABSTRACT

A simple model is presented, where a firm's productivity is endogenized by its R&D investment. It shows that the most productive firms may prefer international outsourcing to foreign direct investment (FDI) in industries with a high innovation share. The high innovation share motivates the firms to economize on organizational cost in order to save resources for R&D investment, making outsourcing preferable to FDI because the former incurs a smaller organizational cost. This model helps explain why Apple Inc., belonging to the electronics industry, which has a particularly high innovation share, launched its innovative iPod through international outsourcing instead of FDI.

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### 1. Introduction

Helpman et al. (2004) argued that the most productive firms prefer foreign direct investment (FDI) to arms-length trade when faced with a proximity-concentration trade-off. Through empirical studies, Head and Ries (2003) examined the case of Japan, Girma et al. (2005) examined the case of the United Kingdom, and Wagner (2007) examined the case of Germany, with all in arguments that the most productive firms prefer FDI over exports. This assertion also gains theoretical support from Antràs and Helpman (2004), who applied an incomplete contract model to demonstrate that most productive firms prefer FDI and less-productive firms prefer international outsourcing. While Helpman et al. (2004) assume positive transportation costs and firms therefore face the choice of whether or not to export, transportation costs are assumed to be absent in the Antràs–Helpman's (2004) model. Instead, Antràs and Helpman (2004) apply an incomplete contract distortion to address the difference between FDI and international outsourcing strategies. In all, both approaches assert that the most productive firms prefer to FDI.

However, some of the world's most productive firms, especially in the electronics industry (e.g., Apple, Microsoft, Nokia, Hewlett-Packard)<sup>1</sup> carry out international outsourcing intensively and operate almost no FDI activities in launching their innovative products (e.g., iPod, game consoles, cell phones and notebook computers, respectively). For example, in October 2001, Apple first marketed the iPod, which was a “disruptive innovation” with a set of innovative functions (Clayton and Raynor, 2003). Being the most revolutionary portable media player in history, and in the six years after its launch, Apple sold over 100 million iPods worldwide (see Apple's “The Best Going On” conference). The success of iPod over competing music players came from radical innovations in its user-friendly interface and smooth integration with Mac and Windows through which users could easily purchase and download music/video content. Apple designed the majority of the system architecture of the iPod in-house but simultaneously outsourced the remaining four hundred-plus intermediate components to both domestic and international contractors.<sup>2</sup> Apple even contracted out

<sup>1</sup> *BusinessWeek* magazine and the Boston Consulting Group's ranking of “The World's Most Innovative Companies” in 2006 gave Apple Computer Inc. the top rank, Microsoft the fifth, Nokia the eighth, Sony the thirteenth, and Hewlett Packard the forty-second.

<sup>2</sup> A few high cost components were made by other companies, such as Japan's Toshiba (hard drive for on board storage), Korea's Samsung (flash memory for temporary storage), and U.S.-based Broadcom (integrated video processor for media playback) (Linden et al., 2007).

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its core software; for example, the user interface was designed with the help of Pixo, and the reference platform was designed by PortalPlayer (Kahney, 2006). Of the \$299 retail price for the 30GB video iPod, Apple accounted for a 25 percent share of the value for the core software design, while 36 percent is attributed to contracted manufacturers in the low-wage Asia-Pacific region that provide generic components and direct labor (Linden et al., 2007).<sup>3</sup> Examples of the generic components and direct labor include the metal casing, provided by Taiwan's Foxconn, and assembly, completed in Chinese factories owned by Taiwanese firms such as Inventee Appliances and Foxconn (Einhorn, 2007). The pattern of global outsourcing also occurs with other electronics products, such as Hewlett-Packard's notebook computers, with 39 percent of the value of a notebook computer attributable to generic inputs and direct labor.

In contrast to the outsourcing literature (e.g., Antràs and Helpman, 2004; Antràs, 2005), which has argued that the most productive firms prefer FDI to international outsourcing especially when the product is at the innovative stage, both Apple and HP have worked closely with outside partners from the beginnings of design. This approach has been dramatically undertaken by the lead firms in the electronics industry (Sturgeon, 2002).

Why is then international outsourcing prevailing for the lead firms (i.e., most productive firms) in the electronics industries? The literature of global value chain provides an explanation: it is the advances in information technology (IT) enabling the electronics industry to more easily standardize the interfaces between components, such that the component modularization has made international outsourcing more attractive by allowing multiple firms to share the same generic components at a lower cost due to economies of scale (Sturgeon and Lee, 2001; Sturgeon, 2002).<sup>4</sup> However, a shortcoming of the product modularization hypothesis is that the lead firms in the electronics industry (e.g., Apple computer and Hewlett-Packard) have contracted out not only generic but also non-generic components.

