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Study of China's International Specialization Status in Advanced Technology Industry: A Case Study of Zhejiang Pinghu Opto-mechatronics Industry Cluster

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Abstract

Using the opto-mechatronics industry cluster of Pinghu, China, as a case study, this paper analyzes the international specialization status of China's advanced-technology industry. Our research indicates that Pinghu's industry cluster follows an exogenous industry cluster development model, which is typical of China's advanced-technology industries. In this model, government-guided foreign investment comes to a region first and generates learning spillovers for local enterprises, enabling the government to create a public platform for technology innovation. Foreign-owned and local private companies then work together to promote the further development of industry clusters. True to this model, the initial driving force behind the opto-mechatronics industry was the Chinese government, with foreign investment as its engine; then followed the

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public technology platform and supporting industries. Our study, based on interviews with industry personnel, also indicates that the performance of Pinghu's opto-mechatronics industry exceeds the national average and that Pinghu is becoming more like an endogenous cluster over time—more market-oriented and increasingly reliant on domestic factors. However, its average value-added ratio was relatively low; imported intermediate inputs still constitute a large share of the value of manufactured output. Thus, although Pinghu's opto-mechatronics industry enjoys a leading position in China, it remains largely concentrated on processing and assembly, which is at the low-skill-intensive end of the production chain.

Key words: Advanced-technology, international specialization, opto-mechatronics industry, industry cluster

1. Introduction

According to the theory of comparative advantage, China should not be strong in exporting advanced-technology products, because it is a large developing country with a huge pool of low-skilled labor. But since the 1990s, China's advanced technology exports have actually been increasing rapidly (figure 1). In 2007, the total volume and value of China's advanced-technology manufacturing exports ranked the second in the world. Some scholars attribute this to the advent of global production fragmentation and intraproduct specialization, which prompted many multinational companies (MNCs) to transfer their assembly processing facilities to developing countries with rich resources and cheap labor (Lall 2000; Mani 2000; Mayer et al. 2002; Branstetter and Lardy 2006; Srholec 2007). However, when it comes to developing a more micro perspective—i.e., understanding how a Chinese industry or industry cluster is embedded into the global advanced-technology industry chain and the role it plays in international specialization—a case study is necessary. Only in this way can we find some patterns in the development of China's advanced-technology industry, which may provide useful lessons for other developing countries.

Pinghu is in Zhejiang province, which has served as a trade route to Arab and Southeast Asian areas since the 12th century. Once dominated by the textile and garment industry, Pinghu has now become the premier destination for Japanese investment in Zhejiang and is home to the province's largest opto-mechatronics industry cluster. China is well known for its effectiveness in using foreign investment to spur industry agglomeration. But how has Pinghu

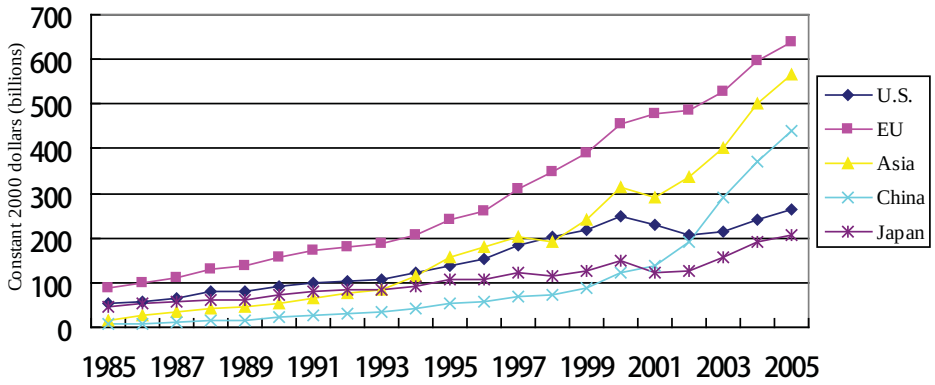
been able to make such substantial progress in just 10 years? Wang (2006) points out that the local government has played an important role in attracting investment and providing specialized services, which have helped Pinghu become, to a significant extent, an "exogenous industry cluster."[2]

However, two questions remain: (1) what was the original impetus to form the opto-mechatronics industry cluster in Pinghu? and (2) what is Pinghu's specialization in the global production chain? There is no empirical study based on company-level survey data that examines these issues. In this paper, we address these two questions with an analysis based on interviews with personnel in 120 opto-mechatronics companies. Our goal is to provide some information on Pinghu's experience and offer some suggestions to other developing countries interested in breaking into global advanced-technology industry chains and eventually upgrading to more advanced stages in those chains.

The paper consists of the following parts: section 2 outlines the current situation of the opto-mechatronics industry cluster in Pinghu and explains the research methodology. Section 3 analyzes the forces driving the industry's formation and growth, based on the survey data. Section 4 conducts cross-national comparisons to explore its international specialization status. Section 5 discusses several lessons that may be drawn from the study.

[2] As described by Zhou Hong et al. (2006), an exogenous industry cluster is started mainly by foreign direct investment, in contrast to an endogenous industry cluster, which is started by domestic investment. We found that the formation of Pinghu cluster benefited from both types of investment.

Figure 1 Export volume of advanced-technology manufactures, by region/country, 1985–2005



Notes: EU = European Union; Asia includes India, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan, and Thailand. China includes Hong Kong.

Source: Global Insight, Inc., World Industry Service database, special tabulations; Science and Engineering Indicators 2008

2. An overview of the Pinghu opto-mechatronics industry cluster and research design

2.1 Overview of the Pinghu opto-mechatronics industry cluster

With its origins in Liangzhu culture, Pinghu was given the name of "Golden Pinghu" in ancient times. Encompassing a number of smaller neighborhoods and towns, it is a city with a developed economy, society, and culture. Pinghu also enjoys a unique geographic location and good transportation. Because it is located in the Hangjiahu (Hangzhou, Jiaxing, Huzhou) plain, Pinghu is near Hangzhou Bay and has convenient access to water transportation. Moreover, Shanghai, Hangzhou, Suzhou, and Ningbo are all within about 100 kilometers distance.

