The Information Technology Industry's Brain Circuit under Stress: The United States, Taiwan and China

XiangQuan Zeng, Renmin University of China, China, zengxq@ruc.edu.cn
Chyi-Herng Chang, National Chengchi University, Taiwan, chyiher@nccu.edu.tw
Trevor Bain, University of Alabama, USA, tbain@cba.ua.edu

July 2012

The Information Technology Industry's Brain Circuit under Stress: The United States, Taiwan and China

XiangQuan Zeng, Renmin University of China, China
Chyi-Herng Chang, National Chengchi University, Taiwan
Trevor Bain, University of Alabama, USA

Submitted For ILERA 2012 Meeting, Track 3

INTRODUCTION

The idea of a brain drain is often used to characterize the movement of skilled personnel from one country to another. (M. Todaro, 1985) This is a zero sum game where the winner takes all. In a globalized economy, however, movement may more closely resemble a brain circuit where all the Countries benefit and there is more than one winner. This has been particularly true in the Information Technology (IT) industry for the movement of scientists and engineers (S&E) among the United States (US), Taiwan and China. This movement is better represented by the term brain circuit. (Saxenian, 2005) Table 1 presents the overseas subsidiaries of the largest Chinese, Taiwanese, and US IT companies within this brain circuit. Management strategies in western economies have focused on protecting their core competencies, including their human resources (HR) that gave them a competitive advantage. The implications for national policy have often been couched in terms of threats to jobs or maintaining national competitiveness. This was the initial approach taken by China, Taiwan, and the US. The evidence from the IT industry, however, indicates that many firms have taken a different approach with regard to S&E. These firms have over-time moved top of the value chain and system integration activities to overseas facilities in the emerging industrial giants in Southeast Asia, particularly China and Taiwan. The implications of this movement raises questions of whether multinational enterprises (MNEs) can continue to maintain their strategic HR advantage or are in the process of losing it.

The principal objective of this paper is to examine whether the birth and growth of a brain circuit under the stress of politics and economics results in a brain drain, or adaptation to a brain circuit.

BIRTH AND GROWTH

US and Taiwan

Silicon Valley was the birthplace of the brain circuit among China, Taiwan, and the US. Apple is an excellent example of this circuit. A US company whose major components for the iPhone are manufactured in China often by a Taiwanese owned company, Foxconn. (C. Duhigg and K. Bradsher, 2012) Apple has 156 major suppliers that account for 97% of the company's global procurement expenditures. Taiwan contributes thirty-nine suppliers of passive components, panels and battery cases to Apple. (Apple, 2012) The company has 43,000 employees in the US and 20,000 overseas. However, the employment in their supplier system is much larger with more than 700 thousands engaged in the design, manufacture, and assembly of Apple products. In mainland China, 8,700 industrial engineers guide 200,000 assembly line workers in a Fordism related production process. This process would be extremely difficult to replicate in the US. (C. Duhigg and K. Brandsher, 2012) The IT company's supply chain may carry "made in China" label but the production facilities are often owned by Taiwanese firms. China ranks first in the production of notebooks with a 2010 export value of 6,196 billion Yuan, and 99% of these are manufactured by Taiwanese owned firms. (MIC III, 2011) [1]

Taiwan, between 1950 and the early 1970s sent about 30,000 students to the US. The largest number majored in the sciences and engineering and many went to work in part-time and full-time jobs in Silicon Valley.[2] The Silicon Valley business model is different from the traditional MNC Fordism model. (D. Ernst, 2002) It encourages small start-ups with little capital that engage in innovation. In the 1960's Taiwan began a talent acquisition strategy to encourage these citizens to return to Taiwan.[3] A "modern technology seminar" was started in Taiwan to establish contacts between the island and their citizens in the US. Technical knowledge and the prospects for international marketing of products produced in Taiwan were exchanged through the promotion of the government's IC Project. The country started with the encouragement of a low-level

[1] According to the statistics from the Market Intelligence Center at Institute for Information Industry, III/MIC, the value of Taiwan's IT industry in 2010 is USD 121,223 million. There are 14 items ranking top around the world: Notebook PC 93.7%, Motherboard 94%, Cable CPE 95.1%, WLAN NIC 91.1%, Net book 88.3%, Server(System & Pure MB) 88.7%, LCD Monitor 71.9%, DSL CPE 64.3%, Tablet Device 95.5%, IP Phone 61%, DSC 46.6%, Desktop PC 46%, IPSTB 48.3%, Server(System) 40.9%. Two rank second: Smartphone 29.1%, ODD 22.9%.

[2] See: Taiwan Students in the USA (1950-2007) at the Website: http://140.111.34.54/BICER/content.aspx?site_content_sn=6235; about one-ninth of the total employees in Silicon Valley's high-tech industries were from Taiwan.(A.L. Saxenian, 1999)

[3] Open social structure in USA was much better for the transnational diffusion of high-tech knowhow than closed social structure in Japan. (T. Mayumi, 2006)

consumption of electronics at home that could be upgraded.[4]

A number of social and professional affinity networks of Taiwanese S&Es in IT were established in Silicon Valley and northern California. The Monte Jade Science and Technology Association were established in 1989 with the Taiwanese government's support. There are 14 branches, of which 10 are located in the US. Other organizations include: Silicon Valley Chinese American Computer & Commerce Association, SVCACA, founded in 1987, Chinese Software Professionals Association, CSPA, founded in 1988, Chinese American Semiconductor Professional Association, CASPA, established in 1991, Chinese American Information Storage Society, CAISS, established in 1995, and the Silicon Valley Taiwanese American Industrial Technology Association, TAITA-SV, founded in 2003.

