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Services' Firms: A Comparison with American Firms**

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**Profitability in Taiwan's Electronics Manufacturing Services' Firms:  
A Comparison with American Firms**

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**Abstract:** The outsourcing of product-related functions has recently become widespread and led to the rise of “Electronics Manufacturing Services (EMS)”. This business model is epitomized by a handful of huge, mainly North American, contract manufacturers such as Flextronics, Solectron, Sanmina-SCI, Celestica, and Jabil Circuit. Taiwanese subcontractors have also become indispensable strategic partners for major computer and IT companies, and recently developed global production networks to rival those of the American EMS business. This paper compares the performance of these two groups of EMS firms finding that Taiwanese firms have generally been more profitable in recent years. Higher profitability of Taiwanese companies is attributed to several factors including maintaining higher revenue growth, better performance in efficiency measures, and much more investment in R&D.

**Keywords:** electronics manufacturing services, electronics, Taiwanese firms, outsourcing, profitability, contract manufacturing

**JEL Categories:** L14, L23, L25, L63

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## 1. Introduction

Electronics Manufacturing Services (EMS) is a type of contract manufacturing business that started in the U.S. electronics industry. EMS firms focus on the provision of production-related services for other firms. EMS firms are thus similar to Japanese subcontractors but EMS firms generally retain more independence than Japanese subcontractors do. They have transactions with various customers and produce various types of products, but are typically good at high-volume assembly of standardized goods. They also purchase necessary parts and materials by themselves, establish global footholds, and have promoted the recent trend toward outsourcing among information technology (IT) and electronics companies in the United States. (Sturgeon 2002). Many of major EMS firms are based in North America (hereafter referred to as American EMS firms).<sup>1</sup>

Taiwanese firms have also become indispensable strategic partners for major global electronics companies in the production and supply of personal computers (PCs) and other IT products. The Taiwanese computer industry has developed mainly through the original equipment manufacture (OEM) system, which is a kind of subcontracting arrangement. The competitiveness of Taiwanese OEM firms originally came from flexible and low-cost operations, supported by extensive division of labor among local

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<sup>1</sup> Of course, there are many non-North American EMS firms which are not analyzed in this paper, for example, Elcoteq Network (Finland), Venture (Singapore), Finmek (Italy), Zollner Group (Germany), Nam Tai Electronics (Hong Kong), VOGT Electronic (Germany), Elite Industrial Group (Hong Kong), SIIX (Japan), VIDEOTON Holding (Hungary), WKK Technology (Hong Kong), Beyonics Technology (Singapore), and so on ([http://www.mfmkt.com/top\\_50.html](http://www.mfmkt.com/top_50.html)).

small and medium-sized enterprises (SMEs) located in the area from *Taipei* to *Hsinchu* (in Northwestern part of Taiwan). This can be viewed as Taiwan's computer cluster. However, in recent years, there has been irreversible trend toward establishing a global networks and scale-intensive manufacturing, similar to American EMS firms (Kishimoto 2004). Moreover, although Sturgeon and Lester (2002) argue that the rapid rise of American EMS firms presents an important challenge to East Asian OEM producers, recent data suggest that American EMS firms have experienced low profits since 2001, while the major Taiwanese EMS firms have generally earned relatively high profits. This paper's main purpose is thus to document the trends in the profitability of Taiwanese EMS firms in comparison to their American counterparts and to analyze some of the factors underlying the trends observed. Although there are several studies examining EMS firms in general (e.g. Sturgeon 2002, Inagaki 2001, Noguchi 2003) and/or Taiwan's OEM business in the computer and IT industries (e.g. Chen and Ku 2002, Ernst 1998 and 2000, Kawakami 1996 and 1998, Kim and von Tunzelmann 1998, Kishimoto 2003), most of these studies do not focus on profitability and related factors. Because firms are typically assumed to maximize profits, a focus on profitability is clearly an important one and this study tries to take a small step toward filling the gap in the literature in this respect.

The analysis focuses on a firm-level sample of major Taiwanese and American EMS firms, beginning with an overview of the development of American and Taiwanese EMS

business in Section 2. Section 3 then compares the performance of these firms more rigorously, focusing on differences in their profitability and factors affecting it. The final section then summarizes the main findings and offers concluding remarks.

## **2. Historical Background and the Related Literature**

In the following two subsections, the development paths of American and Taiwanese EMS businesses are summarized and a preliminary comparison is provided in the third subsection.

### **2.1. The Evolution of North American EMS Business**

In the United States, the outsourcing business began more than thirty years ago. It was primarily labor-intensive subcontracting, in which contract manufacturers manually assembled electronic circuit boards with necessary electronic parts consigned by customers. In the 1980s, subcontractors began to undertake more complicated processing tasks utilizing automated equipment such as surface mount technology (SMT) machines. They also began to undertake the purchase of necessary parts and/or materials for customers. In the 1990s, their services expanded to include the design of electronic circuit boards and the assembly and testing of final products. In the mid-1990s several large EMS firms also began to establish global networks to support major electronics companies with their own brand names. Recently, major EMS firms

have begun to provide comprehensive services' packages, including design support, trial manufacturing, shipment to end-users, as well as after-sales and call-center services. Customers are thus able to concentrate their resources on the core activities such as basic product planning, R&D, and marketing (Inagaki 2001, Noguchi 2003).

The outsourcing of electronic circuit-board and product assembly in the electronics industry, especially the computer and networking sectors, became popular in the late 1980s. Thereafter it has been promoted by established American electronics firms such as IBM, Nortel, Apple Computer, 3 Com, Hewlett-Packard (HP) and Lucent. In many cases, these firms sold their own production plants to major EMS firms. This trend accelerated in many newer electronics companies such as Sun Microsystems, Silicon Graphics, EMC, Juniper Networks and Cisco Systems during their rapid growth in the late 1990s as they outsourced most of their production from the outset. The outsourcing trend then spread to the major European communications firms such as Ericsson, Nokia and Alcatel at the same time. EMS started also attracted attention in Japan after Sony decided to sell two factories in Japan and Taiwan to Solectron, one of the largest EMS firms, in 2000 (Sturgeon 2002). More recently, outsourcing has become widespread globally, involving not only production tasks, but also other functions including logistics and design.

There is a substantial literature on EMS or outsourcing (Ernst 2004, Inagaki 2001, Sturgeon 2002, Sturgeon and Lester 2002, Globerman and Vining 2004, Heshmati 2003,

Grossman and Helpman 2002). This literature identifies five main factors responsible for the growth of EMS. First, there is a need to focus more on product development and brand marketing among leading electronics companies, which stems from increasing product diversity, shorter product life-cycles, and intensified international competition. Second, the production process has become standardized through the proliferation of highly-automated equipment used in electronic circuit board assembly, electronics assembly, and testing. This makes outsourcing easier and cheaper. Third, outsourcing is also an attractive way to reduce the costs and risks associated with acquiring new and expensive equipment, as well as the costs of training workers to use that equipment. Fourth, there has been a closely related change in the dominant business model from a closed, vertically-integrated one to an open, decentralized one. The new model is open in the sense that transactions are not limited to a handful of specific partners and decentralized in the sense that each business function (e.g. design, production, marketing, and after-sales services) can be carried out more or less independently by different business firms or different units of a large firm. This has been facilitated by the development of electronic data communication technology and the establishment of *de facto* standards for a variety of key technologies including production equipment and electronic design software, which makes separation of design and production easier. Fifth, the proliferation of digital technology has further reduced the costs of decentralization among specialized suppliers, because it is easier to use modular

architecture with digital devices than with analog devices. Modular architecture not only facilitates the upgrading of each part/component, but also enables final assemblers to launch new products more quickly by changing module combinations. Shorter product life-cycles are thus accelerated by the modular architecture and vice versa.