The opto-mechatronics industry in Pinghu dates back to Pinghu's processing trade with a Japanese firm—Shibaura Co., Ltd[3]—starting in 1993. After Shibaura had developed a very good cooperative relationship with a state-owned firm processing electric transformers, Shibaura invested $200,000 and formed an

[3] Shibaura Co. Ltd of Japan is a world-renowned motor-producing company. For many types of motors, Shibaura's share of the world market exceeds 50 percent.

alliance with this local business in 1995. In 1998, Nidec of Japan took over the Shibaura manufacturing center. During a visit to Japan Electric Shibaura (Zhejiang) Co., Nagamori Shigenobu, president of Japan's Nidec Corporation, stated that he was motivated by the local government's support and decided to continue investing in the region. Thus began opto-mechatronics' rapid development in Pinghu.

By 2007, the gross output of Pinghu's opto-mechatronics producers reached 12.457 billion RMB, with 22.72 percent of the firms in the industry above the designated scale[4] (table 1). At present there are 128 opto-mechatronics companies in Pinghu, 17 of which have annual output exceeding 100 million units. Pinghu also has five important research and development (R&D) centers affiliated with these companies. Five companies are listed by the Ministry of Science and Technology as key enterprises for their excellent performance in technology innovation and new product development: Kanto Tatsumi Electronics (Pinghu) Co., Ltd, Zhejiang Hannao Digital Technology Co. Ltd, Pinghu Meijia Thermal Insulation Container Industrial Co., Ltd, Nidec Copal (Zhejiang) Co. Ltd, and Jiaxing Hengye Electronics Co., Ltd.

The opto-mechatronics industry cluster is centered in Danghu town, the site of Pinghu's economic and technology development zone. The cluster includes three nearby towns—Zhongdai, Lindai, and Huanggu—that are also part of Pinghu city (figure 2). Other industrial areas in the region, such as Shanghai, Anhui, and western Zhejiang, also benefit from its financial services and labor supply. From the construction schematic (figure 3), it can be seen that the main driving forces behind Pinghu's opto-mechatronics industry are the Japanese-funded enterprises in the economic development zone. At the center of figure 3 is Nidec Corporations. Vertical linkage companies provide it with upstream inputs; horizontal linkage companies make products that replace or complement those it produces; downstream firms buy its output. At the top is support from local government, while at the base are links between Nidec Corporations, banks, and technical schools that provide funds and labor to firms in Pinghu.

[4] Enterprises with annual output value of more than 5 million yuan.

Table 1 Total output of opto-mechatronics industry in Pinghu, 2002–07

Year	Number of enterprises	Total output (billion yuan)	Proportion of the entire industry (%)	Growth rate (%)
2002	22	21.1	13.8	45
2003	65	40.2	17.9	85.2
2004	71	65.9	24.4	64
2005	91	78.6	19	21
2006	102	101.5	27.4	22.68
2007	120	124.57	22.72	21.9

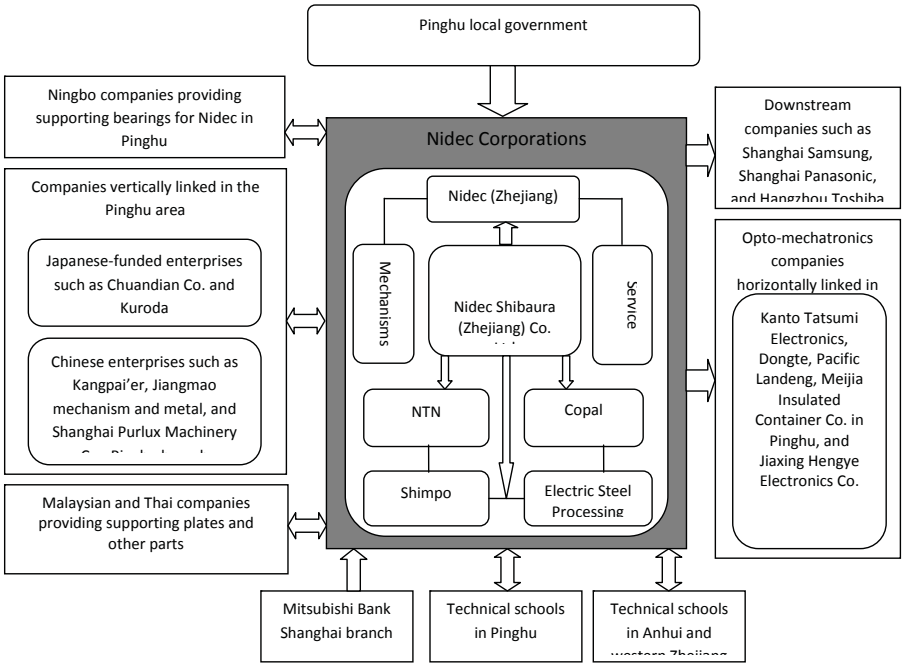
Source: Web site of Pinghu opto-mechatronics industrial base, *http://www.zjgjd.com/index.asp*

Figure 2 Map of Pinghu showing location of opto-mechatronics industry cluster

The primary goods manufactured by Pinghu's opto-mechatronics industry include such advanced-technology products as digital camera shutters, phone cameras, flash disks, MP3 players, fiber optical transceivers, optical fiber branching devices, sophisticated hydrodynamic bearings, micromachines, precision molds, fiber optic cannulas, digital photo printers, overhead projectors, measuring instruments, and electronic part sensors. Many of these are competitive in the international market. For example, Nidec (Zhejiang) Co. Ltd has 70 percent of the global market for spindle motors of laptop hard

drives; Nidec Copal (Zhejiang) Co. Ltd has 30 percent of the global market for mobile phone vibration motors, 70 percent of the market for digital camera shutters, and 80 percent of the market for polygon reflectors. Other world-class products also come from this cluster, such as hydrodynamic bearings from NTN-Nidec (Zhejiang) Co. Ltd, semiconductor measuring instruments from Nidec Mechanism (Zhejiang) Co. Ltd, and derailleurs from Nidec Copal (Zhejiang) Co. Ltd.