Initially, these interpersonal networks were successful in helping the Taiwanese students and their families overcome cultural differences encountered by living in the US. These networks transitioned into professional organization's which provided a variety of resources and role models at their own community, and contact within the community and personnel exchanges between Taiwan and Silicon Valley. A pipe-line was formed. Many of the first-generation of Taiwanese immigrants became entrepreneurs. With their entrepreneurial experience in Silicon Valley they moved between the US and Taiwan exchanging technical and business intelligence on a regular basis. Most of these participants carried dual citizenship. Cooperative arrangements between Taiwanese and US firms were established and technology policy advice was given to local governments in Taiwan.

Industrial clustering on the island provides an excellent environment for attracting talent from the US. (M.E. Porter, 2000) Early clustering can be attributed to the Industrial Technology Research Institute (ITRI) and the Hsinchu Science Park. (Saxenian and Hsu, 2001) ITRI through its Electronics Research and Service Organization (ERSO) is the conduit for attracting both US firms to Taiwan and Taiwanese back from the US.[5] RCA is an early example of this circuit. At a cost of US $10 million a licensing and technology transfer agreement was signed, in 1976, between RCA and CMOS IC whereby engineers were sent to the US for training so that the semiconductor manufacturing

[4] Policy-making of IT development partly depended upon the timing of favorable international environment in 1970s: first, IT keen competition between USA and Japan driven; second, heavily industry cost-up under the twice oil crises.

[5] ERSO renamed to Electronics & Optoelectronics Research Laboratories, EORL in 2006. Now the Monte Jade Science and Technology Association replace EORL to act ERSO role. See the website for about: http://www.mjglobal.org/introduction.htm

process could be brought to Taiwan.[6] Four inch wafers, IC chips, and integrated circuit services companies were developed by Taiwanese entrepreneurs. Among them, Morris Chang, Hu Ding-hua, Yang Ding-yuan and Zhang Quing-ku either studied or worked in US IT companies.

The Hsinchu Science-based industrial park is often called 'the Silicon Valley of the East'. Silicon Valley was the model for the park which added housing and other amenities to attract US trained S&Es. Two universities are also in the cluster. The park started with seventeen firms and had 475 high-tech firms by 2011. Those with a college degree or above account for 68% of the work force in the park. Those with a master's number 24,000 and doctorates exceed 1,400. Forty percent of the companies in the park have entrepreneurs and managers who either studied or worked in the US. All maintain communication, often through travel, with Silicon Valley. (C. Shih, 2006)

In addition to pleasant living arrangements, stock bonus of stock has been issued to employees following the Silicon Valley model. The Companies Act, amended in the 1980s, requires that each company's new issue of stock to set-aside 10% for its employees. The stock distribution is based on earnings and the net profits to the firm.[7]

US and China

China's path to completing the brain circuit was slower and encountered more obstacles. Chinese students, by the 1980's, began to study in large numbers in the US. Networks, similar to those of the Taiwanese students, were established for personal and professional objectives. This caused the country's leadership to begin an internal debate between those who viewed students who studied overseas as a threat to the party and a brain drain and those who viewed these students as a brain bank that would eventually help the country. The debate was settled in favor of the brain bank with Deng Xiaoping's southern tour speech in 1992. The policy of control was changed to support for study abroad and the encouragement of students to return to the mainland. (D. Zweig, 2006) Almost two million students studied abroad between 1978 and 2010. Currently there are approximately 892,000 studying abroad and 632,000 thousand have returned. A Western Returned Scholar Association and Returning Students

[6] RCA authorized IC tech-transferred items included: design, mask, fab, probe, package, appliance, production management, and training ITRI 330 engineers in the US. See: The History of ITRI Website: http://memory.itri.org.tw/history/effortrecord.aspx?id=7&par_id=1 and Ming-Kai Tsai, 2002: p. 120.

[7] It's estimated that more than 30% of the engineers who studied in the USA returned to Taiwan, three times the 1970s' return rate. (OECD, 2002: 253-270)

Venture Parks are supported by the government. Chinese academics and researchers in the US were encouraged to visit Chinese universities on a short-term basis. The Venture Parks offer both infrastructure and financial incentives similar to other parks but also address the special needs of returnees and their families with schools and housing.[8]

Foreign investment from Taiwan was encouraged and the number of foreign firms grew to 6,430 companies in 1992. See Table 2. The initial focus was on the Pearl River Delta near Guangzhou and the southern part of Fukien Province with an investment of $220 billion and $6 billion till 2010. This was followed by the Yangtze River delta and Shanghai with Taiwanese investment of $330 billion and $14 billion. (Mainland Affairs Council, 2011)

Table 2 Taiwan Approved Investment in Mainland China by Area, 1991-2010

Area	Case	Amount	Percentage
Kiangsu	6,164	33,382.31	34.30
Canton	12,316	22,041.95	22.65
Shanghai	5,365	14,144.91	14.53
Fukien	5,383	6,743.87	6.93
Chekiang	2,024	6,434.01	6.61
Tientsin	910	1,849.16	1.90
Beijing	1,181	1,682.45	1.73
Shantung	969	1,936.93	1.99
Chongqing	209	1,281.40	1.32
Hupei	538	1,087.48	1.12
Others	3,626	6,736.45	6.92
Total	38,685	97,320.92	100.00

Note: 1. Figures include lagged reports and approvals.