Of course, for EMS firms to prosper, they must also have cost advantages over their customers in production-related functions (Inagaki 2001, Noguchi 2003, Sturgeon 2002). Low costs can result from the realization of scale economies which stem from specialization, namely, the mass-production of standardized products. High capacity utilization rates are also made possible by the diversification of customers and products, which reduces fluctuations in orders. Overhead costs can be reduced through the use of generic equipment and process technology, generic information system and data formats, and generic parts/components in factories. This also contributes to the rapid spread of manufacturing know-how and the quick coordination of tasks among factories located all over the world. Cost advantages are also derived from use of advanced supply chain management systems, including more efficient inventory control. The bulk purchase of parts, materials, and equipment leads to lowering unit price of parts. Finally, the establishment of affiliates in labor abundant economies helps reduce production costs for goods that can be produced with labor-intensive technologies.



## **2.2. The evolution of OEM in the Taiwanese computer industry**

The PC industry in Taiwan started to develop in earnest in the early 1980s and Taiwan has since played an increasingly important part in the world-wide supply chain of PCs and peripherals. In 2002, the total hardware output of the Taiwanese computer industry reached about US\$48 billion (including offshore production by Taiwanese firms) and Taiwan was among top four countries in the production value of computer-related hardware (MIC 2003, *Information Industry Yearbook 2003*). Taiwan also makes up a large portion of the world's total in many computer-related products.<sup>2</sup> To a considerable extent, the rapid and steady development of Taiwan's computer industry has resulted from OEM arrangements with foreign electronics companies.

The upgrading process proceeded in stepwise fashion, beginning with OEM arrangements where the Taiwanese producer first engages in production with the design specified by the customer. This is followed by and own-design manufacture (ODM) arrangement in which the Taiwanese firm designs part or all of the product, in addition to producing it according to specifications supplied by the buyer. If successful, local firms may advance beyond ODM to engage in other functions such as logistics and eventually they may start own-brand manufacture (OBM) (Gereffi 1999, Hobday 1995, Chen and Ku 2002). In Taiwan's case, although a substantial portion of the total

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<sup>2</sup> For example, in 2002, the share of Taiwanese producers in the world's total (in volume) is 61 percent on notebook PCs, 23 percent on desktop PCs, 75 percent on motherboards, 30 percent on servers, 51 percent on color display tube (CDT) monitors, 61 percent on liquid crystal display (LCD) monitors, 39 percent on digital still cameras (DSCs), 9 percent on projectors, 45 percent on optical disk drives (ODDs) (MIC 2003, *Information Industry Yearbook 2003*).

products of Taiwanese computer firms are still sold through OEM or ODM in recent years,<sup>3</sup> Taiwanese firms have steadily improved their design and logistics capabilities. For example, in the field of design, while in 1993 roughly one half of all PCs supplied by Taiwanese firms were based on Taiwanese designs, this share has increased to more than 70 percent in the late 1990s (Ernst 1998). In recent years, although information on markets and new technologies from major customers are still very important, leading Taiwanese computer manufacturers have come to conduct their own market researches and hold in-house teams of key parts specialists to have close cooperative exchanges with key parts suppliers. As a result, their reliance on major customers in a product design process has steadily decreased (Author's own interview with a leading Taiwanese notebook PC maker, in November 2004).<sup>4</sup>

Since the mid-1990s, logistics-related partnerships with major foreign customers have evolved further. In order to reduce costs and enhance time-to-market efficiency, U.S.'s Compaq made the global logistics production and supply model agreement with Taiwan's MiTAC, whereby Compaq farmed out all stages of the value chain for some of its desktop PCs, with the exception of basic product planning and marketing. Other major foreign computer companies such as IBM have followed Compaq's example

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<sup>3</sup> For example, in 2002, the OEM/ODM rate in the total output by Taiwanese firms is 38 percent on motherboards, 92 percent on notebook PCs, 96 percent on servers, 81 percent on DSCs, 82 percent on LCD monitors, 63 percent on ODDs (MIC 2003, *Information Industry Yearbook 2003*).

<sup>4</sup> In detail, based on an original concept and product specification provided by a major customer, a Taiwanese computer manufacturer undertakes product prototyping, product development and mass production. Between each stage, the Taiwanese firm must pass customers' verification. And R&D staffs from both sides have opportunities of meeting and cooperation (Chiang 2004).

(Ernst 1998). In recent years, leading Taiwanese firms have constructed global production and logistics networks, although they are still heavily concentrated in Taiwan and Mainland China. For example, if one considers the case of desktop PCs, the production process of PCs can be divided into several stages, with each stage is conducted in a location where the best cost efficiency for that stage can be realized. In the case of motherboards, production is carried out in Taiwan or Mainland China. In addition, some other parts/components such as outer cases and switching power supply units are also assembled with motherboards into semi-finished goods (called “barebones”) in the same location. Semi-finished goods are then shipped to final assembly plants located near important markets such as those in the United States and Europe. Meanwhile, some key parts/components, such as central processing units (CPUs) and hard disk drives (HDDs) are purchased and assembled into final products after receiving orders. Key parts suppliers are also required to establish warehouses near important markets. In this way, PC producers can reduce inventory pressure and avoid losses caused by sudden declines in key parts prices. At the same time, they can quickly respond to market changes and customize products to a certain extent (Chaing 2004, Li and Gao 2002, MIC 1999).

In the case of notebook PCs, which are relatively compact and expensive, final products are often assembled in Taiwan or Mainland China, and then sent by air to warehouses near markets. In this case, a manufacturer needs to have only one final

assembly plant in Taiwan or China, where most of the necessary parts are obtained, facilitating high production efficiency and easy inventory control. For example, it takes only 4-5 days to deliver products to customers after receiving the order if shipping from Taiwan and around 7 days when shipping from China (Li and Gao 2002).

Although only a handful of large firms in Taiwan have established full-fledged global operation networks, many firms have tried to follow this trend. Some people try to distinguish Taiwanese OEM/ODM from EMS because overseas operations of Taiwanese firms are still mainly restricted to Mainland China and some Taiwanese firms have (or try to have) own-brand sales besides OEM/ODM. However, I call them “Taiwanese EMS” firms for convenience in this paper.

### **2.3. A Profile of Major Taiwanese and American EMS firms**

Table 1 shows profiles of the top five EMS companies in North America and Taiwan, respectively. In recent years, the top five North American firms have been Flextronics International (based in Singapore), Solectron Corp. (Milpitas, CA), Sanmina-SCI Corp. (San Jose, CA), Celestica Inc. (Toronto) and Jabil Circuit Inc. (St. Petersburg, FL).<sup>5</sup> Total sales of EMS firms increased rapidly, with an increasingly larger portion EMS sales being accounted for by the top five companies (33 percent in

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<sup>5</sup> Flextronics is incorporated in Singapore but managed from its San Jose, CA, headquarters. Sanmina-SCI was created in December 2001 after the acquisition of SCI Systems Inc. by Sanmina. SCI was the largest EMS firm until 1998.

1998 to 59 percent in 2002).<sup>6</sup> According to Table 1, sales of these top five companies combined were US\$55 billion in 2004. The top five EMS firms in Taiwan were Hon Hai Precision, Quanta Computer, Compal Electronics, Lite-on Technology, and Inventec Corporation. Asustek Computer and Acer Incorporated also have substantial EMS businesses, but these two firms are excluded from this sample because they earn a substantial portion of their revenues from own-brand sales and because Acer focuses on its own-brand business. The top five EMS firms identified in Table 1 had combined sales of US\$43 billion in 2004.