Figure 3 Schematic drawing of Pinghu's opto-mechatronics industry cluster



Source: Zhang 2006, 190.

2.2 Research design

We first collected publicly accessible information, including administrative divisions, geographic characteristics of Pinghu, and economic and social statistics published by the government body. We interviewed local officials, members of industry associations, and entrepreneurs so that we could design

and improve our questionnaires. The final field investigation lasted one month, from June to July 2009. It targeted 108 opto-mechatronics companies in the Pinghu economic and technology development zone and 20 in Zhongdai, Huanggu, and Lindai towns. The first step was meeting with chief management staff to get information that could not be obtained through questionnaires, at which time we also asked them to fill out questionnaires. In total we visited 128 companies, receiving 120 effective questionnaires.[5] The information from the companies follows (table 2).

Table 2 Basic statistical information about companies surveyed

Type of company	Industry	Registered capital, in yuan	Value of annual output, in yuan	Number of employees
Wholly foreign-owned 38 (31.6%)	*Electronic information* 19 (15.8%)	*Over 10 million* 44 (36.7%)	*Over 100 million* 26 (21.7%)	*Over 3,000* 37 (30.8%)
Private 56 (46.7%)	*Opto-mechatronics* 88 (73.3%)	*5 to 10 million* 50 (41.7%)	*50 to 100 million* 47 (39.2)	*1,000 to 3,000* 44 (36.7%)
Joint venture 22 18.3%		*1 to 5 million* 8 (9.6%)	*10 to 50 million* 33 (27.5%)	*500–1,000* 12 (10%)
Others 4 (3.4%)	*Others* 13 (10.9%)	*Under 1 million* 18 (15%)	*Under 10 million* 14 (11.7%)	*Under 500* 27 (22.5%)

Note: In parentheses are ratios compared to overall samples. Although our questionnaire spanned the period from 2005 to 2008, respondents only provided data for 2008.

3. The driving force behind the opto-mechatronics industry cluster's formation and growth in Pinghu

Marshall (1920) argues that the forces of cluster formation are (1) knowledge spillovers, (2) markets for specialized machinery and the ability to use specialized machinery with economies of scale, and (3) the pooling of skilled labor with skills specific to an industry. Porter (1998) points out that the evolution of an industry cluster depends on its history and culture, demand stimulation, upstream and other related industries, and new and supporting enterprises. The strategies and structure of a company, as well as competition and opportunities, should also be considered. Brenner (2001) thinks human capital, technology spillovers, cooperation, public opinion, government policies, and venture capital need to be taken into account as well. Saxenian (1996) did a comparative study of the Silicon Valley and advanced-technology zones along Route 128 in the Boston area and found that specialization, competition, and corporate culture are important for the growth of industry

[5] There are 128 opto-mechatronics companies in Pinghu, according to statistics. But 8 of them are very small and didn't complete our questionnaire, so we excluded them from the sample.

clusters. Wang and Cai (2009) and Zeng (2006) studied cluster formation in China and reported that many elements are important, including industry traditions, geographic location, cultures of trust, government policies, foreign trade, natural resources, transaction costs, and more.

Table 3 Primary reasons for investment in Pinghu during various periods

	Reason for investment					
Year founded	Government support and service	Preferential policy	Following up- and downstream companies	Market potential	Available supporting industries	Good geographic location
1999–2001 (20)	9 (45%)	5 (25%)	2 (10%)	0 (0%)	1 (5%)	3 (15%)
2001–2004 (51)	16 (31.37%)	7 (13.73%)	5 (9.8%)	8 (15.69%)	10 (19.61%)	5 (9.8%)
2004–2007 (49)	10 (20.41%)	7 (14.29%)	6 (12.24%)	8 (16.33%)	11 (22.45%)	7 (14.29%)
2007–2008 (13)	2 (15.38%)	2 (15.38%)	2 (15.38%)	4 (30.77%)	7 (53.85%)	1 (7.69%)

Note: The number in parentheses in columns 2–7 is the share of firms. Some of these shares add up to more than 100 because some firms gave more than one answer.

Existing research generally equates the primary force forming the cluster with the sustaining force that pushes its development. However, our study shows that Pinghu did not follow this pattern. This can be seen from the different companies' responses to the question "What was your primary reason for investing in Pinghu?" From table 3 we can see that companies founded before 2004 put government support and service in first place, with location and preferential policies as secondary considerations. But for those set up after 2004, the primary concerns were supporting industries and market potential, which indicates that endogenous factors, such as distance to upstream and downstream companies and to consumer markets, had become the most important criteria in determining location.

In general, therefore, at the initial stage of the exogenous industry cluster's development, the local government plays the key role in attracting investment. At this point, important concerns for potential investors include whether government can offer investment-related services that are convenient and effective and whether it will fulfill commitments it has made to the investors so that investors need not worry about the risks from information asymmetry. After the cluster becomes large enough, the government's roles in terms of preferential policies, supporting measures, and its own credibility all become explicit information. Companies making investment decisions will then pay more attention to judging development opportunities and market potential, as well as to supporting industries.