2. Unit: US$ million.

BRAIN CIRCUIT STRESS

Taiwan's IT industry accounted for 50.9% of world hardware production by 2000. Thirty-one percent of this was produced on the mainland by Taiwanese companies. By 2010 this percentage had increased to 94.9%. (MIC III, 2011) The

[8] The measurements to support returnees after 1990 mainly including the Fund for Returnees to Launch S&T Researches, the Program for Training Talents toward the 21st Century, the Chunhui (literally, Spring Bud) Program, the Changjiang Scholar Incentive Program, the Program of Academic Short-return for Scholars and Research Overseas, and established 21 start-up and incubated base.

driving forces were increased labor costs and real estate prices. Taiwanese firms were also under pressure from their US customers, Hewlett-Packard, Compaq, and Dell, to reduce their costs. Acer, a successful Taiwanese firm, also sought to lower its labor costs and gain access to the mainland consumer market.

The possible loss of talent to the US followed by the move of IT products to the mainland first lead the Taiwanese government to limit the migration of people and companies. On September 14, 1996, President Lee Teng-hui sought to stem these moves in an address to the National Managers Conference. He proposed a "no haste, be patient policy". This policy sought to restrict the size of overseas high-tech investment in infrastructure to US$50 million, and there were plans to prohibit the move of semiconductor wafer processing, core and micro-film studies.[9] These containment policies were unsuccessful. Taiwanese firms first located their production in Hong Kong or obscured their moves to the mainland by registering their companies in Hong Kong or a third country.

Labor and Accommodation

Taiwanese IT firms increased their HR capabilities in order to recruit employees willing to leave their families to work on the mainland. Employment agencies report they have had no difficulty in recruiting people to migrate for jobs. Employment figures for those who migrated are not available. However, some idea of the size of this migration can be obtained from several sources. Since the Taiwanese government allowed their citizens to visit relatives on the mainland sixty-six million have made the trip. About five million traveled in each of the past three years.[10] It is not possible to determine the percentage that stayed for work on the mainland, however, by looking at the number who remained for more than three months we can get an idea of the number who traveled to their jobs. The Chinese 2010 census indicates that 170,000 Taiwanese who remained more than three months reside in Mainland China. Academics in Taiwan think this is an undercount.

A rough idea of changes in the brain circuit can be obtained from the numbers and percentage of foreign business visitors who registered at a five-star

[9] February 26, 2010, 11, prohibited items of the investment in the mainland became into a general class of projects, including second-class telecommunications industry, integrated circuit design industry, etc., and adjusted coverage or review principles of some items to prohibition, such as wafer, panel, etc. See the Review and Screen Regulation on the investment in Mainland concerning wafer foundry, integrated circuit design, integrated circuit packaging, integrated circuit test, and the key technologies of the LCD panel plant.

[10] Travel statistics across Strait see the website:
http://www.mac.gov.tw/public/Data/2279361271.pdf

international hotel near the Hsinchu Science Park from 1999-2011. See Table 3.[11] Visitors from North America made up almost 50% of the total in 2001 and declined after that. This is probably because US customers began to visit their Taiwanese suppliers on the mainland. The opening up of a dialogue across the strait and the availability of direct flights also appears to have encouraged Chinese business travel to the Hsinchu Science Park. Travel from the mainland went from zero in the early years of the last decade to more than six percent by the end.

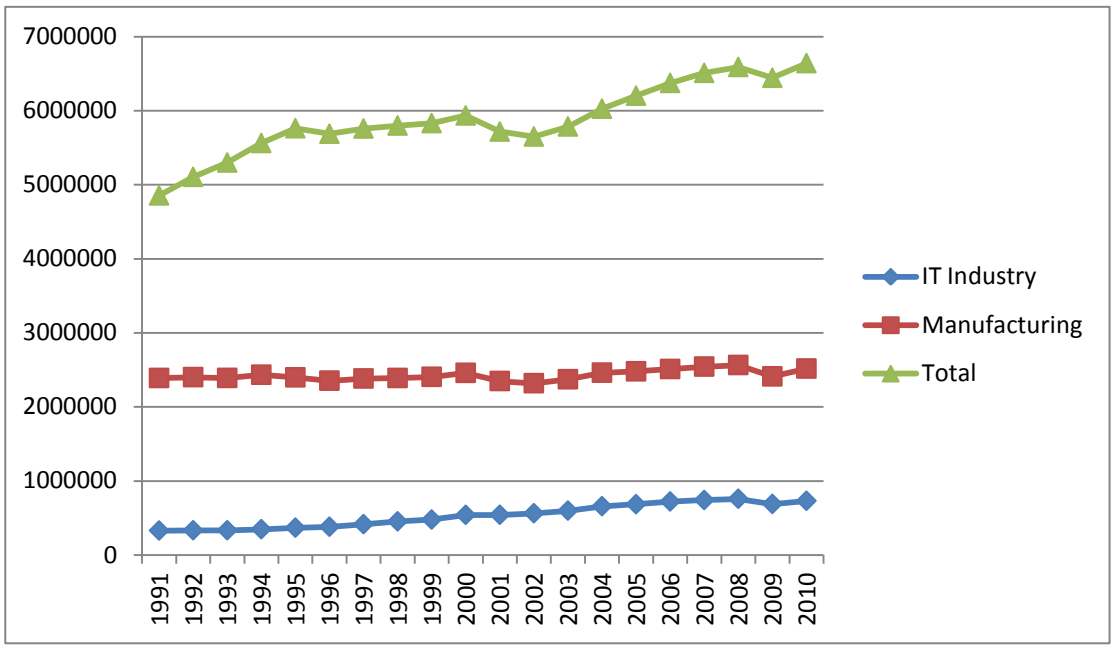
Table 3 Business Visitors to a Five Star International Hotel near the Hsinchu Science Park by Nationality, 1999-2011

