

# **What's New About Outsourcing?\***

Justin Yifu Lin  
Peking University and  
Hong Kong University of Science and Technology

Yingyi Tsai  
National University of Kaohsiung

February 2005

---

\* Paper prepared for the Pacific Asia Free Trade and Development 30<sup>th</sup> Conference to be held at the East-West Center, Honolulu, Hawaii on February 19-21, 2005. Please forward comments of the paper to Justin Yifu Lin, China Center for Economic Research, Peking University, Beijing 100871, China; Email: [jlin@ccer.pku.edu.cn](mailto:jlin@ccer.pku.edu.cn).

# What's New about Outsourcing?

## 1. Introduction

Firms using outside contractors to complement their production of end commodity is not a new phenomenon (Domberger, 1998). Notable examples are production of the Barbie doll, a star product of the Mattel Inc. (Tempest, 1996), the “American” car (WTO Annual Report, 1998), and the Nike sportswear (Tisdale, 1994). One important feature of these activities is the relatively insignificant share of the production value that is generated in the United States even with the rises of outsourcing in the past two decades. Indeed, Abraham and Taylor (1996) document an increase in the outsourcing of business services in thirteen U.S. industries. Campa and Goldberg (1997) measure outsourcing by imported intermediate inputs for various industries for Canada, Japan, the United Kingdom, and the United States, and show, except for Japan, that there is a doubling of the share of imported inputs between 1975 and 1996 for all manufacturing in the United States, and that the United Kingdom demonstrates a large increase in foreign outsourcing. Similarly, Feenstra (1998) measures all imported intermediate or final goods that are used in the production of an American firm, or sold under its brand name, compares different measures of foreign outsourcing, and shows that they have all increased since the 1970s. Hummels, Rapoport, and Yi (1998) take the ‘value chain’<sup>1</sup> aspect of vertical specialization in particular segments and compute for nine OECD countries the imported intermediate inputs. They have also reported growth in international outsourcing.

---

<sup>1</sup> Krugman (1995) uses the term of “slicing the value chain” to characterize the growing disintegration of the production process.

Subsequent to the growth of outsourcing, much attention has been directed to the relations between wage inequality, job losses and outsourcing activities (see, for instance, Abraham and Taylor (1996), Feenstra and Hanson (1996), Slaughter (2000)). Labor-market effects are essentially the central theme of these studies. This issue is important when, in particular, the global economy is characterized as one that “the rising integration of world markets has brought with it a disintegration of the production process, in which manufacturing or services activities done abroad are combined with those performed at home” (Feenstra, 1998, p. 31).

Recent studies, nonetheless, show that outsourcing need not be the culprit for job losses in the United States since, at least, 2001. For instance, Baily and Lawrence (2005) investigate the extent of job dislocation due to offshoring<sup>2</sup> in the manufacturing and service sectors from 2000 and 2003, and show that only about 314,000 jobs (11 percent of the manufacturing jobs lost) were lost as a result of trade. They further show that service sector offshoring destroyed even fewer jobs.

While acknowledging the contribution of previous studies on outsourcing and their valuable insights on explanations for the growing outsourcing activities,<sup>3</sup> firm’s choices of what to outsource and when to outsource,<sup>4</sup> trade structure and the role of multinational companies,<sup>5</sup> some essential issues still beg for more detailed analyses in the wake of globalization. This is due in part to the link with trade alone does not

---

<sup>2</sup> Various terms have been used in the literature to characterize the disintegration of production process. For instance, Jones and Kierzkowski (1990, p. 31) use “fragmentation” to describe the changes of an integrated production system into one with separated production blocks connected by service links. Venables (1999) also uses ‘fragmentation’ while characterizing the changing production structure in the electronics industry. Antras and Helpman (2004, pp. 552-3) define outsourcing in terms of firm’s boundary and categorize such activities into domestic outsourcing and foreign outsourcing.

<sup>3</sup> For instance, Abraham and Taylor (1996), and Deavers (1997).

<sup>4</sup> See, for example, Grossman and Helpman (2003).

<sup>5</sup> See, for instance, Antras (2003), and Antras and Helpman (2004).

feature comprehensively in the developments of this subject, limiting its appeal in understanding some important implications. Further, the very origin of outsourcing and the mechanism by which it relates to speedy technological progress in the developed countries and economic growth in the less developed countries and other undesirable effects are also obviously important questions.

In this paper, we shed light on some topics of fundamental importance to enhance our understanding of the dynamics of outsourcing, its scope, and, most importantly, the policy implications. We shall discuss in what follows three major issues that emerge from outsourcing: first, an examination of the driving forces of outsourcing; second, the impact on relationship-specific investment of outsourcing in the vertical supply links context; and third, the implications for competition and intellectual property protection that may emerge subsequent to the supplier's capability in accumulating knowledge through outsourcing activities.

In contrast to works that focus on wage and employment impacts of outsourcing, and study outsourcing in the relatively labor-intensive industry, we shall draw from semiconductor industry the experiences of outsourcing. This is because development in the semiconductor industry features not only a dramatic changing environment induced by technological innovation but also a close intra-industry partnership between the name-brand producer and the contract manufacturer. We shall analyze detailed industry data to explore how variations in market demand affect the allocation of resources to fixed-asset vs. research investment. Of principal interest is the impact on relationship-specific investment of outsourcing. In fact, we shall argue that by shifting away some production processes, outsourcing has an impact on capital investment in-house that are observationally equivalent to the changes induced by

technological progress. We shall also examine the implications for competition policy, in particular, the protection of intellectual property, of outsourcing. Our goal is to understand how growth of outsourcing activities impinges upon the progress of global technological innovation through learning-by-doing. In fact, it is an important task of any theory of trade to explain the links between technological progress and growth of outsourcing, on the one hand, and between market conditions and innovations, on the other.

## **2. A New Dimension of Production Disintegration**

Recent development of outsourcing has presented a picture different from that characterized by the textile, apparel and footwear industries as evidence by the manufacture of Barbie doll and the production of shoes and clothing for Nike, which characterizes production in the relatively labor-intensive industries with companies shift overseas low-cost parts of the production process, or import products at an intermediate stage of processing then assemble the intermediate products and sell under the brand name (Feenstra, 1998).