The reasons given for investing in Pinghu may be divided into three groups: exogenous ("government support and service" and "preferential policy"), endogenous ("upstream and downstream companies," "market potential," and "available supporting industries") and others ("good geographic location"). Over time, as we have seen, the main driving force shifted from exogenous to endogenous factors. This shift had two defining aspects: first, the transition from dependence on outside or foreign capital, technology, and other factors to domestic sources, and second, the change from dependence on government policies to market-oriented competition.

3.1 Primary driving force

Pinghu's government has made a strong effort to promote the opto-mechatronics industry by implementing a series of policies that have greatly advanced the industry. Hence, the primary driving force in the first stage of industry cluster's development was the local government. First, the vigorous support of the government attracted some leading enterprises in the opto-mechatronics industry, particularly Japan's Nidec Shibaura (Zhejiang) Co. Ltd. Although to some extent Shibaura chose Pinghu quite by chance, undeniably a large part of credit should go to the local government. In 1998, as previously noted, Nagamori Shigenobu, president of Japan's Nidec Corporation, went to Pinghu to investigate the investment environment and was warmly received by the government. Though he was unable to completely research the issues surrounding investment in Pinghu, he was encouraged by the local authorities. However, he also talked about the unsatisfying transportation system—which forced him to take more than four hours to travel from Hongqiao airport, Shanghai, to Pinghu—and hoped it could be improved. The next year, when he returned, it only took him 45 minutes by highway. This giant step signaled a reliable government with which it would be worth cooperating in the long term. In the following years, Nidec established several wholly foreign-owned or joint venture companies one by one in this region, with Kanto Tatsumi Electronics Co. Ltd and Tokyo Special Electric Wire Co. Ltd coming later.

Second, the specialized services provided by the government prompted the growth of the optical-mechatronics industry cluster. When Nidec Shibaura (Zhejiang) Co. Ltd first arrived in Pinghu, the infrastructure was far behind that of other economic development zones like Suzhou Industrial Park and Kunshan. However, the government opened Japanese-language schools, trained staff for Japanese-led companies, and did a great deal to build a

sound economic environment to promote the industry. Consequently, many companies were attracted to the region.

3.2 Sustaining driving force

After this first step, the government of Pinghu focused on establishing a public technology platform to promote self-innovation and to upgrade the local opto-mechatronics industry. In August 2003, the Opto-mechatronics Advanced Technology Industry Promotion Center and the Advanced Technology Business Service Center were established to provide technical support to the companies. Meanwhile, a special development fund was raised for the industry, with an annual allocation of 10 million yuan. Many local businesses were enlivened by the government's vigorous investments in science and technology. Jiaxing Hengye Electronic Co. Ltd made good use of the 500,000 yuan it received from the Jiaxing Science and Technology Department and invented an integrated meter-reading system for communities; Zhejiang Banyu Electronic Co. Ltd, relying on the 1.2 million yuan it received, introduced a new type of MP3 and flash disk, which later gained the support of China's key new products project.

To further encourage this trend, the Pinghu government is now building a service platform for public scientific innovation. In July 2003, Pinghu formed an alliance with Tsinghua University, founding the Pinghu Branch of the Zhejiang–Tsinghua Yangtze River Delta Research Center. Also known as the Integrated Optics Research Institute, it is China's first center specializing in the opto-mechatronics area. The institution is building a fiber optical sensor laboratory research center for developing and industrializing integrated optical technology and products. In four to five years, it is expected to be a leading center for R&D in new technology within China, with influence elsewhere in Asia and a good reputation around the world.

Other important investments have followed. On June 21, 2004, the Pinghu government signed a contract with CAS Shanghai Silicate Research Center, to found CAS Jiaxing Pinghu Nonmetallic Inorganic Material Branch Center. In addition, a total of 47.5 million yuan was invested in an integrated translucent alumina light tube project, conducted by Shanghai Silicate Centre and Pinghu Tianyi Co. These research projects have brought Pinghu many talented people, including nearly 20 eminent science experts and other researchers with advanced degrees, who will help drive not only Pinghu's opto-mechatronics business but also the entire advanced-technology industry.

Moreover, Pinghu is upgrading its industry structure by introducing, learning, and assimilating foreign advanced technologies. The proportion of self-innovation and R&D in Pinghu's economy is rising, and it generates a corresponding effect among other connected companies. To some degree, it reduces Pinghu's dependence on foreign capital. More importantly, Pinghu will not be just an enclave of foreign investors: even without foreign capital, local companies will be able to rely on themselves to develop.

4. The status of Pinghu's opto-mechatronics industry cluster in international specialization

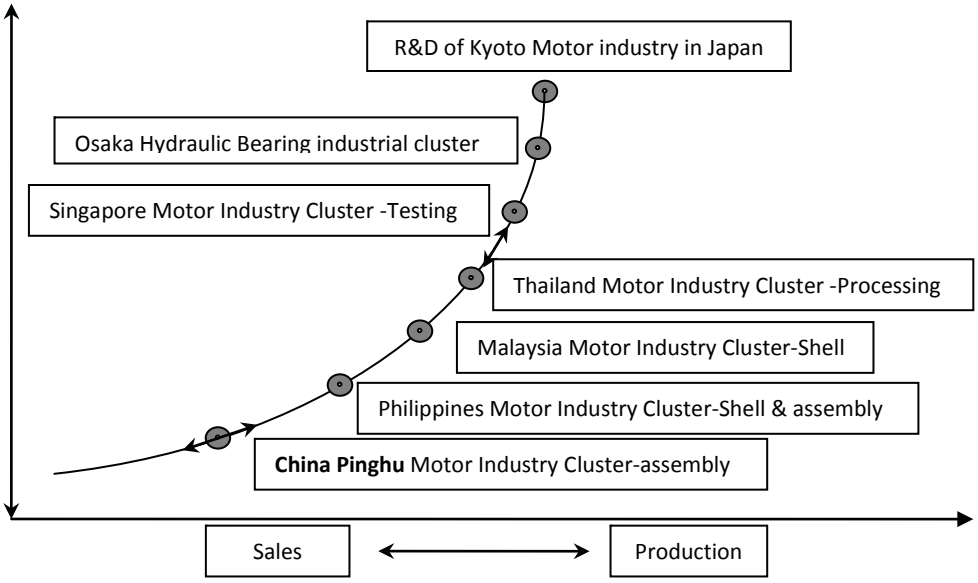
Zhang (2006), through an analysis of motors' basic production processes and the global industrial and value chains, found that Pinghu opto-mechatronics industries were in the lowest value-added sectors (figure 4) in the global value chain hierarchy. The research findings based on analysis of our data are almost the same as those of Zhang. There are some notable differences: mainly, private enterprises within the cluster have reached a level of more advanced development. Moreover, they perform better in R&D investment than the foreign investment-based firms and joint ventures.