	China	%	North America	%	Japan	%	Europe	%	Total
1999	0	0.00	13,600	31.27	5,155	11.85	2,766	6.36	43,492
2000	0	0.00	28,409	47.21	6,840	11.37	4,333	7.20	60,174
2001	0	0.00	22,106	46.04	5,597	11.66	5,637	11.74	48,011
2002	0	0.00	18,787	38.86	6,361	13.16	4,426	9.15	48,347
2003	0	0.00	11,980	31.25	5,076	13.24	3,811	9.94	38,341
2004	0	0.00	16,165	31.83	7,436	14.64	6,948	13.68	50,779
2005	0	0.00	15,537	30.75	6,980	13.82	3,286	6.50	50,520
2006	0	0.00	12,202	26.34	5,087	10.98	1,989	4.29	46,329
2007	0	0.00	14,183	29.09	5,842	11.98	4,307	8.84	48,749
2008	0	0.00	14,969	25.87	6,358	10.99	5,345	9.24	57,866
2009	7,535	11.75	12,119	18.89	9,225	14.38	4,535	7.07	64,144
2010	4,170	6.58	12,015	18.95	15,617	24.63	5,343	8.43	63,403
2011	3,523	6.10	9,815	17.00	8,854	15.34	5,185	8.98	57,728

The economic effects of the move of Taiwanese IT companies to China may be judged by an examination of employment, wages and hours worked on the island between 1991-2010. Figures 1, 2, 3 indicate a steady annual increase in IT employment that leveled off in 2006-2007. The monthly wage rate in IT exceeded that for manufacturing and total wages for the entire period. This wage difference increased beginning in 2005 but declined, as did all wages, in 2008. Monthly hours worked followed the same pattern as the monthly wage rate. These changes can probably be attributed to the effects of the world-wide recession rather than the shift of IT production.

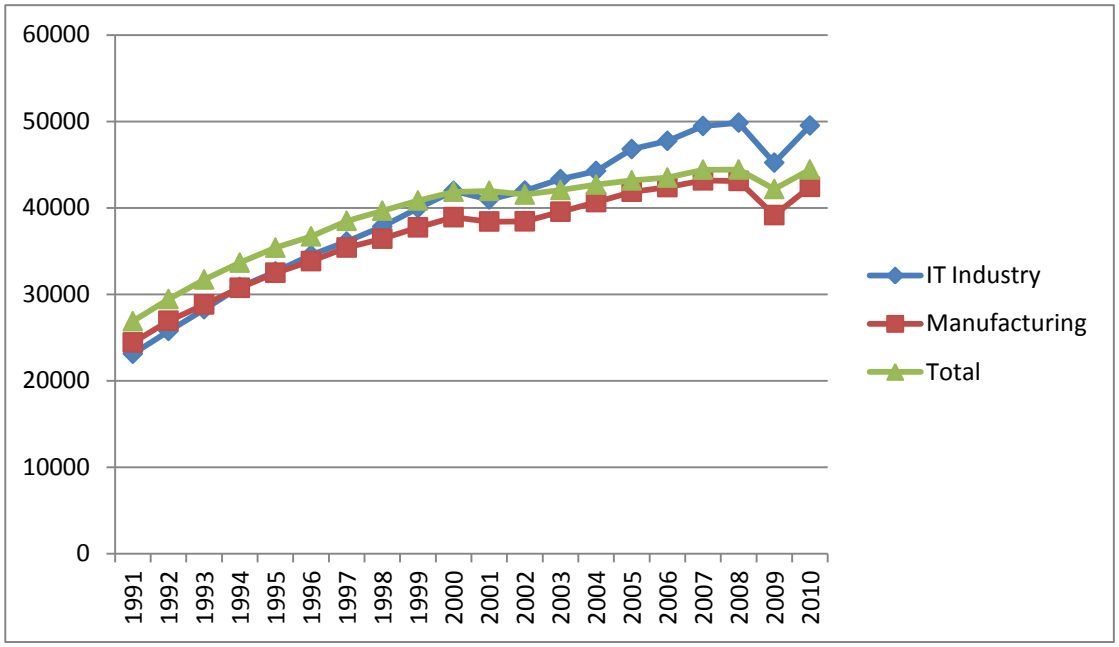
[11] Business visitors were almost the advanced talent to visit IT companies in Hsinchu Science Park.