Consider production of the medical device of pacemaker (Deutsch, 2004). Engineers at Medtronic designed the original monitor for the CareLink, a home-use wireless gadget that can transmit data from implanted device, but for its next model the designing work of monitor will be shifted to other companies at home rather than abroad. Similar examples of design outsourcing abound. Honeywell contracts with IBM for the design of many core processors that are used in fighter jet. Boeing Commercial Aircraft also contracted out the design of the wing structure and fuselage on the Boeing 7E7. General Motors Shanghai has contracted out to Visteon, an

automotive supplier listed in the NYSE offering integrated systems in chassis, driveline, electronics, audio, exteriors, and interiors, the design of the interior of a high-end car that is sold in China.

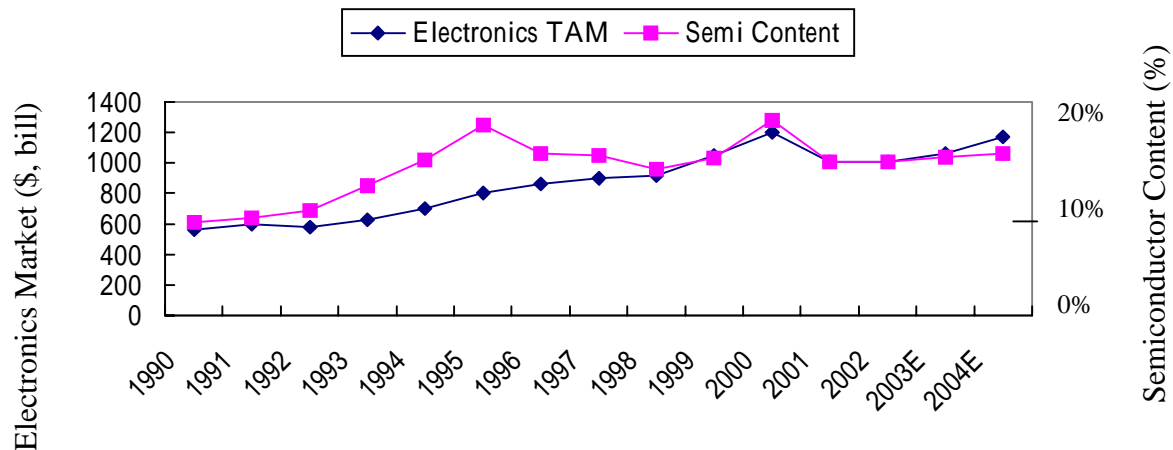
In what sense are the outsourcing activities by Medtronic and General Motors different from those by Mattel and Nike that use a large number of subcontractors abroad but generate at home country a significant share of merchandise value-added? Specialization seems to be able to offer a technological-driven perspective of the explanation for the growing disintegration of the production process, in which manufacturing or services activities done outside the firm's boundary are combined with those performed in house. And economies of scale may provide explanation of the rising offshoring activities in sectors with substantial technology intensity. Nonetheless, looking within comparative advantage, specialization, and scale economies does not provide full perspective on what is happening. This becomes clearer when issues of market competition and technological progress come into play. In fact, brand-producing firms seek to rapidly push forward products at greater varieties in response to the fast changing market environment. To develop new products, the outsourcer can take advantage of the outside opportunities by going to specialists and leverage on other's technology. As a result, it can utilize fully the in-house resources and avoids the time-consuming product development process and even the costly fixed investment.

While comparative advantage, specialization and scale economies explain well the increasing outsourcing, we can add another possibility, as touched upon by Van

Mieghem (2001)<sup>6</sup>: as the variations in market demand increases, so do outsourcing activities, needed in part to offset the external risks from idle capacity.

### 3. Outsourcing in the Technology Sector

To provide a different perspective of the nature of outsourcing in industries that feature rapid technological innovation and fast changing market environment, we use semiconductor as an example. There are several reasons. First, it is a sector that is expanding rapidly and whose effects are permeating the production structures of electronics systems, which, in turn, influence virtually every activity in the manufacturing and service sectors. Figure 1 shows the history of growth of the share of semiconductor component in the electronics product.



Source: Morgan Stanley Research, WSTS, and Dataquest.

**Figure 1. Semiconductor Content Growth in the Electronics System**

Recent industry analyses<sup>7</sup> report that, in 2002, outsourcing generates 15% of the

<sup>6</sup> For instance, Van Mieghem (2001) evaluates the option of outsourcing to improve financial performance and system coordination in a two-stage game with uncertainty.

<sup>7</sup> See, for instance, a publication by the Fabless Semiconductor Association (FSA), available at <http://www.fsa.org/pubs/outsourcingTrends/default.asp>

industry's revenue, which is expected to grow to \$360 billion in 2010 from \$141 billion in 2002, and that this figure is expected to further rise to 34% in 2010.

Second, semiconductor is a sector in which economies of scale prevail in each individual segment at the firm level, but the overall growth is subject to Moore's Law.<sup>8</sup> This implies that cyclicalities strongly influence the growth of the semiconductor industry, and that firms must explore surplus through vertical specialization in the presence of rapid technological changes and a volatile market environment.

And third, semiconductor appears to be a sector in which vertical disintegration has been distinct and quite dramatic,<sup>9</sup> especially over the past twenty years – as evidenced by the increasing specialization of the world's largest electronics producers, such as IBM, the growth of Fabless companies, and the emergence of Foundries in Asia.

Before investigating the impact of rising outsourcing (of business services) on market volatility driven by drastic innovation,<sup>10</sup> we provide a brief background of the semiconductor industry with particular reference to the production specifics and the business models that have been evolved.