4.1 Survey Data Analysis

Pinghu is the only advanced-technology opto-mechatronics industry base in Zhejiang province. In June 2009 Pinghu was officially chosen as a model demonstration area for massive economic transformation and upgrading to a modern industrial cluster. Having analyzed the dynamics of the formation and development of the opto-mechatronics industry cluster in Pinghu, this paper needs to explore another problem: the position of the Pinghu opto-mechatronics industry cluster in the global supply chain, and whether its competitiveness justifies the high market share that some of its products hold internationally.

Huang and Yang (2009), using a cross-country comparison of total domestic value added and labor productivity to explore the position of a country's advanced-technology industries in the international division of labor, argue that their method avoids the error of overvaluing a country's international division of labor in the advanced-technology sector caused by the "statistical illusion" problem. However, without noncompetitive input-output tables, we cannot analyze the status of an industry in a specific region of a country within the international division of labor. Following Huang and Yang, in our interviews with industry personnel we included questions on the average

Figure 4 Global value chain of motor production



Source: Zhang (2006), p. 215.

unit product price of major products, direct value added, labor productivity, and imported share of intermediate inputs, as well as production equipment, product design, R&D sources and inputs, main channels through which products are sold, and the like. Using the responses to these questions, we analyze the Pinghu optical and electrical machinery industries' position in the global supply chain.

As can be seen in table 4, our interviews showed that in 2008 the average direct value-added ratio was about 48 percent, and the average ratio of imports of intermediate inputs was about 28 percent. The average labor productivity was 76,821 yuan (about $11,240), while the average ratio of R&D investment was 10 percent. The direct value-added ratio of foreign-funded enterprises (FFEs) was the lowest of all types of enterprises (about 45 percent). This is consistent with the fact that the production of FFEs used the largest share of imported intermediate inputs—about 45 percent. As to R&D investment, private enterprises' maximum was approximately 12 percent of the value of output; joint ventures followed with about 11 percent, and foreign-funded enterprises trailed with only about 6 percent. By combining this information, we may conclude that while investments in FFEs led to the Pinghu opto-

mechatronics industry cluster's formation and development, foreign firms now just regard Pinghu as a manufacturing base, doing very little R&D or high value-added activity locally.

Table 4 Production patterns of investigated enterprises in 2008

Items	Direct value-added ratio (%)	Labor productivity (USD)	Import ratio of Intermediate Inputs (%)	Input ratio of R&D (%)
Overall average	47.54	11,240	27.85	10.11
Wholly foreign-owned enterprises	44.96	10,960	44.55	6.37
Private enterprises	51.73	11,010	16.87	12.03
Joint ventures	47.05	10,710	31.09	11.3
Others	46.43	10,980	18.92	10.75

The information in table 5 further confirms the conclusion discussed above: in 2008, about 79 percent of enterprises in Pinghu assembled final products, 88 percent tested them, nearly one-third (32 percent) performed ordinary parts processing, and only about 5 percent processed core components. Moreover, of the three types of enterprises, domestic private enterprises were more engaged in core and general parts processing than other types of enterprises, and less engaged in assembly production lines.

As table 5 indicates, 61 percent of the companies' production equipment was imported, while their domestic purchase ratio was just about 24 percent, and their independent R&D ratio was about 13 percent. Wholly foreign-owned enterprises depended the most heavily on imported equipment (81 percent), followed by joint ventures (55 percent), while private enterprises' dependence on imports fell as low as 48 percent. Moreover, about 15 percent and 30 percent of production facilities of private enterprises and joint ventures respectively derived from independent[6] R&D and domestic purchases. In product design and R&D, only about 28 percent of the FFEs relied on independent R&D or design; the majority (about 71 percent) relied on foreign companies, most of which were probably their foreign parent companies. Joint venture enterprises had similar ratios of independent R&D and imports, about 22 percent and

[6] Independent R&D means the production equipment was designed and produced by the firms themselves.