[Place Table 1 around here]

Unfortunately, the information on main products and main customers is incomplete in Table 1, partly because product mixes and customers are constantly changing and partly because information sources are fragmented. Nonetheless, the available information highlights two important points. First, both Taiwanese and American firms are highly diversified, producing a wide range of products, including not only computers and peripherals, but also communications equipment, networking appliances, and consumer electronics, among other products. Second, there is considerable overlap among their major customers, which include many of the world's major computer and electronics companies. In other words, major EMS firms clearly compete for and serve

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<sup>6</sup> These figures are taken from Table 3-7 in Inagaki (2001) and 2003 Annual Report of Flextronics.

the same customers, sometimes in similar product lines.

Diversified product mixes result in part from cycles in various parts of the industry. In the 1980s and the first half of the 1990s, sales of computers and peripherals grew relatively rapidly. Then in the second half of the 1990s, sales of networking appliances grew most rapidly while growth has been more rapid in communication equipment and other products since 2000 (Inagaki 2001). Because of their longer experience with these cycles, diversification tend is more pronounced in American EMS firms, in which computers (including workstations, servers as well as PCs) and peripherals account for around 30 percent or less of revenues in recent years.<sup>7</sup> On the other hand, Taiwanese computer-related firms used to specialize in one or a few products through the late 1990s, and started to diversify in recent years. They often combine the launch of new kind of products with the establishment of new affiliates within their own business groups. Although their product mixes still focus heavily on computer-related products, sales of cellular phones and electronic consumer products are increasingly important for many Taiwanese firms.<sup>8</sup>

Competition for orders from major customers is observed between American and

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<sup>7</sup> For example, computer-related products (computers, servers, storages, and peripherals) account for 15 percent of revenues of Flextronics in fiscal 2002, 30.5 percent of Solectron, 32.0 percent of Celestica, 23.0 percent of Jabil Circuit in fiscal 2004 (each company's annual report).

<sup>8</sup> For example, in 2003, computers accounted for 60 percent, mobile handsets 18 percent, consumer 15 percent, and networking equipment 7 percent of the revenues in Hon Hai ("Why is Hon Hai so shy?", 1 April 2004, <http://www.reed-electronics.com>). In 2003, 72 percent of Compal's revenues came from notebook PCs, followed distantly by display products (13 percent), and handsets and PDAs (15 percent; Compal company report, June 2004). As for Quanta, notebook PCs account for about 90 percent of revenues ("These slim margins are not by design", 1 September 2004, <http://www.reed-electronics.com>).

Taiwanese firms as well as among firms in each group. Taiwanese firms dominate in computer-related products (see footnote 2). For example, Dell used to have close partnerships with American EMS firms, but has rapidly shifted orders of computer-related products to Taiwan since 2001 (*DigiTimes* 20 August 2003).<sup>9</sup> In the notebook PC sector, major American companies including HP, Apple, and Dell farmed out nearly all production to Taiwanese partners in 2002 and 2003.<sup>10</sup> On the other hand, American EMS firms have a longer history of partnerships with major customers in networking and communication appliances, though Taiwanese firms are trying to catch up in this field too.

### **3. Differences in Profitability and Related Factors**

This section analyzes firm-level profitability and related factors. The first step is to compare trends in profitability between the major American and Taiwanese EMS firms identified above (Section 3.1). The second step is then to compare trends in some of the factors affecting profitability that are observed between Taiwanese and American EMS firms (Section 3.2).

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<sup>9</sup> *DigiTimes* is a daily paper specializing in the IT industry and published in Taipei, Taiwan; it can also be accessed online at <http://member.digitimes.com.tw/>.

<sup>10</sup> IBM is exceptional. It farmed out only 30 percent of its production of notebook PCs or less to Taiwan, because IBM Japan was responsible for its notebook PC business. Similarly, Japanese notebook companies including Toshiba, Sony, and Fujitsu-Siemens also farmed out relatively small shares of notebook PCs to Taiwan, around 50 percent or less in 2002 and 2003, because Japanese firms depend on outsourcing to a lesser extent than U.S. firms. NEC was an exception as it farmed out around 90 percent of its notebook PC production (data from *DigiTimes*, 21 January 2003).

### **3.1. Trends in Alternate Measures of Profitability**

Table 2 first shows the trend of two broad measures of corporate profits, gross profits or revenues less the cost of goods sold, and operating profits or gross profits less expenses for labor compensation, selling and administration expenses, and depreciation, among other items. The gross profit rate is the broadest measure which gives a good idea of the margins made on intermediate goods such as raw materials and parts. Gross profit rates were quite high in Taiwanese firms but declined from an average of 16.3-17.3 percent in 1997-1999 to 12.2-13.2 percent in 2000-2002, 8.7-10.6 percent in 2003-2004 (Table 2). Gross profit rates were markedly lower in American firms, averaging 8.1-9.7 percent in 1997-2001 and 4.9-5.9 percent in 2002-2004. Gross profit rates were thus 7.5-7.7 percentage points higher in Taiwanese firms in 1997-1999, 4.2-6.5 points higher in 2000-2003 and 2.8 points higher in 2004. The large decline in the gross profit rates of American firms after 2001 is particularly conspicuous.

[Place Table 2 around here]

The operating profit rate is a narrower definition of profits that indicates the profitability of operations after accounting for other expenses directly related to business operation. In this respect, the operating profit rate is probably the best indicator of the profitability of the firm's main production operations, although it is sometimes



distorted by large depreciation charges which are taken for tax reasons. The average operating profit rate of Taiwanese firms was higher than in American counterparts for every year in 1997-2004. In Taiwanese firms the operating profit rate was rather stable, falling slowly from average of 7.4-8.0 percent in 1997-1999 to 5.9-6.7 percent in 2000-2002, and 3.9-4.8 percent in 2003-2004 (Table 2). Average American profit rates were also much lower by this measure, 2.1-5.4 percentage points lower in 1997-2001 and 2004, and by 10.6-19.8 percentage points in 2002-2003, when American profit rates plunged well below zero.

Table 3 then shows two alternatives of the net profit rate, which are narrow measures of profits relevant to stockholders. Net profits are obtained by further subtracting non-operating income, such as interest and dividends, gains or losses on investments, and tax payments, from operating income. In the table, two often-used measures, net profit rates on revenues and on assets, are shown. Not surprisingly, the trends in these measures are largely similar because the numerator is the same. Trends in net profits on revenues are similar to those in the operating profit rates described above. Measured as ratio to total assets, net profit rates were higher and declined less with Taiwanese firms recording average rates of 9.0-12.5 percent in 1997-2001 and 6.3-8.9 percent in 2002-2004. Mean American rates were always much lower by both measures, with differences of between 4.5 and 23.2 percentage points.

[Place Table 3 around here]

In sum, Taiwanese were much more profitable than American firms by any of the four measures, the gap widened substantially in 2002 as American firms recorded large losses, and profit rates have tended to decline for both Taiwanese and American firms. Of course, these measures are only rough indicators of firms' profitability, and limitations of using simple accounting rates for measuring firm-level performance are mentioned by both mainstream economics (e.g. Varian 1993, Ch.18) and management studies (e.g. Barney 2002, Ch.2). On the other hand, taken together with other indicators, even these rough indicators provide important insights into corporate performance, and suggest that Taiwanese EMS firms have outperformed their American counterparts in recent years in some important respects.

### **3.2. Factors Affecting Profitability**

This subsection examines factors affecting differences of firm-level profitability between Taiwanese and American EMS firms in the recent years. Put simply, profits are defined as revenues minus costs. Thus factors that increase revenues increase profits and others that increase costs reduce profits. This section examines some of these factors in attempt to understand why Taiwanese firms have earned higher profits than American firms.