### **3.1 Vertical Disintegration and Business Models**

Figure 2 illustrates the flow of chip production and the business models of Integrated

---

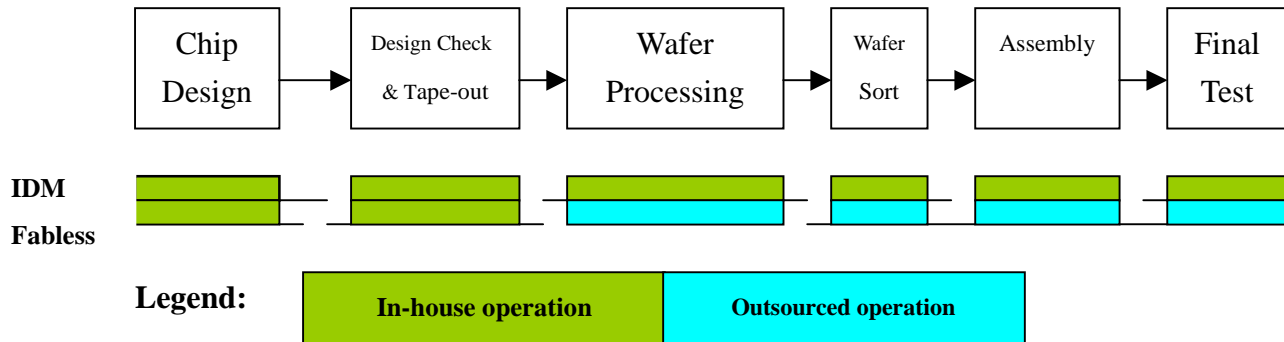
<sup>8</sup> An industry phenomenon observed by Gordon Moore, co-founder of Intel, of the exponential growth rate in the number of transistors in an integrated circuit. Moore predicts that there is a doubling in the number of transistors manufactured on a single piece of silicon every two years. Moore's Law essentially implies that rapid technological progress in the semiconductor industry brings about increased chip functionality at lower costs.

<sup>9</sup> Venables (1999) studies implications for trade of the changing production structure in the electronics industry.

<sup>10</sup> See Tirole (1988) for a detailed analysis on research development.



Device Manufacturer (IDM) and Fables<sup>11</sup>. A functioning chip is the key product of the semiconductor industry. The flow of chip production requires several competencies in each individual segment of the value chain, including circuit design, verification, wafer processing, assembly, testing and product distribution.



Source: International Technology Roadmap for Semiconductor (ITRS, 2002)

**Figure 2. IDM vs. Fables Business Model**

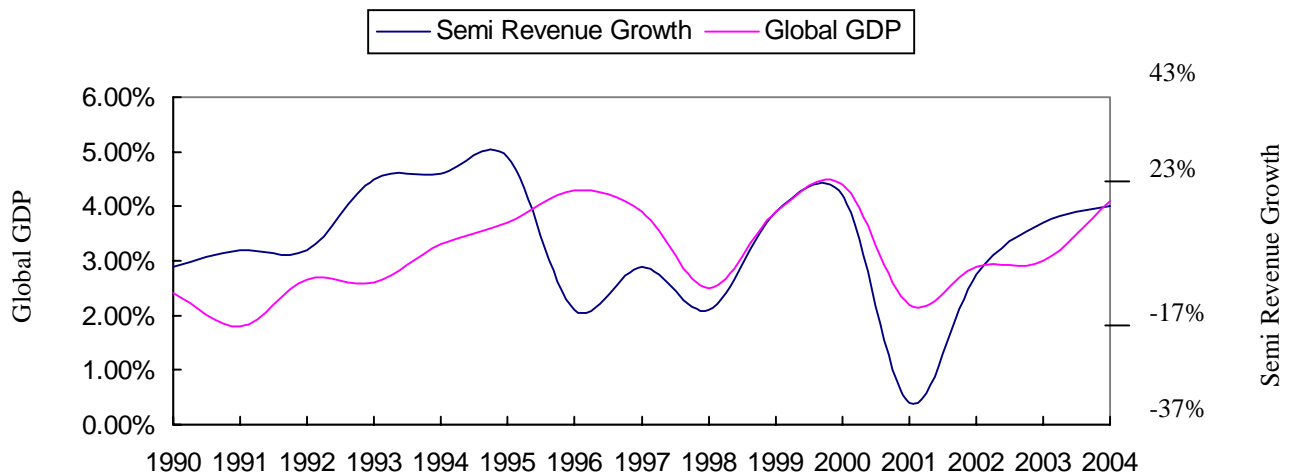
Essentially, the segment of chip design requires huge investments in research and development for product innovation, while each of the remaining segments of wafer processing, assembly and testing involves extensive capital investments.

Since the semiconductor industry is a sector with strong globalization potential driven by technological innovation and close intra-industry linkage. Its production is virtually dependent upon capital, innovation and the ability to acquire technology know-how. For these reasons, differences in technological specialty, capability of

<sup>11</sup> “Fables” refers to the business methodology of outsourcing the manufacturing of silicon wafers. Fables companies focus on the design, development and marketing of their products and form alliances with foundries, or silicon wafer manufactures. And “Integrated Device Manufacturer (IDM)” refers to a class of semiconductor companies that owns an internal silicon fab or, alternatively, the fabrication of wafers is integrated into its business. Nonetheless, even IDMs may undertake some outsourcing activities. “Foundry” is a service organization that caters to the processing and manufacturing of silicon wafers. It typically develops and owns the process technology or partners with another company for it.

engaging in costly fixed investment and the market volatility, can drive the global production location decisions for different fragments in the production process.

As technology progresses and the level of manufacturing complexities rises, companies typically need to invest significant amount of capital expenditure to attain and retain those manufacturing capabilities. The extreme capital intensity and the cyclical nature of the industry have made such high levels of continued investment unsustainable for most companies, especially during economic downturns. Figure 3 shows the revenue growth of semiconductor industry relative to the global GDP. It is clear that this industry suffers from severe cyclicality since 1995, that 2001 has marked the worst year over the past decade, and that decline in the growth of semiconductor revenue has dropped sharply relative to that of the global GDP.