Table 5 Production performance of investigated enterprises in 2008 (percent)

Items	Main processes of production	Source of production equipment	Source of product design and R&D	Main channel of sales
Overall average	Core components processing 5.16	Import 61.45	Inside of firms 35.72	Export 52.24
	General components process 32.5	Domestic purchase 23.51	Domestic firms 13.4	Domestic sales 47.76 (36.7 for Pinghu production)
	Final assembly 79.28	Independent R&D 13.44	Foreign firms 48.01	
	Finished product testing 88.12	Others 3.61	Others 5.54	
Wholly foreign-owned enterprises	Core components processing 4.52	Import 81.45	Inside of firms 28.3	Export 69.56
	General components processing 17.57	Domestic purchase 5.7	Domestic firms 8.9	Domestic sales 30.44 (24.5 for Pinghu production)
	Final assembly 78.4	Independent R&D 10.03	Foreign firms 70.51	
	Finished product testing 87.1	Others 2.82	Others 0.29	
Private enterprises	Core components processing 8.79	Import 47.9	Inside of firms 56.77	Export 19.34
	General components processing 75.5	Domestic purchase 33.81	Domestic firms 21.9	Domestic sales 80.66 (59.49 for Pinghu production)
	Final assembly 70.45	Independent R&D 13.3	Foreign firms 13.4	
	Finished product testing 82.26	Others 4.99	Others 7.93	
Joint ventures	Core components processing 2.18	Import 55	Inside of firms 22.09	Export 67.81
	General components processing 4.44	Domestic purchase 31.01	Domestic firms 9.4	Domestic sales 32.19 (26.12 for Pinghu production)
	Final assembly 89	Independent R&D 17	Foreign firms 60.12	
	Finished product testing 95	Others 3.01	Others 8.39	

Note: As one firm can engage in several processes of production, the sum of main processes of production does not equal 100 percent.

60 percent. Among private enterprises, however, more than half enjoyed independent R&D (about 57 percent), while more than 20 percent were supplied through domestic purchases (about 22 percent).

Product sales patterns were likewise diverse. Overall, export sales averaged 52.24 percent; and domestic sales 47.76 percent (with 36.7 percent of domestic sales going toward supporting manufacturing in Pinghu). Of the three kinds of enterprises, wholly foreign-owned companies and joint ventures showed the highest export ratio: 69.56 percent and 67.81 percent of their total outputs. For private enterprises, this ratio was only 19.34 percent. On the other hand, private enterprises contributed the highest percentage of home market sales, 80.66 percent (nearly 60 percent goes to Pinghu's supporting manufacturers), compared to about 30 percent from foreign and joint venture enterprises (25 percent going to Pinghu's supporting manufacturers).

In sum, enterprises in the Pinghu opto-mechatronics industry cluster do much more processing than product development and innovation, and therefore remain at the low-skill-intensive end of the production chain, where it is naturally difficult to obtain a strong advantage. Although some enterprises in Pinghu—such as Nidec NTN—have more advanced technological products and hold a larger share of the world market, few other enterprises have been able to do likewise.

4.2 International Comparison

In order to more clearly show the position of Pinghu's opto-mechatronics industries in the international production chain, we will compare our Pinghu survey data with those for advanced-technology firms in other countries. Using the OECD statistics database,[7] we extracted seven countries' data in 2000 and 2005 to calculate the relevant coefficients, as shown in table 6. Compared with the data in tables 4 and 5, Pinghu corporations' performance, in terms of their average direct value-added ratio, was better than the national average, with only a small gap between it and those of the developed countries. On the other hand, while average labor productivity for Pinghu enterprises was basically the same as the national average, comparison with Germany, Japan, and the United States reveals a big gap. The same holds true for R&D.

[7] OECD. Stat Extracts, www.stats.oecd.org.

The opto-mechatronics enterprises in Pinghu cluster performed better than the national average, but compared to firms in developed countries the average unit product prices and value-added were relatively low, with a higher proportion of imported intermediate inputs. This demonstrates that while Pinghu enjoys a leading position within China in the advanced-technology industry, it has fewer prospects in terms of international trade and remains largely concentrated in processing and assembly, at the low-skill-intensive end of the production chain.

5. Lessons from this case

5.1 The adjustment of the downstream industry layout is the condition for the formation of industry clusters

As one of seven well-known international centers of motor production, the Yangtze River Delta region has become a major destination for the relocation of downstream Nidec enterprises. For example, many electrical enterprises in Taiwan and Seagate Technology, such as Maxtor, Western Digital, Toshiba, Fujitsu, and Samsung, are transferring their manufacturing facilities to this area. Toshiba and Seagate Technology constructed production facilities in Wuxi, Maxtorare is coming to Suzhou, and Samsung is in Shanghai. As a large number of Nidec's downstream enterprises in the personal computer industry have transferred their production bases to the Yangtze River Delta region, the upstream parts of Nidec's electric products manufacturing have had to follow in order to be close to their buyers. This provided a rare opportunity for Nidec to invest in Pinghu and to form an opto-mechatronics industry cluster.

5.2 Geographic and cost advantages are the basis of industrial agglomeration

Areas offering geographical and cost advantages to businesses considering relocating their production processes often become magnets for foreign investment, allowing these areas to become the leaders of industry development. The distance between Nidec enterprises and its downstream components enterprises can be covered in about two hours by car. According to Porter's 2006 study, by locating near the customer, companies can supply speedy customized services that its more distant competitors cannot. In other words, the relatively short overland distance from Pinghu to Wuxi, Suzhou, Hangzhou, and Shanghai satisfies a necessary spatial condition. At the same time, lower costs of doing business are also vital. Despite the established

Table 6 Production performance of advanced-technology firms in different countries

Year	Country	Direct value-added ratio (%)	Labor productivity (thousand $)	Import ratio of intermediate inputs (%)	Input ratio of R&D (%)
2000	Brazil	48.91	–	58.44	
	China	43.53	10570	27.23	
	German	46.76	51640	67.68	
	Indian	53.76	–	13.15	
	Japan	46.43	75600	25.94	
	South Korea	47.47	20210	57.96	
	United States	46.5	71830	42.22	
2005	Brazil	47.42	–	79.13	
	China	41.32	10850	55.39	
	German	45.02	60490	78.87	17.7 (2004)
	India	–	–	–	
	Japan	51.43	48950	45.43	30.1 (2003)
	South Korea	–	–	–	50 (2004)
	United States	46.18	65970	52.54	23 (2004)

Note: Data for "input ratio of R&D" are from the Organisation for Economic Co-operation and Development, ANBERD database, *http://www1.oecd.org/dsti/sti/ stat-ana/stats/eas_anb.htm* (accessed May 22, 2007). *Science and Engineering Indicators 2008*. Others were calculated using data from OECD.Stat.

infrastructure in Suzhou and Wuxi, the costs of business there are too high. The supply of electronic components there is unstable and cost-sensitive, so businesses interested in investing have looked to surrounding areas instead. Pinghu fully meets the necessary geographic and cost conditions, giving it a good basis for attracting foreign investment.