First, Table 4 depicts trend in revenues and their growth rates. Average revenues in major American EMS firms 2.5 times larger than in Taiwanese firms in 1997 and this differential grew to 3.4-3.5 times in 1999-2001, before shrinking markedly to only 1.3-1.4 times in 2003-2004. Correspondingly, the mean growth rate for American firms exceeded that of Taiwanese firms through 2000, but was much lower thereafter. In 2001, the world-wide IT-industry recession reduced revenue growth markedly in both Taiwanese and American firms but the slowdown was shallower and much briefer for Taiwanese firms. The ability of Taiwanese firms to recover quickly from the effects of the recession was thus an important source of relatively high profits in recent years.

[Place Table 4 around here]

Before the large decline in profits in 2001-2003, leading American EMS firms expanded through the takeover of facilities from major electronics companies and by simultaneously taking orders from those same companies. In this manner, American EMS companies tried to pursue many objectives at the same time. Namely, at the same time they sought to grow rapidly, they increased the variety of services offered, diversified into new product markets, and expanded their own production networks. However, this accelerated expansion created an increasingly sluggish corporate bureaucracy and undermined the primary advantages of the EMS business model. In

other words, American EMS firms became less specialized and incapable of flexibly adjusting of production to meet customers' requirements (Ernst 2004). The world-wide IT industry recession in 2001 underscored these weaknesses and led to restructuring which facilitate the gradual increase of profits in American EMS firms thereafter. However, both net profits and operating profits remained negative through 2004, reflecting the difficulties these firms continue to face.

Second, trends in two measures of capital productivity, sales per unit of total assets (also called total assets turnover) and sales per unit of fixed assets (also called fixed assets turnover), are examined. Both of these measures are not very good indicators of capital productivity because the numerator includes intermediate consumption, but they provide a rough indication of how efficiently the firm utilizes its assets.<sup>11</sup> Higher capital productivity reduces the cost of producing a given amount of output and thus increases profits. These data suggest that both measures of capital productivity were higher in American firms through 2000, but that both measures have been higher in Taiwanese firms since then. Of course these trends reflect the trends observed in Table 4 as declines in revenue growth are a major reason for the low capital productivity levels in American firms in 2001-2003. Rapid growth in total and fixed assets also contributed to the decline.

[Place Table 5 around here]

Third, inventory control is important in EMS firms because IT products are often

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<sup>11</sup> Value added would be a preferable numerator but is unavailable.

composed of huge number of electronic parts that must be supplied to assemblers efficiently.<sup>12</sup> Technologies for key parts are constantly upgraded and the prices of these components fluctuate endlessly. Correspondingly, if they are held too long, inventory stocks can easily lose their value after the appearance of new products. Therefore, rapid or efficient inventory turnover is critical to keeping costs low and profits high and the fewer days to sell inventory, the lower costs and the higher profits will be. Table 6 thus shows a measure in inventory control, the average number of days required to sell inventory stocks for a year. Data on American firms is sparse through 2000. Existing data suggest similar performance in Taiwanese and American firms in 2000 and 2004, while Taiwanese firms were able to dispose of their inventory much more rapidly in 2001-2003.

[Place Table 6 around here]

Research and development (R&D) is another important factor that affects costs through investments in new technologies. If R&D generates new technologies, this will lead to cost reductions and higher profits in the future. The design of computers and peripherals has become a relatively standardized task because basic design rules have been established and many functions are integrated with key parts, especially integrated circuit (IC) chips. However, in order to keep up with continually changing designs and

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<sup>12</sup> For example, one notebook PC includes about one thousand parts (*DigiTimes*, 9 February 2004).

technologies for both parts and final products, firms must invest substantial resources in research and product development. Furthermore, they must minimize manufacturing costs by adapting optimal production methods, which are largely determined when a product is designed.<sup>13</sup> In the EMS industry, these processes often involve substantial trial and error, and Taiwan EMS firms have accumulated a lot of experience with such processes. Moreover, the evidence suggests that Taiwanese firms have invested far more of their revenues (an average of 1.3 percent in 2001-2004) in R&D than American firms (an average of 0.3 percent).

[Place Table 7 around here]

In sum, the examination in this subsection reveals that compared to American firms, Taiwanese firms were (1) able to recover to higher revenue growth more quickly after the 2001 slowdown, (2) maintain higher levels of capital productivity after 2001, (3) manage inventory more efficiently, especially in 2001-2003, and (4) invested much more in R&D. All of these factors (and several others) clearly contributed to the realization of higher profits in Taiwanese firms in recent years.

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<sup>13</sup> Recent research at Rensselaer's Electronic Agile Manufacturing Research Institute (EAMRI) notes that 80 percent of product cost is determined in the design phase ([www.flextronics.com](http://www.flextronics.com)).

#### **4. Conclusion**

This paper began by describing the evolution of EMS business in North America and Taiwan. American firms were the first to engage in large-scale EMS business and developed by providing a wide range of products and services to large electronics and computers manufacturers, which were mainly based in North America and Europe. Taiwanese firms are relative newcomers to the EMS business and were initially much smaller scale operations that provided a narrower range of products and services than their American counterparts. In recent years, Taiwanese firms have grown rapidly and diversified to the point that their product mixes and major customers became similar to those of American EMS firms, though American EMS firms remained somewhat more diversified.

The paper then proceeded to compare various measures of profitability and some of the factors affecting profitability in Taiwanese and American EMS firms. Taiwanese EMS businesses were generally more profitable than American EMS businesses, and the gap widened substantially in 2002-2003. There are many reasons for this trend, but the rapid recovery of sales growth in Taiwanese firms after the 2001 seems particularly important. In addition, Taiwanese firms maintained higher levels of capital productivity, managed inventory more efficiently, and invested much more in R&D after 2001. These factors, among others, contributed to the realization of relatively high profits in Taiwanese firms in recent years.

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**Table 1: Main American and Taiwanese EMS Firms**

Company	Revenues in 2004 (million US\$)	Main products	Main customers
<b>American EMS</b>			
Flextronics International	15,908	Computers & office automation, IT infrastructure, Consumer, Handheld devices, Communications infrastructure, Industrial, medical & other	Hewlett-Packard (HP), Sony-Ericsson, Alcatel, Casio, Dell, Ericsson Telecom AB, Microsoft, Motorola, Nortel, Siemens, Telia, Xerox
Solectron Corp.	11,638	Computing & Storage, Networking, Consumer, Communication, Industrial, Automotove, Other	HP, Nortel, Cisco, Ericsson, HP, IBM, Lucent Technologies, Motorola, NEC, Sun Microsystems
Sanmina-SCI Corp.	12,205	Communications, Computing, Multimedia, Industrial & Semiconductor systems, Defense and Aerospace, Medical, Automotive	Applied Materials, IBM, HP, Alcatel, Dell, EchoStar, Ericsson, Hitachi, Nokia, Nortel, Roche, Philips Electronics, LSI, Tellabs
Celestica Inc.	8,840	Enterprise communications, Telecommunications, Servers, Storage, Workstations & PCs, Other	Avaya, Cisco, EMC, HP, IBM, Lucent, Motorola, NEC, Sun Microsystems
Jabil Circuit Inc.	6,253	Consumer, Networking, Computing & Storage, Instrumentation & Medical, Telecommunications, Automotive, Peripherals, Other	Cisco, HP, IBM, Lucent, Marconi, NEC, Nokia, Quantum, Philips, Valeo
<b>Taiwanese EMS firms</b>			
Hon Hai Precision	16,203	Connector, Cable, Desktop PC, Motherboard, Cellular phone, Networking appliance, Game machine	Intel, Dell, Apple, IBM, HP, Cisco, Nokia, Motorola, Sony, Gateway, Acer
Quanta Computer	9,873	Notebook PC, Server, Cellular phone, Digital TV	HP, Dell, IBM, Fujitsu-Siemens, Acer, NEC, Sony, Apple, Gateway, Panasonic, Philips, Sharp, Toshiba
Compal Electronics	6,875	Notebook PC, Monitor, Personal data assistance (PDA), Cellular phone, Digital TV	HP, Dell, Toshiba, Fujitsu-Siemens, Acer, Apple, NEC, Hitachi, Motorola
Lite-on Technology	6,419	Desktop PC, Monitor, Optical storage, Printer, PDA, Cellular phone, Digital steel camera (DSC)	Dell, HP, IBM, NEC, Fujitsu-Siemens, Canon
Inventec Corp.	4,111	Notebook PC, Server, Cellular phone	HP, Toshiba, Apple, T-Mobile

Note:

Based on data available as of July 2005; data on main products and main customers are incomplete in some cases.