Another key factor facilitating the growth of international outsourcing in the product modularization hypothesis is the lead firms' desire to reduce fixed organization investment, especially in manufacturing facilities (Sturgeon and Lee, 2001). I borrow this concept in this paper, and argue that the prevailing dependence on global outsourcing in the electronics industry is largely due to Northern firms' leveraging the mass production capacity of those in the South. For example, Flextronics,<sup>5</sup> a contract electronics maker headquartered in Singapore, worked with Microsoft in the initial stage of developing its innovative game console, Xbox, by building customized (as opposed to generic) mechanical parts and performing system tests. More importantly was Flextronics' capacity to ramp up production from zero to 100,000 consoles per week in less than five weeks. Production capacity was important because "if the system [Xbox] could not be built cost effectively and ramp up in volumes, it would have little chance against the more established systems on the market" (Carbone, 2002). Therefore, the innovative Microsoft focused on R&D activities in order to develop a game system that was technologically superior to rival systems (e.g., Sony's PlayStation), and then outsourced the

low-tech components to these contract firms that specialized in mass production, thereby avoiding the substantial organizational costs of establishing a production capacity abroad through FDI.<sup>6</sup> With these specialized contract manufacturers around the world, the world's most productive and innovative firms, well known for their R&D capabilities, may prefer international outsourcing to FDI as a way to cut costs and improve general productivity when launching their innovative products because FDI incurs a larger fixed organization cost than international outsourcing.

The purpose of this study is to determine why the world's most productive and innovative firms may prefer international outsourcing to FDI. I incorporate Griliches' (1986) production function into Antràs–Helpman's (2004) model to argue that a Northern firm determines its global organizational structure based not only on a trade-off between low-waged production costs and incomplete contract distortion, but also on a trade-off between R&D investment and organizational cost. I argue that an increase in the innovation share augments the trade-off between R&D investment and organizational cost, which may take precedent over the trade-off between production costs and incomplete-contract distortion when the innovation share is sufficiently large. As it happens, in industries with a sufficiently high innovation share, the most productive firms tend to carry out international outsourcing activities rather than FDI because the high innovation share enhances the advantages of R&D investment. On the other hand, in industries with a relatively low innovation share, the most productive firms prefer FDI to outsourcing because outsourcing incurs a larger incomplete-contract distortion.

The remainder of this paper is organized as follows. In Section 2, I revisit Griliches' (1986) results by applying data from the Industrial R&D Investment Scoreboard reported by Eurostat to determine how the innovation share varies across industries. In Section 3, I add to Antràs–Helpman's (2004) model of Griliches' (1986) production function, in which firms' productivity is augmented by innovation, and I argue that this difference in the innovation share reshapes a firm's global organizational form. In particular, the ordering in Antràs–Helpman's (2004) model is reversed when an industry has a sufficient high innovation shares. Section 4 concludes.

## 2. R&D investment and productivity

It is well documented that research and development has a positive effect on productivity (e.g., Leonard, 1971; Mansfield, 1980; Griliches, 1980, 1986; Lichtenberg and Siegel, 1991; Medda et al., 2003).<sup>7</sup> Theoretically, Griliches (1986) defined an augmented Cobb Douglas production function with an input of R&D investment and illustrated that R&D contributes to productivity growth in U.S. manufacturing.<sup>8</sup> By using the National Science Foundation dataset on about 1000 of the largest U.S. manufacturing firms from 1957 through 1977, Griliches (1986) found that the innovation share, measured by the contribution of the R&D on

<sup>6</sup> In response to Microsoft's general production cost saving from outsourcing, Sony outsourced its PlayStation game console to Foxconn, a Taiwanese firm whose major production facilities are located in China.

<sup>7</sup> Empirically, Griliches (1980) has revealed a positive and robust relationship between R&D and total factor productivity for the United States, as did Medda et al. (2003) for Italy.

<sup>8</sup> The production function in Griliches' (1986) model is given by  $Y = A t^{\alpha} L^{1-\beta} C^{\beta}$  (see also Lichtenberg and Siegel, 1991), where  $L$  denotes labor and  $C$  denotes capital. Here,  $A$  denotes neutral technology stock that is accessible to all producers. R&D input  $I = \sum_{j=0}^{\infty} s_j K_{t-j}$  is a measure of the distributed lag effect of past research investments on productivity, where  $K_{t-j}$  measures the real gross investment in research in period  $i$ , and  $s_j$  connects the levels of past research to the current state of knowledge.

<sup>3</sup> Distribution and retails accounted for another 25 percent. Inputs from Japan accounted 9 percent, while inputs from Taiwan accounted for 1 percent.

<sup>4</sup> Nevertheless, the product modularization is also underway in many other sectors as well, such as apparel and footwear, toys, food processing, home furnishings and lighting, brewing, and automotive parts, pharmaceutical production, but not only been dramatic in the electronics industry (Sturgeon, 2002).

<sup>5</sup> Foxconn also manufactures iPods for Apple, cell phones for Nokia, and computers for Hewlett Packard, among others.

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