5.3 "Seed" enterprises drive the relocation of upstream enterprises and the emergence of local supporting businesses

Since Nidec settled in Pinghu, the NTN company—one of the three major bearing manufacturers, with headquarters in Osaka, Japan—has also jumped on the bandwagon. These enterprises have brought and will bring in many related enterprises from Japan, while also helping to support a number of local domestic suppliers. The arrival of these major corporations has made the Pinghu opto-mechatronics industry cluster boom. Following the successful lead of Nidec, 12 foreign-funded enterprises have already settled in Pinghu, with a total investment of $410 million. The local production of digital camera shutters, cell phone cameras, microprecision motors, fluid dynamic pressure

bearings, and other products has reached an internationally competitive level, and many of these products are now exported.

The Pinghu city government did not have unrealistic expectations when courting Nidec, but Nidec nonetheless played a pivotal role in the creation of Pinghu's industry cluster. The example of Nidec shows that it is essential for governments to attract seed enterprises with a strong leading role to encourage the development of industry clusters.

5.4 Effective government support and service system provide a strong incentive for the development of industry clusters

Nidec's investing in Pinghu is inseparable from the local government's commitment to its promise to implement support policies. The realization of the Pinghu municipal government's commitment to improving traffic motivated Kanto Tatsumi Electronics Co., Ltd., and Tokyo Special Electric Wire Co., Ltd., to make the decision to invest in Pinghu. Pinghu City set up the Advanced-technology Center and the Advanced-technology Innovation Service Center to promote the development of the opto-mechatronics industry. In cooperation with Tsinghua University, the Pinghu city government founded the Zhejiang–Tsinghua Yangtze River Delta Research Center, Pinghu Branch, and set aside advanced-technology industry development and industrialization funds of 10 million yuan a year. This provided an attractive platform for R&D, supporting enterprises through the introduction, absorption, and then integration of the innovation necessary to achieve industrial restructuring and upgrading.

The Pinghu government has built a support system using the following plan. First, improve the infrastructure and make Pinghu a satellite town of Shanghai. In early 1999, the Pinghu government built the Shanghai-Hangzhou high-speed road, reducing the drive between Shanghai Hongqiao Airport and Pinghu from 4 hours to less than 45 minutes. At the same time, the Pinghu government invested heavily in urban renewal, improving the city's infrastructure and landscaping. This helped a number of optical and electrical machinery enterprises to consider Pinghu to be a Shanghai satellite town, which in turn encouraged them to establish production bases in Pinghu while setting up a number of R&D and service sector facilities in Shanghai. The convenient transportation between the two cities permitted them to enjoy both the business environment of a metropolis and the low production costs of a satellite town.

Second, create a living environment suitable for foreign investors—specifically, Japanese investors. After Japanese opto-mechatronics enterprises had begun to establish themselves in Pinghu, the local government built a street named Japan Street in the downtown area with a number of Japanese-style luxury villas, instituted Japanese captioning on the local cable TV news, added Japanese classes in vocational secondary school, and also asked government officials to master conversational Japanese—all in order to create a harmonious living and working environment for the foreign nationals working in Japanese enterprises.

Third, provide professional services through the relevant government departments to create a favorable environment for the opto-mechatronics industry. In order to promote the development of the optical, mechanical, and electrical industries, the relevant departments in Pinghu have taken the initiative to provide effective professional services. For example, the Development and Plan Bureau made a plan for the development of the Pinghu opto-mechatronics industry and issued related development policies. The Technology Bureau included a detailed electromechanical advanced-technology industrial base in the provincial development plan; formed the Light Electrical Industry Promotion Center, an optical and electrical machinery testing center; and facilitated the launch of a variety of scientific and technological projects by the optical and electrical machinery enterprises. To address the shortage of skilled workers, the Labor Bureau worked in two directions at once: on the one hand, it provided local courses to train light mechanical and electrical staff; on the other hand, it went to vocational secondary schools in Jiangsu, Anhui, Shanxi, Shaanxi, and other places to recruit qualified personnel. The Personnel Bureau gave the green light for senior light electrical and professional talents to work in Pinghu. The Development Zone Committee provided a full range of services, from developing zone infrastructure construction and low-cost supporting staff quarters to processing documents, such as the export tax rebate form. Future plans include building a business park for the opto-mechatronics industries.

5.5 Typical model of an exogenous advanced-technology industry cluster in China

From analyzing the formation and development of the opto-mechatronics industry cluster in Pinghu, we can propose the following development model. The government encourages the introduction of foreign capital to start the engine of industrial development. By providing supporting services for the

foreign enterprises, domestic enterprises accumulate capital, technology, and management experience. Once the industry cluster has developed to a certain extent, the local government builds a public platform for R&D and innovation to promote the R&D and innovation capabilities of local enterprises, encouraging interactive development between foreign and local enterprises and thereby stimulating the growth of the industrial cluster. This is a typical model of exogenous advanced-technology industrial cluster growth in China.