Sources:

Revenues from Appendix Table 1.

Product Information for Taiwanese firms from the Company Home Pages and *DigiTimes* (see Appendix Table 2 for details).

Product Information for American firms from the Company Home Pages (see Appendix Table 2 for details)

**Table 2: Gross Profit Rates and Operating Profit Rates (percent, consolidated basis)**

Firm Group, Firm	Gross Profit Rates (percent of revenues)								Operating Profit Rates (percent of revenues)							
	1997	1998	1999	2000	2001	2002	2003	2004	1997	1998	1999	2000	2001	2002	2003	2004
<b>Taiwanese EMS Firms</b>	<b>17.28</b>	<b>16.76</b>	<b>16.31</b>	<b>13.17</b>	<b>12.68</b>	<b>12.24</b>	<b>10.58</b>	<b>8.74</b>	<b>7.36</b>	<b>7.95</b>	<b>7.94</b>	<b>6.72</b>	<b>6.01</b>	<b>5.93</b>	<b>4.81</b>	<b>3.92</b>
Hon Hai	30.35	29.60	25.23	21.99	18.27	14.74	13.09	12.22	15.48	14.63	12.62	10.69	9.21	7.44	6.56	6.20
Quanta	-	-	-	11.48	12.48	10.13	7.13	6.81	-	-	-	7.48	9.09	6.75	4.36	3.29
Compal	-	16.19	14.23	9.98	9.07	11.16	10.23	7.41	-	12.08	10.33	6.85	5.34	7.33	6.58	4.63
Lite-on	7.71	6.84	15.55	15.49	16.72	15.56	14.20	11.68	-0.54	-1.71	4.79	6.74	6.17	6.23	4.77	4.59
Inventec	13.77	14.40	10.24	6.92	6.89	9.61	8.25	5.56	7.14	6.79	4.04	1.86	0.22	1.91	1.77	0.89
<b>American EMS Firms</b>	<b>9.74</b>	<b>9.07</b>	<b>8.59</b>	<b>8.98</b>	<b>8.09</b>	<b>5.72</b>	<b>4.89</b>	<b>5.92</b>	<b>5.28</b>	<b>4.20</b>	<b>5.27</b>	<b>3.62</b>	<b>0.62</b>	<b>-13.84</b>	<b>-5.80</b>	<b>-0.02</b>
Flextronics	12.53	9.19	8.86	3.89	3.17	3.45	2.40	6.30	-	-	-	-4.01	-1.15	-0.41	-1.64	2.33
Sollectron	-	10.92	9.68	9.02	7.71	4.70	4.50	4.99	6.88	6.04	5.34	4.98	-0.61	-32.10	-24.01	-0.32
Sanmina-SCI	-	-	-	15.96	13.36	4.28	4.46	5.08	-	5.49	7.52	8.53	1.57	-31.55	-0.75	0.87
Celestica	6.96	7.10	7.22	7.05	7.12	6.71	3.86	4.61	1.44	-0.56	2.17	2.63	-0.50	-6.50	-3.51	-6.45
Jabil Circuit	-	-	-	-	9.10	9.44	9.21	8.61	7.53	5.84	6.07	5.98	3.78	1.36	0.94	3.45

Notes: - = not available; figures for firm groups are means for the group.

Sources: Appendix Table 1.

**Table 3: Net Profit Rates (percent, consolidated basis)**

Firm Group, Firm	Net Profit Rates on Revenues (percent of revenues)								Net Profit Rates on Assets (percent of total assets)							
	1997	1998	1999	2000	2001	2002	2003	2004	1997	1998	1999	2000	2001	2002	2003	2004
<b>Taiwanese EMS Firms</b>	<b>9.89</b>	<b>7.18</b>	<b>7.86</b>	<b>7.92</b>	<b>7.01</b>	<b>5.94</b>	<b>5.40</b>	<b>3.45</b>	<b>12.53</b>	<b>9.04</b>	<b>9.62</b>	<b>10.72</b>	<b>10.55</b>	<b>8.92</b>	<b>8.61</b>	<b>6.34</b>
Hon Hai	15.30	13.76	12.76	10.56	8.50	6.55	6.24	5.49	16.35	14.94	13.22	11.70	13.10	12.79	11.13	9.81
Quanta	-	-	-	10.33	10.69	7.60	4.45	3.63	-	-	-	13.04	16.35	10.87	8.48	6.90
Compal	-	12.42	11.41	7.93	6.96	6.46	6.39	2.86	-	16.21	14.45	11.90	8.43	8.18	8.67	5.12
Lite-on	5.93	-4.35	2.40	6.98	4.24	4.91	5.03	3.52	5.27	-5.38	2.78	8.65	5.35	5.65	6.63	5.76
Inventec	8.45	6.88	4.88	3.82	4.64	4.15	4.89	1.76	15.96	10.38	8.03	8.29	9.54	7.11	8.15	4.11
<b>American EMS Firms</b>	<b>3.17</b>	<b>1.92</b>	<b>3.00</b>	<b>2.20</b>	<b>0.30</b>	<b>-12.98</b>	<b>-8.40</b>	<b>-1.28</b>	<b>6.40</b>	<b>4.22</b>	<b>5.08</b>	<b>2.40</b>	<b>0.56</b>	<b>-14.32</b>	<b>-12.48</b>	<b>-2.45</b>
Flextronics	3.36	1.29	2.28	-3.68	-1.17	-0.62	-2.43	2.14	4.64	1.83	3.09	-5.89	-1.78	-0.99	-3.68	3.09
Sollectron	4.62	4.12	3.62	3.52	-0.67	-28.96	-35.22	-1.45	9.22	8.84	6.46	4.79	-0.94	-28.24	-53.02	-2.90
Sanmina-SCI	-	1.80	4.00	4.96	1.00	-30.78	-1.32	-0.09	-	-	-	-	1.11	-35.87	-1.86	-0.15
Celestica	-0.34	-1.49	1.29	2.12	-0.40	-5.51	-3.96	-9.66	-0.51	-2.96	2.58	3.48	-0.60	-7.84	-5.19	-17.29
Jabil Circuit	5.03	3.87	3.79	4.09	2.74	0.98	0.91	2.67	12.25	9.19	8.19	7.22	5.03	1.36	1.33	5.01

Notes: - = not available; figures for firm groups are means for the group.

Sources: Appendix Table 1.

