行政院國家科學委員會專題研究計畫 成果報告

女性科技社群、創新環境與創新績效之研究 - 以新竹地區為例 (WR43)
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一、中英文摘要

1980 年代末期以來，在全球化與國際競爭壓力的驅使下，創新活動於地方經濟之角色與重要性已愈趨關鍵。因此在一成熟互動的潛在事業環境，可藉機會、適當性與演進的系統運作，將有助於地區產業的必要轉型、新興產業引入以及產業競爭優勢的維持。但過去相關研究主要從廠商層面與學研機構的空間鄰近，探討產業聚群形成有助於廠商創新活動；因此本研究嘗試基於過去系列的研究成果以及相關研究之顯著關係上，更進一步藉由創新環境中，性別層面探究女性科技人才衍生與流動所形成之科技社群的互動關係，對創新活動之影響，藉此檢視在產業聚群內女性科技社群網絡構連進程的重要性差異。

關鍵字：產業群聚、女性科技人才、社群互動、創新網絡、新竹科學園區

Knowledge has been seen as a central element of economic growth in knowledge-based economy era. It directly relies on the efficient acquiring, using and accumulating of knowledge and information, and emphasizes the involving of human resources who own the technological knowledge and specialization. Thus knowledge creation and the ability and efficiency of using knowledge become the supporting engine of industrial clustering and economic sustainability. Recently, the related researches which focus on the proximity of firms and advanced institutes discuss that industrial cluster is positive to innovative activities of firms.

This research attempts to establish a model from the conceptualization approach of female social capital via the thoughts of cognitive, organizational and social proximity explored by the related references. Further the study focus on how the female talent community exploit community interaction and network relations, and acquire and diffuse various innovation knowledge and activities, and on the formation of innovative environment in intangible perspectives. Moreover, this work will asses the importance of the configuration of female community networking in cluster.

Keywords: Industrial cluster, female technological talent, community interaction, innovative network, Hsinchu Science Park

二、研究緣起與目的

自 1980 年代末期以來，在知識經濟時代、全球化與國際競爭壓力的驅使下，創新活動於地方經濟之角色與重要性已愈趨關鍵（Feldman, 1994; Malmberg, 1997; Porter, 1990; Ritsila, 1999; Storper, 1995）。然而，全球化同時也漸強調依據地方能力、與環境所產生地方差異的顯著性 ；尤其，貧窮的國家普遍缺乏發展完善的地區聚群，因而使區域或國家經濟只能憑藉廉價勞力與自然資源於世界市場中競爭(Porter, 1998)。於是產業聚群的效益是可預期的，但在依賴新知識之產業活動中，聚群的區位是重要的，其必須具有充分的技術基礎設施、成熟的創新生產互動、及可抵銷不經濟要素之利益，如此聚群產生之空間鄰近性，才能促使廠商學習與知識積累、並為廠商引入契合的知識外溢效果，進而在地區的各作用者間形成一正向積累的互動氣氛。

地區創新聚群的形成，諸多研究立基於合作之互動關係，提出集體學習、地方著床、非交易互依、乃至網絡的形成；但從高科技產業競爭市場中所強調，即為新產品與新技術的競賽，為了能領先提出新產品或新技術，廠商進入產業集結地區競取關鍵性資源。此些資源包括知識作用者、技術人才、流動資訊、為獲取更大市場利益而階段合作的對象（包括地區廠商、供給者等）

等，甚至聚群地區內廠商僅薄弱的依附於地區、但彼此是座落在相當緊密的空間關係。同樣地，產業聚群所形成的技術人力源中，知識作用者間爭取更適合其預期價值的廠商，技術人才爭取更有利的工作機會；而為了預期價值的追尋，技術人才離開原組織而新創一個公司，如此的人才衍生就會產生（Lindholm, 1997）。其次，新創科技廠商其科技人才有兩個主要來源，分別為高等教育機構與建置良好的產業廠商（Oakey, 1995）；而新廠商可能傾向去群聚於大學、研究組織與既有廠商的周邊，除同樣欲藉空間的鄰近性掌握前述競爭要素外，係考量地區技術基礎架構之技術移轉、技術人才的衍生、及再研發的設備資源。