Pinghu seized the opportunity offered by multinational companies' transferring their manufacturing bases to China to successfully embed itself in the MNCs' global production chain. Its development is both a typical model of China's exogenous advanced-technology industrial cluster growth and an archetype of industrial development in China's coastal areas. Although Pinghu's opto-mechatronics enterprises are categorized as advanced-technology firms and enjoy high annual output values as well as a large share of the world market, we find that most of the enterprises within the cluster serve only as the processing and assembly bases for multinational companies, doing very few high value-added production activities such as R&D and design. Therefore, several questions—how to increase the R&D and innovation roles of the cluster, how to upgrade the whole industry, and how to improve both its profitability in international trade and its position in the international production chain—remain urgent issues for industry clusters similar to that of Pinghu. This is a critical concern not only for Zhejiang province but for the whole Chinese economy: to change from a world processing factory to a world factory.

References

Branstetter, Lee, and Nicholas Lardy. 2006. China's Embrace of Globalization. NBER Working Paper 12373.

Brenner, Thomas. 2001. Simulating the Evolution of Localised Industrial Clusters: An Identification of the Basic Mechanisms. J*ournal of Artificial Societies and Social Simulation* 4 (3).

Ferrantino, Michael, Robert Koopman, Zhi Wang, Falan Yinug, Ling Chen, Fengjie Qu, and Haifeng Wang. 2006. Classification of Trade in Advanced Technology Products and its Statistics Reconciliation: The Case of China and the United States. Joint Working Paper on U.S.-China Trade in Advanced Technology Products.

Huang, Xianhai, and Gaoju Yang. 2009. High-Tech Industry and Its International Specialization Status: Literature Review and New Analytical Framework. *Journal of Zhejiang University Humanities and Social Sciences* 6: 145–54 (in Chinese).

Koopman, Robert, Zhi Wang, and Shang-jin Wei. 2008. How Much of Chinese Exports Is Really Made in China? U.S. International Trade Commission Working Paper 2008-0B.

Lall, Sanjay. 2000. The Technological Structure and Performance of Developing Country Manufactured Exports, 1985–98. *Oxford Development Studies* 3: 337–3.

Mani, Sunil. 2000. Exports of High Technology Products from Developing Countries: Is It Real or a Statistical Artifact? UN University INTECH Discussion Paper 2000-1.

Marshall, A. 1920. *Principles of Economics*. New York: Macmillan.

OptraNet. N.d. Optics_and_mechatronics.

Porter, M.E. 1998. *The Competitive Advantage of Nations*. New York: Free Press.

Porter, M.E., & M. R. Kramer. 2006. Strategy and Society: The Link between Competitive Advantage and Corporate Social Responsibility. *Harvard Business Review* 84 (12): 78–92.

Saxenian, Annalee. 1994. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.

Srholec, M. 2007. High-Tech Exports from Developing Countries: A Symptom of Technology Spurts or Statistical Illusion? *Review of World Economics* 2: 227–55.

Wang, Fangming, and Cai Ning. 2009. Study on the evolution of industrial clusters based on ecological organization theory. Modern Management Science 3: 21–35 (in Chinese).

Wang, Lijun. 2006. The role of government in promoting exogenous industry clusters: Case study of the Pinghu opto-mechatronics industry cluster. *National Business* 5: 53–64 (in Chinese).

Wang, Zhi, and Shang-Jin Wei. 2010. What Accounts for the Rising Sophistication in China's Exports? In *China's Growing Role in World Trade*, ed. R. Feenstra and S. Wei, 63–108. Chicago, IL: NBER and University of Chicago Press.

Zeng, Yongmei. 2006. The dynamic mechanism of industry cluster formation. *Journal of Hunan Economic Management College* 5: 33–41 (in Chinese).

Zhang, Hui. 2006. *Local industry clusters restructuring and upgrading under global value chain*. Beijing: Economic Science Press (in Chinese).

Zhou, Hong, Luzhuang Wang, and Yuwei Dai. 2006. Comparing endogenous and exogenous industrial cluster upgrading models. *Zhejiang Economy* 3: 12–22 (in Chinese).

Appendix: Advanced-technology enterprises questionnaire

Basic Information	Date of registration		Registered capital		
	Square footage		Telephone		
	Your company is	A. State-level key advanced-technology company; B. Provincial-level key advanced-technology company; C. Key advanced-technology company of Jiaxing city			
	Type of company	1. state-owned; 2. collectively owned; 3. private; 4. joint-operation; 5.joint-stock; 6. joint-venture; 7. foreign-invested; 8. joint-venture with Hong Kong or Macao; 9. wholly owned by Hong Kong or Macao; 10. other			
	Your company belongs to the industry of	1. electronic information; 2. new materials; 3. biopharmaceuticals 4. opto-machatronics; 5. environmental protection; 6. new energy; 7. other			
Economic Index and Products		2005	2006	2007	2008
	Annual output value of main products				
	Annual output of main products				
	Proportion of added value in output				
	Export value ($10,000)				
	Value of raw materials and intermediate input (10,000 yuan)	__imported __	__imported__	__imported__	__imported__
	Market share	world ___ domestic___	world ___ domestic___	world ___ domestic___	world ___ domestic___
	Main sources of manufacturing facilities	A. imported; B. domestically purchased; C. internal R&D; D. others	Sources of product design and R&D	A. within the company; B. domestic companies; C. foreign companies; D. other	
	Primary sales channel	Export __%; domestic __% (produced by supporting companies %)			
	Major production process	A. key parts processing; B. general parts processing; C. final assembly; D. product testing			

Scientific Activity		2005	2006	2007	2008
	Number of R&D staff				
	Annual R&D input (10,000 yuan)				
Development	Reason for investing in Pinghu	A. Efficient government service; B. preferential policies; C. sound geographic location; D. following up- and downstream companies; E. resources; F. new market opportunities; G. available supporting industries; H. other reasons _____			
	The most difficult situation in development	A. Financing difficulties; B. lack of talent; C. excessive pressure of the company; D. environmental protection and adjustment of industrial policies			