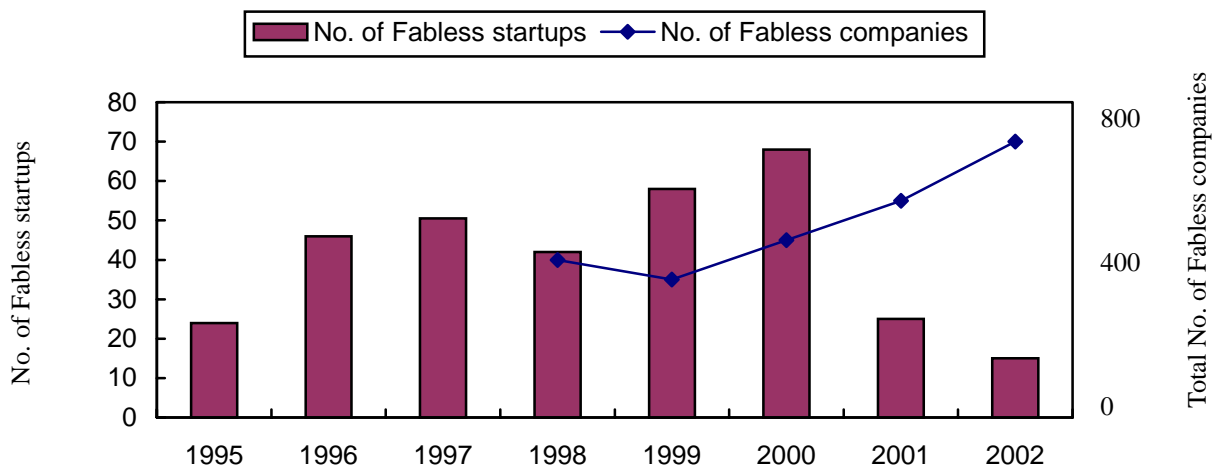


Source: Morgan Stanley Research, WTS, and US Government Data

**Figure 3. Cyclicalty of the Semiconductor Industry**

Consequently, firms in the semiconductor industry began to partially outsource manufacturing steps. Indeed, this is evident from the division of chip design and

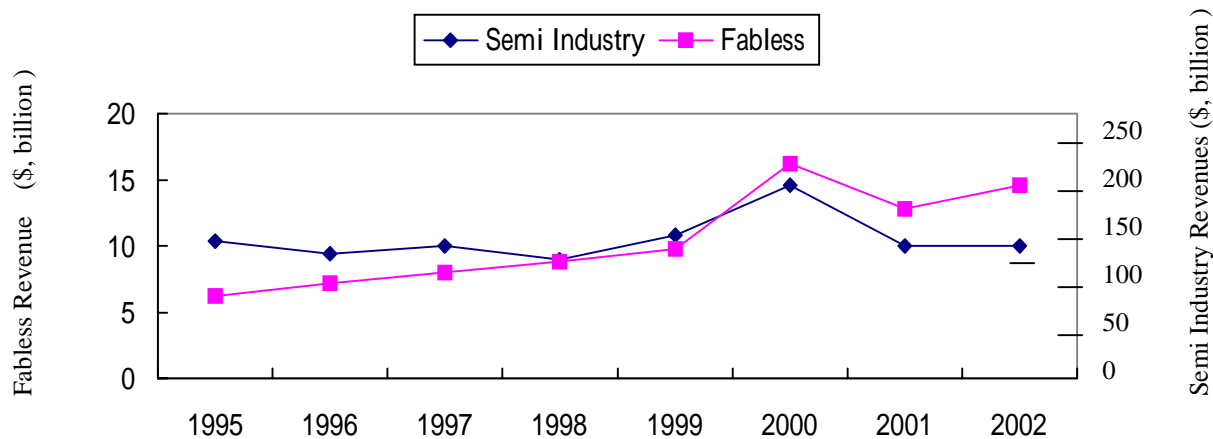
manufacturing competencies into separate businesses, with many “fabless” design companies feeding focused, manufacturing-oriented foundries, set the stage for a true outsourcing business model. With this change, the focus for chip-design companies shifted more toward product marketing, increasing the ability of these companies to leverage the value chain for the end user. The function of research and development (R&D) splits into two domains: the manufacturing R&D, which the foundries assumed, and the product development R&D, which the fabless companies assumed. Figure 4 demonstrates the growth of Fabless companies since 1995. It shows a substantial growth in the number of Fabless startups during 1995-2000, and a significant drop in years 2001-2.



Source: FSA, 2003

**Figure 4. Growth of the Fabless Companies**

Figure 5 further shows the trend of revenue growth of Fabless companies as compared to that of the semiconductor industry.



Source: FSA, 2003

**Figure 5. Revenue Growth of the Fabless Companies**

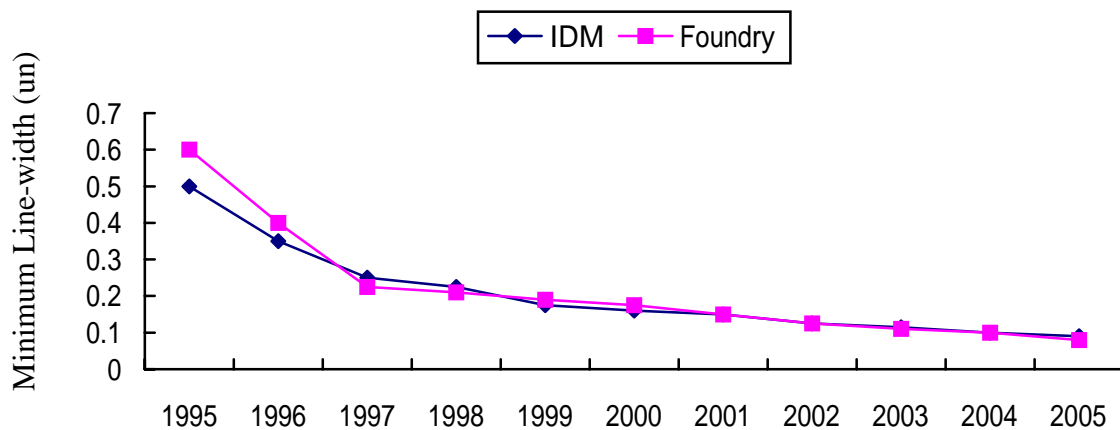
This aforementioned development, therefore, gives rise to three business models: Integrated Device Manufacturer (IDM) model, Fabless model, and Hybrid model with which companies in the semiconductor industry is characterized.<sup>12</sup> IDM model refers to a company that undertakes exclusively in-house the jobs of product design, wafer manufacturing, chips assembly and testing in a vertical supply chain flow. Intel and Samsung are good examples of IDM companies. Fabless model refers to companies that retain in-house the chip design segment and outsource other functions. Broadcom, NVIDIA and Xilinx fall into this category. And Hybrid model means that companies engage in partial outsourcing of their manufacturing processes, Motorola and LSI Logic are examples of companies that are increasingly relying on foundries to provide a portion of their manufacturing needs. Note that the partial outsourcing strategy allows a company to selectively utilize wafer foundry services from other IDMs or foundries or both.