因此，除相關研究從廠商層面與學研機構的空間鄰近而形成產業聚群，有助於廠商創新活動外；從另一個角度觀之，在技術人力源藉由面對面互動而組成各種非交易互依的連結關係中，更進一步經由個體性別層面去探究知識作用者衍生與技術人才流動所形成之女性科技社群的互動關係，對創新活動與產業發展環境的差異影響，而這是過去相關研究所缺乏的。因此，除藉此檢視在產業聚群內女性科技社群網絡構連的種要性，同時亦做為科技產業環境建構之基礎。於是，本研究即在此一概念下，解析科技廠商聚群形成與科技社群網絡構連的關聯，藉此達成下述二個目的：

(一) 由園區周邊之發展進程明確呈現量產、培育與研發之緊密網絡鏈結，除各種鄰近性向度外，本研究嘗試基於過去相關研究之基礎上，更進一步從個體性別層面探究女性科技人才衍生以及流動所形成之科技社群的互動關係，對廠商創新活動呈現之差異影響。

(二) 藉此檢視在產業聚群內女性科技社群網絡構連、機制、人力資本等向度上之差異影響要素，可做為產業空間政策、產業創新環境形塑之重要參酌。

三、相關文獻探討

在二十世紀後期技術基礎產業面對全球化所形成之跨界性分工，不可避免地導致經濟活動之生產方式、組織機制、及空間結構一再的再層級化。然而在聚群影響空間尺度已由區域或地方層級聯結至全球層級，實質的空間聚群如何構連成互動密集的跨界分工，尤其，技術基礎設施所提供之功能正足以扮演地區創新環境建構與聚群跨界分工鏈結之關鍵作用者。

因此，首先回顧相關地方產業群聚之發展與理論演化，並且就空間群聚之內涵與發展型態進行探討；其次，回顧地區創新環境形塑的相關論述，做為進一步探討地區產業創新聚群與女性科技社群互動關係之基礎。

(一) 技術基礎設施、創新活動與知識外溢

在過去十年間，電腦與電信技術的演變，新的通訊技術改變生產區位而引發空間的變遷，此些情勢引起全球對知識基礎產業之需求成長快速，然而，能將新知識應用生產並商業化之從業者只侷限在世界上的少數產業聚群地區。由於此些聚群是由各種不同的機制所產生的，所以也呈現多樣化，然其最基本的邏輯假定，不同聚群型態需要不同型態的政策以提升創新與競爭力(Hart, 2000)。創新活動的引發與積累除空間鄰近性外，原始來源外溢，即知識外溢是另一管道或機制；此外溢機制主要以新知識的契合性為考量，亦即廠商會對相關採用技術進行投資，以提昇其自我能力達到可適應其他廠商所開發的新技術與理念，並且藉此獲得因新知識外部性所形成的利益（Cohen and Levinthal, 1989），而為迎合知識/技術的契合性考量，亦間接促使相關產業趨於集結。其次，知識外溢機制以技術人才流動或知識作用者衍生為主要的憑藉， Audretsch（1998）指出科學家、工程師、或其他的知識工作者，都是具有新經濟知識稟賦的作用者，如何能從知識中獲取最合適的報酬，主要緣於科學家或工程師能否於正在發展之新知識中，找到適合該知識預期價值之廠商。換言之，廠商提供契合特定新知識的預期價值以競爭知識工作者，而導致知識工作者選擇新廠商或以衍生方式另組創新廠商將知識外溢。