Figure 1 Employment in Taiwan IT Industry, 1991-2010



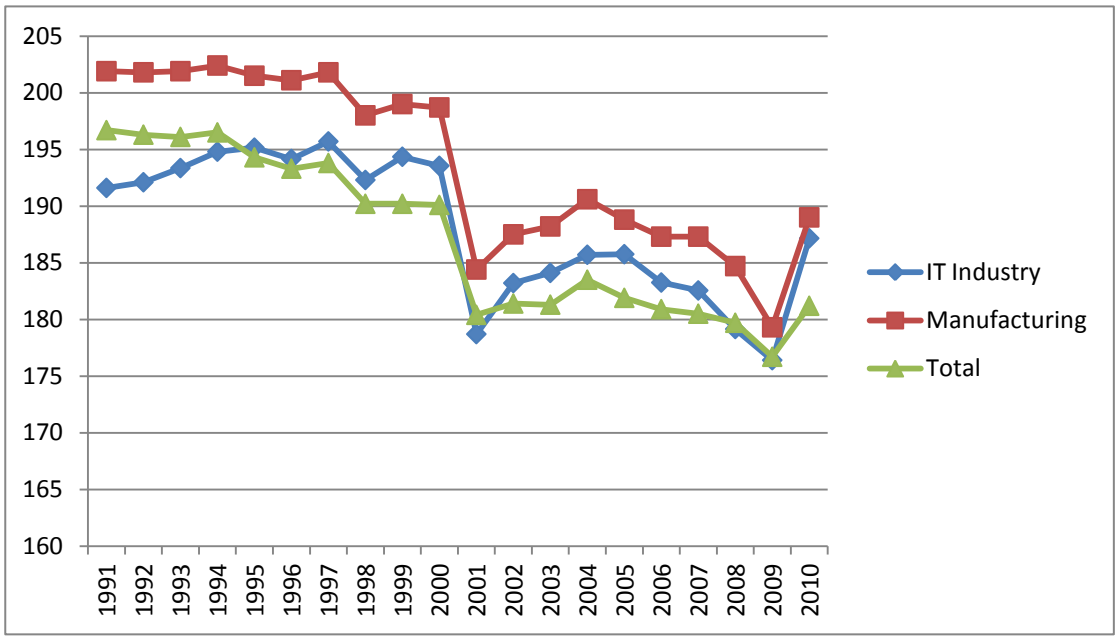
Source: DGBAS, *Governmental Statistics*, 2011.

Figure 2 Monthly Average Wage in Taiwan IT Industry, 1991-2010



Source: DGBAS, *Governmental Statistics*, 2011.

Figure 3 Monthly Average Working Hours in Taiwan IT Industry, 1991-2010



Source: DGBAS, *Governmental Statistics*, 2011.

The early labor practices of Taiwanese IT firms' on the island were transferred by these companies when they moved to the mainland. Their management driven practices were designed to rapidly allow companies to hire farmers and turn them into factory workers. A century later this migration to jobs resembles the beginning of the Ford Motor Company. Taiwanese and Chinese government labor policy helped shape the human resources practices of IT firms on the island and the mainland. Labor conflict has resulted both on the island and the mainland. On Taiwan workers are represented by a large number of independent trade unions and conflict is understood and resolved. This has not been true with the single union status on the mainland. (C.-H. Chang and T. Bain, 2006) Second generation Taiwanese migrant workers are more familiar with a more democratic labor relations policy than their Chinese counterparts and are more vocal in pressing their demands. They have received food, housing, transportation and other benefits not common in Taiwan. At the same time Taiwanese IT firms' operating in China are resented because they have brought f high-talent and well-paid employees from the island. This is combined with the mental and physical stress of large numbers of workers, employed long hours, working overtime, and crowded into employer-owned housing. Workers, men and women, are separated from their families who often live many hours of travel from the factories. The results have been strikes, demonstrations and worker threats of suicide. (D. Barboza, 2012)

Both the Taiwanese and Chinese governments have made some

accommodations to this circuit. Taiwanese IT companies have hired Chinese S&E, skilled, and assembly-line workers. However, the Taiwanese companies remain concerned about the theft of their intellectual property. Taiwan still limits the number of Chinese who can be brought to the island by their IT firms for training. In China a Social Insurance Law, 2010, enables the transfer of funds to the social security system. Local and regional governments have altered their labor market policies to attract Taiwanese IT firms. A labor contract law was enacted in 2008 and higher minimum wage policies instituted in 2009-2011.