<sup>12</sup> Scherer and Ross (2000, p. 531) use the term ‘tapered integration’ to characterize the hybrid business model. Kerschbamer *et al.* (2002) investigate firm’s investment choices under different scenarios of full integration (equivalent to the IDM business model), non-integration (the Fabless model), and tapered integration (the hybrid model).

Essentially, IDMs internalize the entire chip production supply chain, while foundries satisfy only the wafer manufacturing part of the supply chain. Wafer foundries, which offer basic wafer processing services with customized process modules to accommodate distinctive processing requirements of different customers, are able to offer an attractive processing cost option. This is because they are able to aggregate demand from multiple customers, to achieve economies of scale needed to operate a multibillion-dollar wafer fab optimally and damp rising costs of capital. As a result, the ability to benefit from the increased scale and focus derived from a captive and well-funded customer base has enabled the foundries to support concentrated investments in process R&D and to narrow or even exceed the technology lead that most IDMs previously maintained.

### 3.2 Technology Compatibility and Outsourcing Choices

Figure 6 illustrates the development of technology compatibility between IDMs and Foundries.



Source: International Technology Roadmap for Semiconductor (ITRS, 2002)

**Figure 6. Process technology capability: Foundry vs. IDMs**

It is evident that the differences in technology module between the two parties had narrowed down since 2001. An important message emerging from this development is that the close intra-industry linkage connected by technological compatibility leads to an interesting interplay. In fact, by engaging business with the foundries, IDMs can take advantage of excess capacity that the foundry may have in the high end, while internalizing legacy processes in-house. Alternatively, IDMs use foundries for advanced process development and transfer the process back to their fabs as needed, so that at the high end, the IDMs can be fab-lite while retaining their vertically integrated structure. Foundries, at the same time, invest heavily in the wafer fabrication facility, market available capacity to the IDMs and thereby pursue more product varieties to amortize their fixed development costs. Moreover, foundries must also invest in process innovation in addition to capital investment. This is because the level of manufacturing complexities demands foundries to keep up with frontier technology in order to secure contracts from the fabless and/or the IDMs.

While IDMs can bring to a foundry their technology expertise and share the costs of advanced technology development, the IDMs face, nevertheless, the hold-up problem, that is, the IDMs run the risk of not attaining the status of a preferred customer for the foundry. This is because IDMs simply use foundries purely as a second source of wafers. Therefore, it is reasonable to expect that foundries will seek customers with volume drivers that have a high barrier to switch. An additional risk to the IDMs in engaging with a foundry is that during the peak of a business cycle, when capacity becomes tight, foundries might not completely support an IDM's needs, as they are not considered a preferred customer. This implies that the IDM-foundry relationships can survive because of shared capital, as well as the optimal allocation of assets and risks. Hence, while a company like Intel has the scale and financial resources to

handle the risk of investing in a new process technology by aggressively investing in R&D and supporting its exposure over a number of products, many other IDMs do not have the scale to do so, and the need to strike a partnership with a foundry becomes potentially even more critical.

The Fabless Semiconductor Association (FSA), using the 2002 Survey results, reports that nearly 84% of global fabless companies use four Asian foundries catering for the processing and manufacturing of silicon wafers. Along with these few partners in the vertical-related production alliances, fabless companies focus on the design, development and marketing of their products. The worldwide public fabless company revenue grew steadily on an average of 40% since 2003, totaling \$8.3 billion.

Three important messages emerge from the trend of semiconductor outsourcing development. First, variations in market demand associated with technological innovation plays a crucial role in determining the direction of vertical specialization, and, therefore, the production location of specific segment. Second, the interaction of technology progress and market size with increasing returns plays an important role in shaping intra-industry trade within the broader context of globalization. And third, a cumulative process in which the suppliers acquire knowledge through outsourcing facilitates technology progress as well as market competition.

#### **4. Market Volatility as an Explanation of Outsourcing**

While most early works on outsourcing have focused on the link between outsourcing and labor cost (see, for instance, Feenstra and Hanson (1996), and Feenstra (1998)), more recent studies have offered alternative explanations. Grossman and Helpman

(2002, 2003) show that when by specialization a firm can gain production affiance, the firm would seek contracting out parts of production. Van Mieghem (1999) shows that depending on cost structure of manufacturer and subcontractor and the type of contract written between the two parties, either subcontracting or outsourcing can be an optimal way to resolve demand uncertainty. De Kok (2000) demonstrates that in presence of capacity constraints, an order processing firm can be better served to outsource its packaging instead of postponing the services whenever costs permit.

In the light of rapid technological progress characterizing volatile market environment, brand-producing firms face a tradeoff between costly and irreversible fixed investment associated with lower marginal costs and the flexibility of avoiding such a fixed investment at the cost of paying the supplier a premium relative to the marginal cost. Lin, Tsai and Wu (2003) offer an explanation of outsourcing based upon demand uncertainty. They show that outsourcing can be Pareto-improving in the presence of uncertain demand even though it involves some fixed cost. Under uncertainty, if it is possible to use outside resources, a brand-producing firm can explore the flexibility that is allowed for from outsourcing by adjusting its resources even the fixed investment was incurred. This suggests, therefore, that volatile market demand can impact on firm's make-or-buy decision, in addition to concerns over transaction costs (Coase, 1937; McAfee and McMillan, 1988), scale economies (Cachon and Harker, 2002), and specialization (Pisano, 1990).

Several studies have also addressed the explanations of outsourcing. For example, Abraham and Taylor (1996) show the volatility of output demand, together with the wage and benefit savings a firm can realize, and the availability of specialized skills possessed by the outside contractor all help to explain the observed contracting



behavior (p. 394). Deavers (1997) argues that several factors, including rapid technological change, increased risk and the search for flexibility, greater emphasis on core corporate competencies, and globalization, are at work simultaneously to increase outsourcing. Gonzalez-Diaz, Arrunada, and Fernandez (2000), however, report, using the panel data on construction firms in Spain, that uncertainty does not show any statistically significant effect on subcontracting although a higher risk of hold-up reduces subcontracting and a greater product variety can increase subcontracting (p.184).