知識的外溢鮮少被爭論，但在經濟活動的空間群聚時，知識外部性之重要性就較被爭論。尤其知識外部性是如此重要且有力，是否有地理空間界線去侷限外溢之空間範圍，換言之，知識當其遇到某些地理界線時會停止外溢；特別是重大突破、且存有高度不確定性的智識，其在穿越同一地區之建築與街道時，遠比跨越海洋與州陸來得容易傳播（Glaeser et al., 1992）。基於知識具模糊不明確的、難於符碼化、與經常僅是無意中所發現之特性，於是在跨越地理空間藉由通訊的轉移已成為一個不變之方式，但轉移知識的邊際成本，特別是潛移默化的知識，會隨著距離的增加而上升。因此，針對環境背景複雜、困難模糊、與不確定的創新知識，其最佳的轉移方式，就是由面對面的互動及經常且重複的聯繫（Von Hipple,

1994)，且絕大部份此種知識轉移所仰賴的是非正式人際間的接觸。而如此的人際互動模式，除經常談及的合作模式外，另一重要的可能方式則藉由空間鄰近性刺激廠商的模仿、爭取專業人才以提升競爭力。

因此，若特定產業對新創知識的契合性與累積性程度越高，將有助於技術領導廠商做進一步的創新，以維持其競爭優勢（Breschi， 2000），這亦意味著高度的特定相關部門群集，對其創新活動的空間聚集更易產生。而依據一般結構、專業化程度及區域產業基礎的內部關聯性，地區內愈多相關產業的廠商，將有較多機會與新技術的初期採用者接觸；經由技術人才流動或衍生，於是有關特定技術的資訊會更快速的循環，而且反覆經由更大量的潛在採用者，進而更易受主流效果的影響。

在如此一個學習基礎的時代環境下，區域網絡形成、研究與技術發展、以及集體學習，對未來地方發展與地方吸引力而言，皆是重要的關鍵過程。為了相關技術衍生與獲取，新高技術小型廠商其專業人才有兩個主要來源，分別為高等教育機構與建置良好的產業廠商（Oakey, 1985），而新廠商設置可能傾向去群聚於大學、研究組織與既有廠商的周邊。此一結果，自然的趨向於在區域間產生穩定且可能不一致的成長，即已擁有內生科技活動的區域，會有穩定且較佳的成長，相對地其他區域則無法產生較佳的成長；因而具創新研發能力的大學及一些建置良好的大型產業廠商，經由衍生與技術轉移，對生成一個成功的區域技術密集之中小企業聚群，是一個重要的指標(Feldman and Florida, 1994)。所以在一個經濟系統中，大型與中小型廠商經由相關技術的取得與衍生互動，是相當有助於整體的創新研發與長期的成長。

此外，技術改變在經濟成長上的最大衝擊發生在於擴散階段，假若一區域落後於發明或新技術採用之後，則其將會面對產業的衰退。而在技術擴散過程，對技術的採用並非僅是一個簡單的知識機能，除廠商既有的技術承接能力，而且須評估與試驗；其次採用過程諸多的必要資訊經由個人接觸來支援創新流的擴散，於是連結組織發展與採用技術創新之人際間溝通的網絡，在擴散過程中是相當重要的。

因此區域內技術人才的流動與衍生，使技術擴散更形快速；而衍生對區域內無意識之集體學習的研究合作則是一非常重要的機制，其甚至比有意識、正式的合作更頻繁且重要。

(二) 技術社群與創新互動

在地區產業聚群中，學研機構與產業廠商有關科學技術之互動，是廣義技術基礎設施的一部份，此些技術基礎設施被安排於進行知識、資訊、技術的產生、轉移與運用。而學研機構與產業互動間之論證已產生相當大量的研究與文獻，其中一個有趣的面向為經由對機制（此些機制能促進與強化產學間的互動）有關文獻的回顧來探索，而在這些可用的機制中，科學園區所衍生的產業聚群特別受到絕大多數的注意。科學園區具有最成熟與積極的機制去設置基礎設施，此些基礎設施能使學研機構與廠商間、以及科技人才社群的互動被形塑與強化（Bell, 1993）。