Companies in the three economies of this IT brain circuit have been responsive, on occasion, to internal and international pressure as well as reports in the media. IT firms in the US continue to lobby for looser immigration restrictions on the recruiting of high-talent migrants. In China some major examples are the unionization of Wal-Mart store employees. (T. Bain, C.-H. Chang, and Zhi Tang, 2006) Foxconn has pledged to raise salaries and reduce overtime. (D. Barboza and C. Duhigg, 2012) Apple announced the independent inspection of working conditions in their contractors and subcontractors. (C. Duhigg and N. Wingfield, 2012)

CONCLUSION

The question asked in this paper is: when firm's move productions overseas do they lose their strategic HR advantage and their core competencies. A related question is whether the US and Taiwan have exported jobs overseas. The case reported here is the experience of Taiwanese and Chinese students, who received their formal education in the US in the sciences, engineering and information technology and their informal education in the Silicon Valley model of entrepreneurships and start-ups, to develop a brain circuit.

The evidence from our work is mixed with regard to the costs and benefits of this brain circuit. There is no doubt that the development of an IT brain circuit between the three economies brought benefits to each of the economies. The US has benefited from these former students who have either remained in the US or shuttle back and forth, some with dual citizenship. Taiwan and China have benefited by the transfer of knowledge and technology to their own IT industries. The companies first served as suppliers to US MNE and then as developers of their own products. US IT production has moved to both economies and Taiwanese IT production has moved almost entirely to the mainland.

Entrepreneurs who return to the US, after completing their graduate

education, may establish headquarters or research labs in Silicon Valley, and seek venture capital, professional, managerial, and technical talent in the US. These activities raise US employment. If these entrepreneurs also raise funds in the US this benefits US capital markets. Taiwanese workers employed on the mainland provide remittances to their families on the island.

The Silicon Valley model was not replicated but adapted to the home economies of the returning students. Personal connections remain important to success in Taiwan and China. At the same time changes have been introduced in the use of venture capital finance, merit-based advancement, and corporate transparency. Investment in IT has also differed in the two economies. In Taiwan private venture capital has been used within an established legal framework. In China government-owned companies have lead the way.

There is also no doubt that there have been costs to the US and Taiwan in jobs. US IT firms have outsourced their production to Taiwanese companies and to their own firms in Taiwan and China. When Taiwanese IT firms moved to the mainland jobs were also lost on the island. The brain circuit has benefited from partnering and the co-development and co-architecture of new products and new components. The three economies have also made some adaptations in migration and labor practices and we expect these accommodations to continue. However, the circuit remains under stress from what are often different political and economic goals of each of the economies.

Table 1 Overseas Subsidiaries of The Largest Chinese, Taiwanese, and U.S. IT Companies In the Other Two Countries*

Company	Subsidiary	Country/Location	Product or Service	Sales USD Mil	Employees
CHINA					
Lenovo Group Ltd.	Parent	Hong Kong/Hong Kong	Public Sector and Government	21,594.4	26,341
	Quantum Designs, Ltd.	Hong Kong	Computer Peripherals	n.a.	1,757
	Parent	United States, Morrisville, NC	Computer Hardware	13,302.9	19,500
TAIWAN					
Acer	Acer American Corp.	US, San Jose, CA	Computer Hardware	7,000.0	5,400

	Acer America	US Temple, TX	Computer Hardware	140.5	120
	Acer Computer Far East	Hong Kong, Kowloon	Misc. Capital Goods	971.0	350
	Acer China	China, Shanghai	Office Equipment	519.0	220
	Gateway	US, Irvine, CA	Retail	3,980.8	199
	Gateway emachines	US, Irvine CA	Computer Hardware	n.a.	131
	Acer Latin America, Inc.	US, Miami, FL	Office Equipment	n.a.	n.a.
	Acer Computer (Shanghai)	China, Shanghai	Computer Hardware	n.a.	n.a.
ASUSTEK	Asus Computer International	US, Fremont, CA	Retail (Technology)	68.6	200
Hon Hai Precision Industry Co., Ltd	Foxconn Int'l Holdings, Ltd.	China, Shenzhen, Guangdong	Communications Equipment	6,626.0	126,687
		China	Communications Equipment	6,626.0	94,490
		US branches in Santa Clara, CA, Durham, NC, Westborough, MA, Hillsboro, OR, Harrisburg, PA, Houston, TX	Electronic Instruments and Controls, Retail, Business Service	65.4	136
	Foxconn Precision Industry Co., Ltd	China, Shenzen, Guangdong	Computer Peripherals	n.a.	n.a.
	Foxcoon	Hong Kong,	Miscellaneous	n.a.	n.a.

	International Holdings, Ltd.	Kowloon	Capital Goods		
HTC Corp	Dashwire	US, Seattle, WA	Retail (Technology)	1.0	3
Taiwan Semi-conductor Mfg. Co. Ltd	TSMC China Company Ltd.	China, Shanghai	Semiconductors	n.a.	n.a.
	TSMC North America	US branches in Burlington, MA, Austin, TX	Semiconductors	10.3	18
UNITED STATES					
Cisco Systems Inc.	Cisco Systems Inc.	China, Beijing	Computer Networks	n.a.	n.a.
	Cisco Systems Networking Tech. Co. Ltd.	China, Beijing, Chaoyang District	Office Equipment	750.0	350
	Cisco Systems (HK) Ltd.	Hong Kong , Central District	Computer Networks	103.0	200
	Cisco Systems Taiwan Ltd.	Taiwan, Taipei City	Office Equipment	n.a.	60
Computer Sciences Corp.	Automated Systems (HK) Ltd.	Hong Kong	Office Equipment	150.0	1,000
Hewlett-Packard Co.	H-P China Ltd.	China. Beijing, Chaoyang, District	Computer Hardware	874.0	2,000
	Autonomy Systems (Beijing) Ltd. Co.	China, Beijing	Business Services	n.a.	n.a.
	3Com Asia Ltd.	Hong Kong, Taikoa Shing	Office Equipment	160.0	200.
		China,	Office Equipment	150.0	100