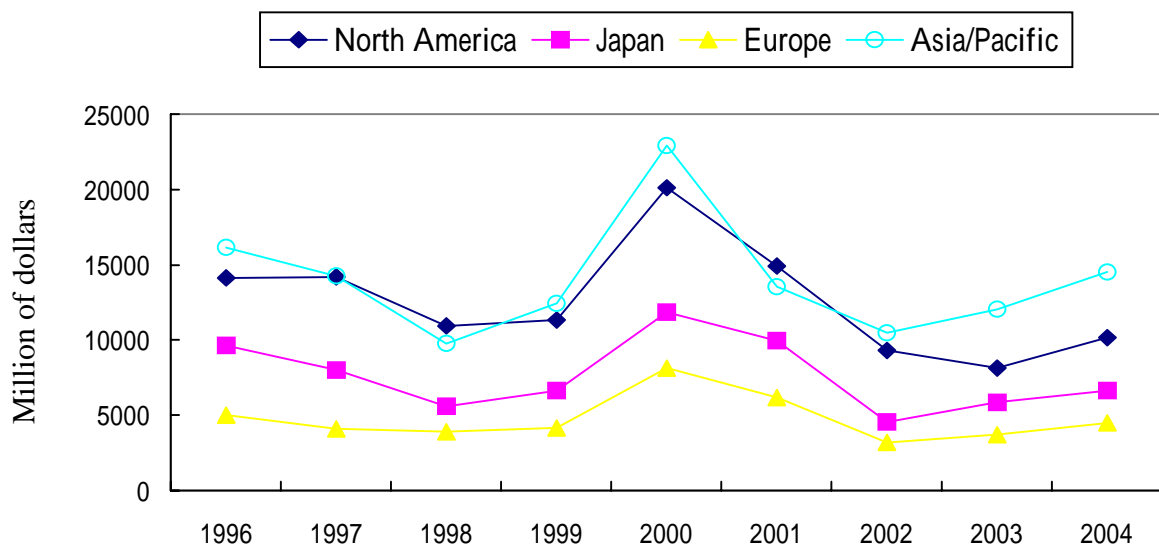
Hence, these insights suggest that we should not assess the proximate cause of the rising outsourcing activities by attributing all cross-industry shifts in labor demand to cost concerns (see, Feenstra and Hanson (1996), and Feenstra (1998)). Although comparative advantage can explain outsourcing, capacity constraints associated with irreversible, in-expandable investment must be taken into account, in particular, when the industry-specific characteristics involve high level of market volatility.

## **5. Implications for Fixed-Asset Investment**

The decision of firms to source production outside their boundaries will most certainly impact the in-house fixed-asset investment, and can be expected to have different effects on the allocation of resources for research activities. Indeed, the issue of investment choice under uncertainty has been much discussed (Abel *et al.*, 1996; Caballero, 1991; Dixit and Pindyck, 1994; Pindyck, 1988, 1993). In a volatile market environment with rapid technological progress, a firm's problem is to decide whether to invest now or postpone the decision until later, and is, therefore, comparable to a financial call option (McDonald and Siegel, 1986). Waiting will gain additional

information about market demand at the cost of losing the discounted payoff difference as of today. Outsourcing provides an opportunity to balance a trade-off between having capacity shortage while demand unexpectedly surges and excess capacity otherwise.

Lin, Tsai and Wu (2005) demonstrate that demand uncertainty can give rise to the optimality of outsourcing. They model a firm with irreversible and in-expandable production technology that faces an uncertainty quantity demanded. In a two-stage periodic process, the firm first determines the variable input of labor and then optimal capital needed to maximize its profits. They introduce the notion of outsourcing by assuming that the firm has exhausted its capacity and that outside units can be acquired at some cost. They then show that the level of positive random shock at or above which outsourcing is feasible is negatively related to the unit labor cost and positively associated with the outsourcing cost.

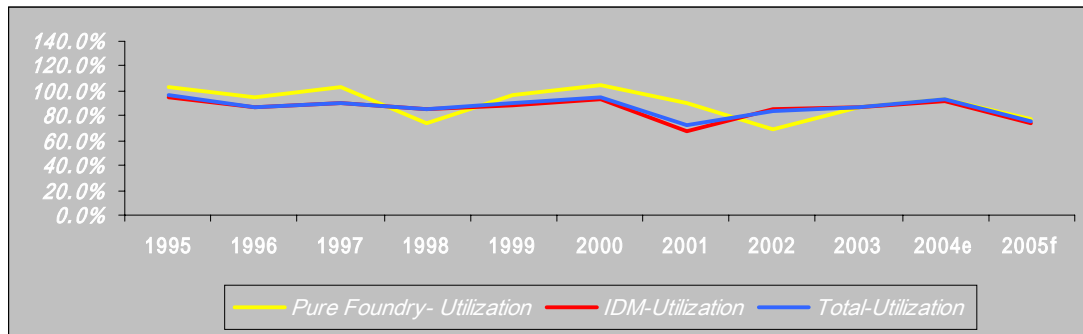


Source: Gartner Dataquest (2003)

**Exhibit 7. Worldwide Semiconductor Capital Spending - by Region**

Exhibit 7 illustrates the worldwide semiconductor capital expenditure by geographical location. It is evident that the Asian semiconductor companies engaging in back-end activities of wafer fabrication, chip test and assembly have invested a great deal in production facilities.

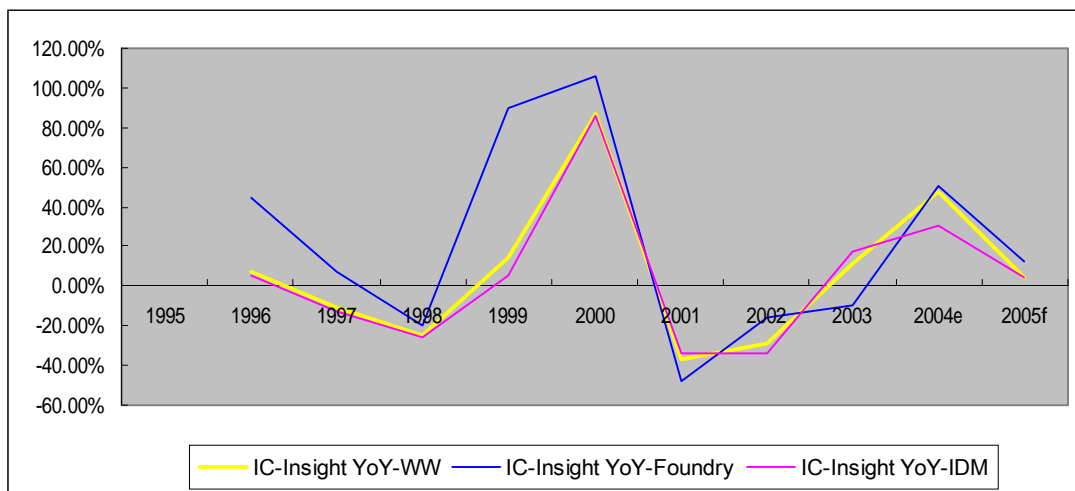
Exhibit 8 demonstrates the capacity utilization rate between the IDMs and Foundries.