**Table 4: Revenues and Revenue Growth (consolidated basis)**

Firm Group, Firm	Revenues (US\$ millions)								Revenue Growth (percent)							
	1997	1998	1999	2000	2001	2002	2003	2004	1997	1998	1999	2000	2001	2002	2003	2004
<b>Taiwanese EMS Firms</b>	<b>1,016</b>	<b>1,144</b>	<b>1,512</b>	<b>2,561</b>	<b>2,844</b>	<b>4,103</b>	<b>6,447</b>	<b>8,696</b>	-	<b>36.7</b>	<b>25.0</b>	<b>64.0</b>	<b>20.9</b>	<b>48.2</b>	<b>50.8</b>	<b>36.3</b>
Hon Hai	826	1,196	1,800	3,133	4,553	7,455	11,706	16,203	-	68.8	45.3	68.4	57.3	67.5	56.3	34.4
Quanta	-	-	-	2,650	3,301	4,128	8,657	9,873	-	-	-	-	34.9	27.9	108.8	10.8
Compal	-	1,172	1,466	2,417	2,295	3,545	5,142	6,875	-	-	20.6	59.6	2.8	58.0	44.4	29.8
Lite-on	639	722	776	1,388	1,641	3,017	4,205	6,419	-	31.8	3.7	73.0	28.0	88.1	38.7	48.2
Inventec	1,583	1,486	2,008	3,219	2,430	2,371	2,524	4,111	-	9.5	30.4	55.1	-18.3	-0.2	6.0	58.2
<b>American EMS Firms</b>	<b>2,543</b>	<b>3,392</b>	<b>5,357</b>	<b>8,759</b>	<b>10,013</b>	<b>8,939</b>	<b>9,237</b>	<b>10,969</b>	<b>40.2</b>	<b>44.9</b>	<b>53.8</b>	<b>65.0</b>	<b>11.9</b>	<b>8.1</b>	<b>6.6</b>	<b>21.8</b>
Flextronics	2,578	3,953	6,959	12,110	13,105	13,379	14,530	15,908	72.1	53.3	76.1	74.0	8.2	2.1	8.6	9.5
Solectron	4,409	6,102	9,669	14,138	18,569	10,739	9,828	11,638	36.4	38.4	58.5	46.2	31.3	-42.2	-8.5	18.4
Sanmina-SCI	-	2,171	2,621	4,239	4,054	8,762	10,361	12,205	-	-	20.7	61.8	-4.4	116.1	18.3	17.8
Celestica	2,007	3,249	5,297	9,752	10,004	8,272	6,735	8,840	-	61.9	63.0	84.1	2.6	-17.3	-18.6	31.2
Jabil Circuit	1,179	1,484	2,238	3,558	4,331	3,545	4,729	6,253	12.2	25.9	50.8	59.0	21.7	-18.1	33.4	32.2

Notes: - = not available; figures for firm groups are means for the group.

Sources: Appendix Table 1.

**Table 5: Capital Productivity**

Firm Group, Firm	Total Asset Turnover (revenues/total assets)								Fixed Asset Turnover (revenues/fixed assets)							
	1997	1998	1999	2000	2001	2002	2003	2004	1997	1998	1999	2000	2001	2002	2003	2004
<b>Taiwanese EMS Firms</b>	<b>1.28</b>	<b>1.28</b>	<b>1.28</b>	<b>1.46</b>	<b>1.52</b>	<b>1.50</b>	<b>1.61</b>	<b>1.89</b>	<b>6.92</b>	<b>8.13</b>	<b>8.47</b>	<b>9.83</b>	<b>11.52</b>	<b>11.67</b>	<b>15.05</b>	<b>16.61</b>
Hon Hai	1.07	1.09	1.04	1.11	1.54	1.95	1.78	1.79	3.73	3.75	4.11	4.03	4.98	8.19	8.17	9.15
Quanta	-	-	-	1.26	1.53	1.43	1.91	1.90	-	-	-	3.26	14.60	13.65	17.27	13.80
Compal	-	1.30	1.27	1.50	1.21	1.27	1.36	1.79	-	9.85	8.30	12.62	11.81	15.46	19.12	22.12
Lite-on	0.89	1.24	1.16	1.24	1.26	1.15	1.32	1.64	4.29	8.74	9.40	12.88	14.08	8.31	14.66	23.22
Inventec	1.89	1.51	1.65	2.17	2.06	1.71	1.67	2.33	12.73	10.16	12.06	16.38	12.14	12.73	16.02	14.76
<b>American EMS Firms</b>	<b>1.83</b>	<b>1.98</b>	<b>1.82</b>	<b>1.59</b>	<b>1.48</b>	<b>1.31</b>	<b>1.44</b>	<b>1.75</b>	<b>11.57</b>	<b>10.42</b>	<b>9.86</b>	<b>10.29</b>	<b>8.77</b>	<b>8.19</b>	<b>9.84</b>	<b>12.91</b>
Flextronics	1.38	1.42	1.36	1.60	1.52	1.59	1.52	1.45	-	-	5.26	6.62	6.45	6.81	8.94	9.33
Soletron	1.99	2.15	1.78	1.36	1.42	0.98	1.51	2.00	-	-	13.36	13.09	14.23	9.93	12.57	16.02
Sanmina-SCI	-	-	-	-	1.11	1.17	1.40	1.62	-	-	-	-	6.41	8.08	11.48	15.59
Celestica	1.49	1.99	1.99	1.64	1.51	1.42	1.31	1.79	16.15	15.12	14.50	15.40	10.93	11.37	9.88	15.53
Jabil Circuit	2.43	2.37	2.16	1.77	1.84	1.39	1.46	1.88	7.00	5.73	6.33	6.06	5.82	4.79	6.34	8.05

Notes: - = not available; figures for firm groups are means for the group.

Sources: Appendix Table 1.

**Table 6: Average Days to Sell Inventory (365/Average Inventory Turnover)**

<b>Firm Group, Firm</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>Taiwanese EMS Firms</b>	<b>41.53</b>	<b>55.84</b>	<b>48.60</b>	<b>40.74</b>	<b>32.04</b>	<b>31.90</b>	<b>32.15</b>
Hon Hai	54.06	59.10	57.26	40.78	23.40	28.04	39.09
Quanta	-	-	-	31.87	40.11	28.49	28.25
Compal	16.13	40.08	35.68	36.04	27.71	27.30	26.36
Lite-on	53.52	73.25	66.20	66.54	43.84	43.84	41.12
Inventec	42.40	50.94	35.24	28.46	25.12	31.81	25.94
<b>American EMS Firms</b>	<b>44.97</b>	<b>42.82</b>	<b>55.61</b>	<b>60.04</b>	<b>51.62</b>	<b>44.06</b>	<b>38.78</b>
Flextronics	-	-	48.05	45.97	35.11	30.91	33.21
Solectron	-	-	70.72	74.52	89.74	61.23	45.96
Sanmina-SCI	-	-	-	-	35.40	38.73	32.17
Celestica	44.97	42.82	48.05	59.65	50.81	50.91	45.31
Jabil Circuit	-	-	-	-	47.03	38.51	37.27

Notes: - = not available; average inventory turnover is the ratio of cost of goods sold to average inventories, where average inventories are the average of inventories in the current and previous years.

Sources: Appendix Table 1.

**Table 7: Research Development Expenses on Revenues (percent)**

<b>Firm Group, Firm</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>Taiwanese EMS Firms</b>	<b>1.31</b>	<b>1.47</b>	<b>1.38</b>	<b>1.17</b>
Hon Hai	1.47	1.49	1.38	1.31
Quanta	1.20	1.33	0.85	0.89
Compal	1.33	1.60	1.49	1.28
Lite-on	0.97	1.11	1.63	1.36
Inventec	1.56	1.84	1.54	1.03
<b>American EMS Firms</b>	<b>0.21</b>	<b>0.27</b>	<b>0.35</b>	<b>0.23</b>
Flextronics	-	-	-	-
Solectron	0.35	0.56	0.70	-
Sanmina-SCI	0.18	0.10	0.14	0.24
Celestica	0.17	0.22	0.36	-
Jabil Circuit	0.15	0.22	0.21	0.22

Notes: - = not available; figures for firm groups are means for the group.