	Hangzheu			
3Com International Inc.	Taiwan, Taipei City	Office Equipment	n.a.	10.
Hewlett-Packard Asia Pacific Ltd/HK SAR Ltd	Hong Kong, Quarry Bay	Office Equipment	386.0	750
Compaq Computer Hong Kong	Hong Kong	Computer Hardware	n.a.	n.a.
China Hewlett-Packard Company Ltd	China, Shanghai	Computer Hardware	1.0	300
Electronic Data Systems Taiwan Corporation	Taiwan, Taipei	Computer Networks	n.a.	494
Hewlett-Packard	Taiwan, Taipei	Business Services	206.0	400
EDS Electronic Data Systems Hong Kong Ltd.	Hong Kong	Computer Network	n.a.	45
HP China	China, Beijing	Office Equipment	n.a.	n.a.
HP Enterprise Services	China, Beijing	Business Services	n.a..	n.a.
	Hong Kong	Business Services	n.a.	n.a.
	Taiwan, Taipei	Business Services	n.a.	n.a.
Hewlett Packard Taiwan, Ltd.	Taiwan, Taipei	Computer Hardware	75.0	n.a.
Hewlett-Packard HK SAR Ltd.	Hong Kong, Taikoo Shing	Computer Hardware	1.0	n.a.
Hewlett Packard China Co. Ltd	China, Beijing	Computer Hardware	n.a.	n.a.
HP Enterprise Services	Hong Kong, Quarry Bay	Office Equipment	n.a.	n.a.

IBM Corp	Cognos Far East Pte Ltd	Hong Kong	Software Programming	n.a.	4.
	Cognos Hong Kong Ltd.	Hong Kong	Software/Programming	1.0	n.a.
	IBM China/Hong Kong	Hong Kong, Quarry Bay	Office Equipment	n.a.	1,650
	IBM	China. Tianhe District, Guangzhou	Office Equipment	n.a.	100
	IBM China Company Ltd.	China, Beijing	Software/Programming	1.0	n.a.
	IBM Taiwan	Taiwan, Taipei	Computer Hardware	n.a.	n.a.
	Reach and Range	Taiwan, Taipei City	Computer Services	n.a.	52

*Hong Kong, a part of China, is listed separately in this table because Taiwanese and US IT companies established subsidiaries in Hong Kong before its integration.

Source: OneSource Information Services, Inc., accessed December, 2011

References

Apple. (2012) *Apple Suppliers 2011*, Jan. 2012. (http://images.apple.com/supplierresponsibility/pdf/Apple_Supplier_List_2011.pdf)

Bain, Trevor, Chyi-Herng Chang and Zhi Tang. 'MNCs in China: Regulation and Reality', *Proceedings of the Sixty-First Annual Meeting*, Boston, 2006, Labor and Employment Relations Association, Champaign, IL.

Barboza, David. 'Foxconn Resolves a Dispute with Some Workers in China', *New York Times*, January 13, 2012.

Barboza, David and Charles Duhigg. 'Pressure, Chinese and Foreign, Drives Changes at Foxconn', *New York Times*, February 20, 2012.

Buckley, Peter J., Jeremy Clegg and Chengqi Wang, 'Inward FDI and host country productivity: evidence from China's electronics industry', in *Transnational Corporations, 15: 1*, April 2006, pp. 13-37.

Chang, Chyi-Herng and Trevor Bain. Employment Relations across the Taiwan Strait: Globalization and State Corporatism, *Journal of Industrial Relations, Vol. 49, No. 1*, 2006.

Chang, Pao-Long and Chien-Tzu Tsai. 'Finding the Niche Position: Competition Strategy of Taiwan's IC Design Industry', *Technovation, 22*, 2002, pp. 101–111.

Chase, Michael S., Kevin L. Pollpeter and James C. *Mulvenon, Shanghaied? : The economic and political implications of the flow of information technology and investment across the Taiwan Strait*. Santa Monica, Calif.: RAND Corporation, 2004.

Chen, Shin-Horng and Meng-Chun Liu. 'International R&D Deployment and Locational Advantage A Case Study of Taiwan', In Ito Takatoshi and Andrew Rose; eds., *International Trade in East Asia, NBER-East Asia Seminar on Economics, Vol. 14*, 2005, University of Chicago Press, Chicago.

Chen, Shin-Horng. 'Taiwanese IT firms' offshore R&D in China and the Connection with the Global Innovation Network', *Research Policy, 33*, 2004, pp. 337–349.

Choi, H. *An International Scientific Community-Asian Scholars in the United States*. New York: Praeger, 1995.

Clark, Cal. 'The China-Taiwan Relationship: Growing Cross-strait Economic Integration', *Orbis*, Fall 2002, pp. 753-766.

Duhigg, Charles and Keith Bradsher. 'How the U.S. Lost Out on iPhone Work', *New York Times, A1/Jan. 22*, 2012.