Source: Gartner Dataquest, and IC-Insight.

### Exhibit 8. Capacity Utilization Rate

Exhibit 9 further shows that foundries, relative to the IDMs, invested a substantial amount in capacity during the period 1998-2000.



Source: IC-Insight and Gartner Dataquest

### Exhibit 9. Growth Rate of Capital Expenditure – by Business Models

## **6. Outsourcing and Intellectual Property Protection**

We have seen the wave of massive “manufacture outsourcing” that occurred since the 1990s, as with the development of major brand-name producers such as Hewlett-Packard, Motorola and IBM. The ability of these corporations to constantly provide new products has depended on an extensive system of outsourcing to the Newly Industrialized Countries. Compatibility of technology expertise between the supplier and the purchaser certainly plays an important role. Nevertheless, intellectual property protection within the outsourcing relationships cannot be ignored. Indeed, firms at the frontier invest significant amount of resources to develop technology libraries that may be used either in numerous products or in fewer and sometimes single products (Dell, 1999). While the development costs could be amortized over product varieties, the decision to invest scarce resources for library development exposes the research firm to high risk, not only in terms of prospect for marketability but also competition threat through spillovers. According to a 2002 market survey by Dataquest, the worldwide intellectual property market grew 10% in 2002, while the semiconductor market grew only 1%. And the top 20 companies accounted for about 84% of all intellectual property revenues in the industry, suggesting the industry is highly concentrated. Indeed, this is also evident from the semiconductor experiences of high concentration in a few Asia foundries of wafer fabrication for global IDMs and Fabless companies, and substantial growth of the Fabless semiconductor companies as a result of intellectual property outsourcing since, at least, 1995 (Fabless Semiconductor Association, 2005).

Clearly, outsourcing introduces a different dimension of intellectual property protection from those discussed in the trade-related intellectual property literature (see,

for instance, Helpman, 1993). More specific, outsourcing paves an avenue for intentional technology spillovers (or transfer) in a contracting environment under which both parties are closely interdependent. In fact, contracting out more work necessitates relying on suppliers to do some of the design work, since now the expertise that comes from learning by doing is located outside the purchasing firm. Furthermore, increasing the amount work outsourced means relying on subcontractors to discover cost-reducing and quality-improving innovations, activities that formerly were controlled within the buyer's own firm. Hence, the knowledge contained in the outsourcer's working blueprint is encouraged for rapid accumulation of the subcontractor. This implies outsourcing has suggested a rethinking into the issues of intellectual property protection in a broader context of globalization. In particular, the relations between intellectual property protection and its slow growth, and the concentration of intellectual property revenue in a few leading firms. Since outsourcing involves as much the appropriation problem and the incentives problem as does the trade-related intellectual property, the incumbent supplier knows that it mostly likely will benefit from its own improvement over a longer period than just the term of the current contract even though the purchasing firm can give the subcontractor incentives to innovate by promising to favor it over other potential suppliers when the contract is renewed (Laffont and Tirole, 1988).

Much attention in the theoretical literature of industrial organization has been devoted to the tradeoff between incentives and risk sharing (Holmstrom and Milgrom, 1987). The supplier must be given incentives to hold down production costs. The contract that does this best specifies only in advance a fixed price. But a fixed-price contract pushes all of the risk of unforeseeable and unpreventable cost fluctuations onto the supplier. Under such circumstances, the fixed price contract is not in the supplier's

interest, despite giving full incentives. It is, therefore, not surprising to see that, once having acquired technology expertise through learning by doing, the supplier can indeed pose a competitive threat to the purchaser.

## **7. Concluding Remarks**

In this paper, we have studied the nature of outsourcing by exploring the differences in industry-specific characteristics, which relates largely to technology progress and market demand. We argue that uncertainty can offer an explanation for the growing outsourcing activities, in particular, when the products are characterized by the level technology content. We also examine the implications for capital spending of outsourcing. We demonstrate that the possibility to outsource allow for greater relationship-specific investment in the outsourcing contract, as evidence in the semiconductor industry. We further examine the relations between outsourcing and intellectual property protection. The important message that emerges suggests a revisit into the simply make-or-buy decision under outsourcing.

Nevertheless, much remains to be done. Future empirical investigations are likely to unveil the impact of market volatility on outsourcing decision that cannot be accounted for by the simple theoretical model. On the one hand, the Helpman-Grossman theory helps our understanding of only a subset of the determinants of outsourcing decision. It would be interesting to investigate the implications of such a view for firms in different industries. On the other hand, future work should help us to understand potential channels by which technological differences, asset specificity and learning capability can affect the outsourcing decision and trade patterns.