Sources: Appendix Table 1.



**Appendix Table 1: Financial Data for EMS Firms (consolidated basis) (US\$ millions)**

<b>Firm Group, Firm</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>1. Gross Profits</b>								
Taiwanese EMS Firms	172.7	201.7	247.3	334.4	378.7	522.0	696.1	828.1
Hon Hai	250.8	353.8	454.1	688.8	831.7	1,099.0	1,532.0	1,980.5
Quanta	-	-	-	304.2	411.9	418.1	617.2	672.4
Compal	-	189.8	208.6	241.2	208.2	395.4	526.0	509.1
Lite-on	49.3	49.4	120.7	215.0	274.4	469.6	597.1	750.0
Inventec	218.0	213.9	205.6	222.8	167.4	228.0	208.3	228.5
American EMS Firms	231.3	420.1	645.1	777.8	699.1	446.3	389.7	629.8
Flextronics	322.9	363.3	616.4	471.3	415.5	462.1	348.5	1,002.0
Solectron	-	666.6	936.3	1,275.3	1,431.9	504.9	442.0	580.3
Sanmina-SCI	-	-	-	676.7	541.5	374.7	462.5	620.2
Celestica	139.7	230.5	382.5	688.0	712.5	555.1	260.1	407.9
Jabil Circuit	-	-	-	-	394.1	334.6	435.5	538.4
<b>2. Operating Profits</b>								
Taiwanese EMS Firms	79.1	101.3	124.2	170.4	189.7	265.2	345.8	395.9
Hon Hai	128.0	174.9	227.2	335.0	419.5	554.6	768.3	1,005.3
Quanta	-	-	-	198.3	299.9	278.6	377.3	324.8
Compal	-	141.6	151.4	165.6	122.6	259.8	338.3	318.4
Lite-on	-3.5	-12.4	37.2	93.5	101.2	187.9	200.5	294.5
Inventec	112.9	100.9	81.1	59.8	5.4	45.2	44.8	36.4
American EMS Firms	140.3	139.0	241.0	210.1	-17.5	-1,351.0	-573.7	17.0
Flextronics	-	-	-	-485.2	-150.7	-54.5	-238.5	371.1
Solectron	303.2	368.6	516.1	704.2	-114.1	-3,446.9	-2,359.8	-37.4
Sanmina-SCI	-	119.1	197.0	361.5	63.5	-2,764.2	-77.9	105.7
Celestica	28.9	-18.3	115.1	256.9	-49.8	-537.5	-236.7	-570.2
Jabil Circuit	88.8	86.7	135.9	212.9	163.8	48.1	44.5	216.0
<b>3. Net Profits</b>								
Taiwanese EMS Firms	99.4	95.2	128.4	203.2	216.4	255.6	355.9	348.7
Hon Hai	126.5	164.5	229.7	330.9	387.0	488.4	730.7	890.2
Quanta	-	-	-	273.9	353.0	313.8	385.0	358.2
Compal	-	145.6	167.3	191.6	159.8	229.0	328.6	196.6
Lite-on	37.9	-31.4	18.6	96.8	69.5	148.3	211.5	226.1
Inventec	133.8	102.2	98.0	123.0	112.7	98.5	123.4	72.5
American EMS Firms	85.6	70.1	153.4	122.7	-31.6	-1,262.2	-835.0	-105.5
Flextronics	86.5	51.0	158.6	-446.0	-153.7	-83.5	-352.4	339.9
Solectron	203.7	251.3	350.3	497.2	-123.5	-3,110.2	-3,462.0	-168.9
Sanmina-SCI	-	39.2	104.7	210.1	40.4	-2,696.8	-137.2	-11.4
Celestica	-6.9	-48.5	68.4	206.7	-39.8	-455.4	-266.7	-854.1
Jabil Circuit	59.3	57.5	84.8	145.6	118.5	34.7	43.0	166.9

**Appendix Table 1 (continued)**

<b>Firm Group, Firm</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>4. Revenues</b>								
Taiwanese EMS Firms	1,016.1	1,143.8	1,512.4	2,561.2	2,844.2	4,103.2	6,446.7	8,696.2
Hon Hai	826.5	1,195.5	1,800.2	3,132.9	4,553.1	7,455.3	11,705.6	16,202.9
Quanta	-	-	-	2,649.9	3,301.2	4,127.6	8,656.8	9,873.4
Compal	-	1,172.2	1,465.7	2,416.9	2,295.3	3,544.6	5,142.2	6,874.7
Lite-on	639.1	721.8	776.0	1,387.5	1,641.2	3,017.3	4,204.8	6,418.7
Inventec	1,582.7	1,485.7	2,007.8	3,218.9	2,430.3	2,371.3	2,524.1	4,111.3
American EMS Firms	2,542.9	3,392.0	5,356.9	8,759.3	10,012.6	8,939.2	9,237.0	10,968.8
Flextronics	2,577.9	3,952.8	6,959.1	12,109.7	13,104.8	13,378.7	14,530.4	15,908.2
Solectron	4,408.5	6,102.2	9,669.2	14,137.5	18,569.0	10,738.7	9,828.3	11,638.3
Sanmina-SCI	-	2,171.4	2,620.6	4,239.1	4,054.0	8,761.6	10,361.4	12,204.6
Celestica	2,006.6	3,249.2	5,297.2	9,752.1	10,004.4	8,271.6	6,735.3	8,839.8
Jabil Circuit	1,178.6	1,484.2	2,238.4	3,558.3	4,330.7	3,545.5	4,729.5	6,252.9
<b>5. Total Assets</b>								
Taiwanese EMS Firms	804.8	892.0	1,196.7	1,828.1	1,898.4	2,703.4	3,920.5	4,760.7
Hon Hai	773.4	1,101.1	1,737.9	2,827.8	2,953.8	3,819.6	6,565.9	9,075.7
Quanta	-	-	-	2,100.5	2,159.1	2,885.8	4,538.4	5,194.6
Compal	888.1	898.3	1,157.7	1,609.9	1,896.5	2,800.4	3,792.6	3,841.6
Lite-on	719.8	584.0	670.6	1,119.1	1,300.7	2,624.8	3,191.5	3,925.6
Inventec	838.0	984.4	1,220.5	1,483.2	1,181.9	1,386.1	1,514.3	1,766.1
American EMS Firms	1,475.9	1,972.3	3,561.6	6,475.3	6,871.1	7,056.2	6,376.8	6,528.1
Flextronics	1,862.1	2,783.7	5,134.9	7,571.7	8,644.7	8,394.1	9,583.9	11,007.6
Solectron	2,209.9	2,843.7	5,420.5	10,375.6	13,079.9	11,014.0	6,529.5	5,817.0
Sanmina-SCI	-	-	-	-	3,640.3	7,518.1	7,390.9	7,546.6
Celestica	1,347.3	1,636.4	2,655.6	5,938.0	6,632.9	5,806.8	5,134.7	4,939.8
Jabil Circuit	484.1	625.2	1,035.4	2,015.9	2,357.6	2,547.9	3,244.7	3,329.4
<b>6. Cost of Goods Sold</b>								
Taiwanese EMS Firms	843.4	942.1	1,265.2	2,226.8	2,465.5	3,581.2	5,750.6	7,868.1
Hon Hai	575.7	841.7	1,346.1	2,444.1	3,721.4	6,356.3	10,173.6	14,222.4
Quanta	-	-	-	2,345.7	2,889.3	3,709.6	8,039.6	9,201.0
Compal	-	982.5	1,257.1	2,175.7	2,087.1	3,149.2	4,616.3	6,365.6
Lite-on	589.8	672.4	655.3	1,172.6	1,366.8	2,547.7	3,607.7	5,668.7
Inventec	1,364.7	1,271.8	1,802.2	2,996.1	2,262.9	2,143.3	2,315.7	3,882.8
American EMS Firms	2,056.6	3,988.8	6,660.9	9,154.2	9,220.6	8,439.7	8,751.8	10,323.3
Flextronics	2,246.1	3,512.2	6,335.2	11,127.9	12,225.0	12,650.4	13,704.6	14,827.9
Solectron	-	5,435.6	8,732.9	12,862.2	17,137.1	10,233.8	9,386.3	11,058.0
Sanmina-SCI	-	-	-	3,562.4	3,512.6	8,386.9	9,899.0	11,584.4
Celestica	1,867.0	3,018.7	4,914.7	9,064.1	9,291.9	7,716.5	6,475.2	8,431.9
Jabil Circuit	-	-	-	-	3,936.6	3,210.9	4,294.0	5,714.5