再者，區域的技術基礎設施，此一途徑是創新與技術系統分析的核心，尤其區域內大學、研究與技術設施的能力，以及與廠商之間的學習互動，以使技術基礎設施之地方化效果產生，例如唯有與研發或創新者一起工作、或經由一同在實驗工作，則受轉移者才可能學習到（Zucker et al.，1994）；這也使得在資訊技術發達的時代，縮減了空間交易成本，但創新活動卻必須藉由空間鄰近性來面對面溝通。然而此空間聚群不同於傳統聚集經濟所強調著重交易互動成本降低與價格競爭，其區位競爭在於獲得更多的資訊與發展成熟的技術基礎設施等匯集成之大環境，因應生命週期越趨縮短的市場競爭。因而，由技術基礎設施面向反而強調創新活動所需倚賴各種不同資源與組織的構連，而所謂不同資源與組織則包括地方長期發展良好之相關產業廠商網絡的製造能力、廠商與大學之研發投入與能力、專殊商業化支援服務的集結程度(Feldman and Florida, 1994)；換言之，此些特定地區會為創新而發展不同技術能力與容量。此外對於一般技術基礎設施除學研機構外，Feldman and Florida（1994）指出尚包括有相關產業之廠商、產業的研發投入、大學的研發投入、以及生產者服務業的提供等；且此些技術基礎設施對地區產業聚群發展的進程中，將創新培育導向、研發導向、與量產導向之各種支援空間、以及有關之生產者服務業間加以鏈結，而形成一維持地區聚群持續發展的產業網絡（胡太山等，2003）。

而產業技術基礎設施如何浮現以促進與強化創新活動？技術社群架構對技術與組織系統如何一同演進（co-evolve）提供新觀點；Van de Ven and Garud (1989)是最早發展與應用社會學基礎的技

術社群架構之一，他們對主要世上先進技術之商業化的檢核，建構了一個產業的『社會體系』架構，並且運用此架構去研提研究方法學。至目前為止，有關技術社群相關文獻的各種不同貢獻，仍缺乏在組織層級上概念性之連貫條理。過去相關研究運用社會體系架構之社群，了解在生成一個支援新技術開發與商業化之產業基礎設施時，公私部門作用者的角色扮演（Van de Ven, 1993），或以技術社群或創新社群架構對技術創新與組織系統如何一同演進提供了新的觀點，進一步探討社群的各種不同特徵如何影響創新被運用的速度與範圍（Lynn et al., 1997）；尤其，創新社群的焦點著重在一些作用者上，此些作用者已被實證確認會影響創新商業化的過程。其次，依據Rosenkopf and Tushman(1994)的觀點，激發技術停滯的競爭，很典型地即藉由引入新的競爭者，例如新學科、專業的社群、技術的運用者等；且在技術停滯將開啟下一個發酵期時，需歷經一段在技術機制中或機制間之競爭的技術不確定時期，一些合作技術組織（CTOs）可能構成競爭的技術複合體（Rosenkopf and Tushman, 1994）。在此期間，組織間行為會決定技術競爭的結果，因而，技術發酵期間是與社群發展時期並行。

對於產業聚群中科學園區能成功的運作，學研機構的重要性在諸多研究中已被相當的強調（Monck et al., 1988; Massey et al., 1992; Westhead and Batstone, 1998），亦即，區內廠商間、及與鄰近學研機構間所建立起連結的本質；在往昔國內外已發展的一些研究，已藉由比較園區內外的廠商、以及地區內產學間互動情形來探究此一空間鄰近性觀點；在這些研究與實證的觀點中，很清楚的對產學間連結之建立有一較佳的認識，特別是那些經由科學園區所產生聚群的連結，因而假若要改善預期的連結關係與機制，則科學園區是很根本的。然而，如 Massey 等所指『此些連結的深度是不清楚的』（Massey et al., 1992, p.38），雖然產學間空間距離的鄰近性，是維持與促成科學園區及周邊產業聚群做為產學連結互動機制的重要因素，但科學技術人才與廠商之間被預期的緊密關係，對此些連結的促進與強化是否具重要性？在此論證上即是，產學間的空間鄰近性（就如園區所提供的）會促進廠商與學研機構間必要的增效作用，相對地，合作夥伴之科技人才間知識、資訊、甚至技術的交換亦將會受到刺激與提升。然而，關於產業聚群內科技社群之互動情形則較缺乏探究，雖然在這種議題上實證研究缺乏，卻無法阻止政策制定者廣泛運用合作夥伴間空間鄰近性為論點，用以做為科學園區設置的判斷與激勵。