Duhigg, Charles and Nick Wingfield. 'Apple Asks Outside Group to Inspect Factories', *New York Times, Feb. 13*, 2012.

Ernst, Dieter and Linsu Kimb. 'Global Production Networks, Knowledge Diffusion, and Local Capability Formation', *Research Policy, 31,* 2002, pp. 1417–1429.

-. 'Global production networks and the changing geography of innovation systems: Implications for developing countries', *Economics of Innovation and New Technology, 11:6*, 2002, pp. 497-523.

Fannin, Rebecca A. *Silicon Dragon: How China is winning the Tech Race*. Singapore: McGraw Hill, 2008.

Hwang, Z.Y., et. al. 'HeJian Case: Prosecutors took Shu into Custody', A1/EDN, 2005-02-17.

Lane, Kevin and Florian Pollner. 'How to Address China's Growing Talent Shortage', *The McKinsey Quarterly, 3*, 2008, pp. 33-40.

Lee, Chuan-Kai. 'How does a Cluster Relocate across the Border? The Case of Information Technology Cluster in the Taiwan–Suzhou Region', *Technological Forecasting & Social Change, 76,* 2009, pp. 371–381.

Leng, Tse-Kang. 'Economic Globalization and IT Talent Flows across the Taiwan Strait: The Taipei/Shanghai/Silicon Valley Triangle', *Asian Survey, 42:2*, 2002, pp. 230–250.

Lin, Z.J. and C.H. Hwang. 'FDI and Labor Restructuring: Taiwan Case', Bulletin of Humanity and Social Science, 18:1, March 2006, pp. 171-214.

Liu, Yuwen, David J. Pucel and Kenneth R. Bartlett. 'Knowledge Transfer Practices in Multinational Corporations in China's Information Technology Industry', *Human Resource Development International, 9: 4*, 2006, pp. 529 – 552.

Mainland Affairs Council. 'Taiwan Approved Investment in Mainland China by Industry,' *Cross-Strait Economic Statistics Monthly, no.225* (Aug. 2011).

Manning, Stephan, Silvia Massini, and Arie Y. Lewin. 'A Dynamic Perspective on Next-Generation Offshoring: The Global Sourcing of Science and Engineering Talent', *Academy of Management Perspectives*, August 2008, pp. 35-54.

Mayumi, Tabata. 'Network Structure and the Diffusion of Transnational High Tec Know-how: Comparative Analyses on Taiwan IC and TFT-LCD Industries,' *Soochow Journal of Sociology, no. 20* (June 2006, Chinese version), pp. 109-148.

MIC, III. *Country Report: Mainland China*, (Chinese version), 2011.

MIC, III. Country Report: Taiwan, (Chinese version), 2011.

MIC, III. *2011 Taiwan IT Industry Annual Report*, (Chinese version), 2012.

OECD. *International Mobility of Highly Skilled, OECD Proceedings*. Paris: OECD Publishing, 2002.

Porter, M. E. 'Location, Competition, and Economic Development: Local Clusters in a Global Economy,' Economic Development Quarterly, Vol. 14 (2000), pp. 15-34.

Regets, Mark C. *Research Issues in the International Migration of Highly Skilled Workers: A Perspective with Data from the United States*. Working Paper SRS 07-203. Arlington, VA: Division of Science Resources Statistics, National Science Foundation.

Saxenian, Annalee. Silicon Valley's New Immigrant Entrepreneurs (CA: Public Policy Institute of California, 1999).

-. 'The Silicon Valley Connection: Transnational Networks and Regional Development in Taiwan, China and India', *Science, Technology & Society, 7: 1*, 2002, pp. 117-149.

-. From Brain Drain to Brain Circulation: Transnational Communities and Regional Upgrading in India and China, *Studies in Comparative International Development, Vol. 40, no. 2*, Summer 2005.

Sender, Henny. 'Capital flight of China's wealthy gets ready for take-off', *Financial Time Chinese*, Feb. 6, 2012.

Shih, C. 'Hsinchu, Taiwan: Asia Pioneering High-Tech Park,' in H. S. Rowen, et. al. (ed.), IT: the Rise of Asia in High Tech (CA: Stanford Univ. Press, 2006), pp. 101-122.

Todaro, Michael P. *Economic Development in the Third World*. New York: Longman, 1985.

Tsai, Ming-Kai. Explore Competitiveness: Strategy and Overview on the Practice of the IC Design and High Tec Industry. Taipei: Monthly Wealth, Chinese Version, 2002.

Wang, M.Z. and X.L. Chen. 'Investment Commission took Richard Chang Fine 5 million dollors and withdraw Investment in Half Year', A9/EDN, 2005-04-01.

Wang, S. H., et. al., *the trends and strategies on the offshore production of Taiwanese IT industry*. Taipei: III/MIC, 2001, Chinese version.

Zhou, D. H. 'President Lee: Patience is the best policy for across straits Relationship', 01/UDN, 1996-09-15.

Zweig, David. 'Learning to Compete: China's Efforts to Encourage a "Reverse Brain Drain"', Christiane Kuptsch and Eng Fong Pang, ed., *Competing for Global Talent*. Geneva: International Institute for Labour Studies, 2006, pp. 187-214.