## References

- Abel, Andrew B., Avinash K. Dixit, Janice C. Eberly and Robert S. Pindyck, "Options, the Value of Capital, and Investment," *Quarterly Journal of Economics*, 1996, 111(3), 753-777.
- Abraham, Katharine G., and Susan K. Taylor, "Firms' Use of Outside Contractors: Theory and Evidence," *Journal of Labor Economics*, 1996, 14, 394-424.
- Antras, Pol, "Firms, Contracts, and Trade Structure," *Quarterly Journal of Economics*, 2003, 118, 1375-1418.
- Antras, Pol, and Elhanan Helpman, "Global Sourcing," *Journal of Political Economy*, 2004, 112, 552-80.
- Baily, Martin N, and Robert Lawrence, "What Happened to the Great US Job Machine? The Role of Trade and Offshoring," *Brookings Paper on Economic Activity*, 2005, forthcoming.
- Caballero, Ricardo, 1991, "On the Sign of the Investment-Uncertainty Relationship," *American Economic Review*, 1991, 81(1), 279-288.
- Cachon, Gerard P, and Patrick T. Harker, "Competition and Outsourcing with Scale Economies," *Management Science*, 2002, 48, 1314-1333.
- Campa, Jose and Linda Goldberg, "The Evolving External Orientation of Manufacturing Industries: Evidence from Four Countries," *Federal Reserve Bank of New York Economic Policy Review*, 1997, 4, 79-99.
- Coase, Ronald H, "The Nature of the Firm," *Economica*, 1937, 4, 386-405.
- Deavers, Kenneth L., "Outsourcing: A Corporate Competitiveness Strategy, not a Search for Low Wages," *Journal of Labor Research*, 1997, 18, 503-19.
- De Kok, Ton G., "Capacity Allocation and Outsourcing in a Process Industry," *International Journal of Production Economics*, 2000, 68, 229-39.
- Deutsch Claudia H, "Companies, Focusing on Brands, are Outsourcing some Design Work," *The New York Times*, December 30, 2004.

- Dixit, Avihash K. and Robert, S. Pindyck, 1994, *Investment under Uncertainty*, (Princeton University Press).
- Domberger, Simon, 1998, *The Contracting Organization: A Strategic Guide to Outsourcing*, (Oxford University Press).
- Fabless Semiconductor Association (FSA), 2003 Publications – Outsourcing Trends, available at <http://www.fsa.org/pubs/outsourcingTrends/default.asp>.
- Feenstra, Robert C., “Integration of Trade and Disintegration of Production in the Global Economy,” *Journal of Economic Perspectives*, 1988, 12, 31-50.
- Feenstra, Robert C., and Gordon H. Hanson, “Globalization, Outsourcing, and Wage Inequality,” *American Economic Review Papers and Proceedings*, 1996, 86, 240-45.
- Feenstra, Robert C., and Gordon H. Hanson, “The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990,” *Quarterly Journal of Economics*, 1999, 907-40.
- Glass, Amy Jocelyn and Kamal Saggi, “Innovation and Wage Effects of International Outsourcing,” *European Economic Review*, 2001, 45, 67-86.
- Gonzalez-Diza, Manuel, Benito Arrunada, and Alberto Fernandez, “Causes of Subcontracting: Evidence from Panel Data on Construction Firms,” *Journal of Economic Behavior and Organization*, 2000, 42, 167-87.
- Grossman, Gene and Elhanan Helpman, “Integration versus Outsourcing in Industry Equilibrium,” *Quarterly Journal of Economics*, 2002, 117(1), 85-120.
- Grossman, Gene and Elhanan Helpman, “Outsourcing versus FDI in Industry Equilibrium,” *Journal of the European Economic Association*, 2003, 1, 317-27.
- Hart, Oliver, and John Moore, “Property Rights and the Nature of the Firm,” *Journal of Political Economy*, 1990, 98, 1119-58.
- Jones, Ronald W., and Henryk Kierzkowski, “The Role of Services in Production and International Trade: A Theoretical Framework” In Ronald W. Jones and Anne O. Krueger eds., *The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin*. Oxford: Basil Blackwell, 1990, 31-48.



Holmstrom, B, and Paul Milgrom, "Aggregation and Linearity in the Provision of Intertemporal Incentives," *Econometrica*, 1987, 55, 303-28.

Hummels, David, Dana Rapoport, and Kei-Mu Yi, "Vertical Specialization and the Changing Nature of World trade," *Federal Reserve Bank of New York Economic Policy Review*, June 1998.

Kerschbamer, Rudolf, Nina Maderner, and Yanni Tournas, "Idiosyncratic Investments, Outside Opportunities and the Boundaries of the Firm," *International Journal of Industrial Organization*, 2002, 20, 1119-41.

Krugman, Paul, "Growing World Trade: Causes and Consequences," *Brookings Paper on Economic Activity*, 1995, 1, 327-77.

Laffont, Jean-Jacques, and Jean Tirole, "Repeated Auctions of Incentive Contracts, Investment, and Bidding Parity, with an Application to Takeovers," *Rand Journal of Economics*, 1988, 19, 516-37.

Lin, Justin Y., Yingyi Tsai and Ching-Tang Wu, "Outsourcing, Product Innovation, and Optimal Investment under Uncertainty," *National University of Kaohsiung*, mimeo, 2003.

Lin, Justin Y., Yingyi Tsai and Ching-Tang Wu, "Optimal Capital Investment, Uncertainty and Outsourcing," *China Economic Quarterly*, 2005, forthcoming.

McAfee, Preston, and John McMillan, "Search Mechanisms," *Journal of Economic Theory*, 1988, 44, 99-123.

McDonald, Robert L., and Daniel R. Siegel, "The Value of Waiting to Invest." *Quarterly Journal of Economics*, 1986, 101, 707-28.

Pindyck, Robert S., "Irreversible Investment, Capacity Choice, and the Value of the Firm," *American Economic Review*, 1988, 78(5), 969-985.

Pindyck, Robert S., "A Note on Competitive Investment under Uncertainty," *American Economic Review*, 1993, 83(1), 273-277.

Pisano, G. P., "The R&D Boundaries of the Firm: An Empirical Analysis," *Administrative Science Quarterly*, 1990, 35, 153-76.

Scherer, Frederic M, and David Ross, *Industrial Market Structure and Economic Performance*, 2000, 3<sup>rd</sup> edition (Rand McNally).

Slaughter, Mathew, J., "Production Transfer within Multinational Enterprises and American Wages," *Journal of International Economics*, 2000, 50, 449-72.

Shy, Oz, and Rune Stenbacka, "Strategic Outsourcing," *Journal of Economic Behavior and Organization*, 2003, 50, 203-34.

Tempest, Rone, "Barbie and the World Economy," *Los Angeles Times*, September 22, 1996, A1 and A12.

Tirole, Jean, *The theory of Industrial Organization*, 1988 (Cambridge, MA: MIT Press).

Tisdale, Sallie, "Shoe and Tell," *The New Republic*, September 12, 1994, 10-11.

Van Mieghem, J., "Coordinating Investment, Production and Subcontracting," *Management Science*, 1999, 45, 954-971.

Venables, Anthony, J., "Fragmentation and Multinational Production," *European Economic Review*, 1999, 43, 935-45.