**Appendix Table 1 (continued)**

<b>Firm Group, Firm</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>7. Inventory at the end of the Current Year</b>								
Taiwanese EMS Firms	91.9	128.4	236.4	284.5	257.1	351.8	602.5	823.6
Hon Hai	93.4	169.3	260.5	497.7	371.8	451.6	1,109.8	1,903.8
Quanta	-	-	-	203.2	316.7	505.7	747.0	655.2
Compal	10.8	77.6	195.6	223.3	205.9	276.9	412.5	494.7
Lite-on	126.9	88.5	171.3	248.3	269.0	349.1	515.9	746.0
Inventec	136.5	178.5	318.1	249.8	122.1	175.7	227.1	318.0
American EMS Firms	312.9	430.9	1,020.6	2,412.9	1,362.0	1,051.6	1,005.1	1,152.0
Flextronics	-	-	1,142.6	1,787.1	1,292.2	1,141.6	1,179.5	1,518.9
Solectron	-	-	1,197.0	3,787.3	3,209.9	1,822.1	1,327.3	1,457.2
Sanmina-SCI	-	-	-	-	503.8	1,123.0	977.8	1,064.5
Celestica	312.9	430.9	722.3	1,664.3	1,372.7	775.6	1,030.6	1,062.9
Jabil Circuit	-	-	-	-	431.5	395.9	510.2	656.7
<b>8. Inventory at the end of the Previous Year</b>								
Taiwanese EMS Firms	-	91.9	128.4	236.4	284.5	257.1	351.8	602.5
Hon Hai	-	93.4	169.3	260.5	497.7	371.8	451.6	1,109.8
Quanta	-	-	-	-	203.2	316.7	505.7	747.0
Compal	-	10.8	77.6	195.6	223.3	205.9	276.9	412.5
Lite-on	-	126.9	88.5	171.3	248.3	269.0	349.1	515.9
Inventec	-	136.5	178.5	318.1	249.8	122.1	175.7	227.1
American EMS Firms	-	312.9	430.9	1,020.6	2,412.9	1,362.0	1,051.6	1,005.1
Flextronics	-	-	-	1,142.6	1,787.1	1,292.2	1,141.6	1,179.5
Solectron	-	-	-	1,197.0	3,787.3	3,209.9	1,822.1	1,327.3
Sanmina-SCI	-	-	-	-	-	503.8	1,123.0	977.8
Celestica	-	312.9	430.9	722.3	1,664.3	1,372.7	775.6	1,030.6
Jabil Circuit	-	-	-	-	-	431.5	395.9	510.2
<b>9. Research and Development Expenditures</b>								
Taiwanese EMS Firms	21.2	21.7	26.3	32.9	38.2	59.8	83.8	103.4
Hon Hai	27.8	30.3	36.3	58.7	67.1	110.8	161.7	211.5
Quanta	-	-	-	30.3	39.7	54.8	73.7	87.9
Compal	-	16.0	20.7	26.3	30.6	56.6	76.5	88.1
Lite-on	10.5	9.4	9.7	11.1	15.9	33.4	68.3	87.1
Inventec	25.4	31.1	38.6	38.1	37.9	43.6	38.9	42.2
American EMS Firms	-	-	-	-	24.2	23.6	29.5	21.6
Flextronics	-	-	-	-	-	-	-	-
Solectron	-	-	-	-	65.9	59.7	69.1	-
Sanmina-SCI	-	-	-	-	7.4	8.6	15.0	29.4
Celestica	-	-	-	-	17.1	18.2	24.0	-
Jabil Circuit	-	-	-	-	6.4	7.9	9.9	13.8

**Appendix Table 1 (continued)**

<b>Firm Group, Firm</b>	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>10. Fixed Assets (Property, Plant and Equipment, net)</b>								
Taiwanese EMS Firms	165.0	166.6	215.8	417.3	330.3	398.2	529.6	670.3
Hon Hai	221.7	318.5	437.7	778.3	914.3	910.0	1,433.5	1,770.2
Quanta	-	-	-	812.2	226.1	302.4	501.2	715.5
Compal	-	119.0	176.5	191.5	194.4	229.3	269.0	310.9
Lite-on	148.8	82.6	82.5	107.8	116.6	363.0	286.9	276.5
Inventec	124.4	146.2	166.5	196.5	200.2	186.3	157.6	278.4
American EMS Firms	146.3	237.0	691.6	1,032.4	1,125.9	1,120.0	947.5	911.9
Flextronics	-	-	1,323.7	1,828.4	2,032.5	1,965.7	1,625.0	1,704.5
Solectron	-	-	723.8	1,080.4	1,304.7	1,081.3	781.9	726.6
Sanmina-SCI	-	-	-	-	632.6	1,084.5	902.9	782.6
Celestica	124.2	214.9	365.4	633.4	915.1	727.8	681.4	569.3
Jabil Circuit	168.4	259.0	353.5	587.5	744.7	740.9	746.2	776.4

Notes: - = not available; figures for firm groups are means for the group.

Sources:

Taiwanese firms from the Taiwan Stock Exchange Corporation home page (<http://emops.tse.com.tw/>)

American firms from the Company Home Pages (See Appendix Table 2)

**Appendix Table 2: Data Sources (Home Pages) for EMS Firms**

<b>Item</b>	<b>Detail</b>
<b>Corporate Home Pages</b>	
Hon Hai	<a href="http://www.honhai.com.tw/">http://www.honhai.com.tw/</a>
Quanta	<a href="http://www.quanta.com.tw/">http://www.quanta.com.tw/</a>
Compal	<a href="http://www.compal.com.tw/">http://www.compal.com.tw/</a>
Lite-on	<a href="http://www.liteon.com.tw/">http://www.liteon.com.tw/</a>
Inventec	<a href="http://www.inventec.com.tw/">http://www.inventec.com.tw/</a>
Flextronics	<a href="http://www.flextronics.com/">http://www.flextronics.com/</a>
Solectron	<a href="http://www.solectron.com/">http://www.solectron.com/</a>
Sanmina-SCI	<a href="http://www.sanmina-sci.com/">http://www.sanmina-sci.com/</a>
Celestica	<a href="http://www.celestica.com/">http://www.celestica.com/</a>
Jabil Circuit	<a href="http://www.jabil.com/">http://www.jabil.com/</a>