(三) 社會資本、社群網絡與創新環境相關理論

A. 社會資本理論

在社會裡的社會資本的基本概念中，主要特徵包含社會的正式(社區活動、協會)與非正式(透過網路朋友，鄰居，家庭與工作同事)、信任程度、容受力、相互關係、公民權利、社會認可與社區聚合性（Woodhouse, 2006）。即由一行動者與另一行動者因某種特定關係而產生互動行為，並藉由此過程中交換彼此的資源或資訊，行動者藉此互動關係而獲得的資源或資訊，便是一種「社會資本」。

過去研究指出對於科技人才所具備的社會資本對於創新機會的發掘(Shane, 2000)、新事業的發展、創新績效(Davidsson & Honig, 2003)等，皆具有顯著的影響。Aldrich(1989)發現到女性創業網絡主要透過工作、家庭，與社會生活(social life)所構織而成，這與男性創業的網絡沒有太大差異，唯一較不同的是，男性創業者的社會網絡較少涵蓋女性，然而女性創業者的社會網絡卻涵蓋較多的男性。Inman(2000)的研究指出女性同時使用強連結及弱連結社會網絡關係，去獲取創業技能及資訊。顯示女性創業者也積極擴充社會資本，以獲取足夠的創業資源。除了由創業者自身所延伸出的社會網絡外，Lerner, Brush & Hisrich(1995)則發現到參與由女性企業家所組成的協會組織，對女性創業的事業有正面的影響(蔡依倫、謝如梅，2008）。

B. 社群網絡理論

企業組織外部所建立的合作關係，如策略聯盟、合資等，稱之為組織的「外部社會網絡」；而企業組織內部的各部門之間、成員之間的互動關係所建立起來的關係結構，稱之為組織的「內部社會網絡」。這兩種不同類型的社會網絡可分別為企業組織帶來外部社會資本及內部社會資本，前者強調的是資源的獲取，後者則強調資源的內部流動及運用，兩者皆對企業競爭優勢有相當的影響力。若以企業組織內的部門為分析的單位，則某部門對外與其它部門之間的關係連結，彼此能相互溝通、合作、協調，即形成該部門的「外部社會網絡」，進而能獲取外部社會資本，或稱之為「自我中心(ego-centric)」觀點的社會資本。某部門內部的成員之間，因正式或非正式關係所建立的互動連結，則可視為該部門的「內部社會網絡」，而能為此部門帶來內部社會資本，或稱之為

「社會中心(socio-centric)」觀點的社會資本（陳榮德，2004）。

創新的社會網路理論根據在企業和其它角色之間形成複雜的交互作用過程 (從創新的技術網路理論被借用)。新的洞察力為知識在促進創新的過程中的扮演的角色越來越重要，知識的成長是重要成長因素，累積的知識與與技術，透過全球規模的通信技術使得知識運用更加快速。與創新的技術網絡理論相比，社會網絡理論的創新主要重視更多相對關係，以及作為技術網絡創新的無形因素，而不是技術工具上的戰略與網絡。以知識為基礎的創新發展要求實現能力和技術的相關工具：新訊息和通信技術的獲得與使用。這些技術工具不僅造成競爭優勢，其他人也是可以利用的。

雖然男性與女性所建構的網絡關係沒有多大差別，但是一般的人際互動方式傾向「性別－隔離網絡」(gender-segregated networks)。組織成員間會利用非正式組織或互動來達成知識的交流與訊息傳遞，因此，女性較難進入男性所建立的網絡關係(如下班之後聚會、交際應酬等)，進而造成影響力減低、資訊來源缺乏，自然也就較難進入權力核心，進而影響女性的在工作上的表現與機會。

C. 科技聚群與創新環境概念

現代合作研究或開發新產品往往不是透過正式的合約，而是有一些默契的技術轉移和知識交流，這種過程是不能用道統的所有製來控制和管理的。這就需要一種新的制度性的手段，以創造區域創新環境，活化資源和訊息，增加靈活性，減少不確定性，增強企業創新能力。(王緝慈，1999)

面對全球化的競爭，唯有營造創新環境，才可以創造競爭力的產生。創新與技術改變的系統方法強調一個觀念，即多數的創新活動不是分散在各國的合作，而是聚集在高科技創新的區域。而創新的績效視廠商與其所在環境的互動而定，此一環境包括廠商互動的作用者網絡、廠商行動的一般架構，如機制架構、社會價值與文化等。換言之，創新系統可能依據互動，而將真實的經濟與技術的變動與流動及遊戲規則予以概念化。當地方廠商的運作管理是根植於外部資訊來源緊密關聯的各種網絡，而且當廠商所在的地區因地方化與都市化使其聚集經濟程度愈高時，透過地區創新學習網絡使廠商學習愈佳，則廠商使用新技術機率也愈高，進而營造區域創新環境(解鴻年，2006)。

因此女性科技人才在此創新環境氛圍中，有了創新的契機，前因是來自於全球產業結構的變遷、資訊科技的革新、教育程度提升以及服務業的興起，使得女性在其社會化角色的限制下開始有其發展的舞臺空間(蔡依倫、謝如梅，2008)，開始自己的科技社群網絡。

D. 科技社群衍生與區域鄰近性

由知識經濟所依賴的創新活動之特性，強調空間鄰近性、地方化學習網絡、面對面互動等，使得相關高科技事業產生聚集的現象。科技條件並非均質地分布在各廠商、各產業、各區域或各期間中，但產業與空間的創新型態應密切相關，因為其間具有一些共通的因素。因而科技條件或機制特質將影響創新活動的區位，包括：研發投入、知識基礎、創新數量以及契合條件。而創新活動一般集中在特定產業之科學知識基礎較雄厚之地區，促成創新更有效率的被產生與轉移，使立基於新知識的經濟活動高度傾向於集結在同一空間區域，進而產生新的科技社群(胡太山，2006)。

在一些科學領域例如組織研究、創新研究和區域研究中，理解到鄰近性有助於經濟互動與績效；而鄰近性經常被提出做為包含諸多不同向度之概念，例如包括有認知、實質、組織、和制度等的鄰近性，而 Boschma（2005）更進一步充分探討多面向之鄰近性 。廣義而言，鄰近性之概念主要把焦點從作用者間互動汲取出不同的基礎，亦即經濟作用者當嘗試去合作與提昇其經濟績效時，會建構在不同之鄰近性向度基礎上；而更進一步的問題是，是否此些互動基礎在不同社經時空背景下會有所不同。本研究採用的思考面向包含 Boschma（2005）其中三種鄰近性面向：

- **認知的鄰近性（Cognitive proximity）**

藉由互動之有效學習，可能伴隨著為固守認知鄰近性（亦即為了溝通的緣故，必須有充分的認知重疊）而維持一些認知距離（限制認知的重疊）。空間群聚如 Maskell (2001) 所定義，會執行這些需求條件；Maskell 主張在群聚中知識產生，係經由勞力差異與勞力深度分工所形成，在水平面向，具類似能力之地方競爭者間的差異會刺激新的實驗，其在一個透明的群聚中準備接受，此意味著學習過程有助於認知距離與鄰近性二者間有效的結合。因此，作用者需要認知鄰近性係為

了在分享知識基礎上去溝通、了解，並成功的運用新資訊。

● 組織的鄰近性（Organizational proximity）

組織鄰近性必須去控制組織內外於知識產生時的不確定性和投機取巧；然而，過度的組織鄰近性因為閉鎖和缺乏彈性，而損害互動學習。而依據 Nooteboom（2000）以及其他研究者指出，在組織內外寬鬆的連結系統，則反映出組織鄰近性之層級的控制與彈性毋庸擔心；而如此的治理結構也會導致洽到好處的認知層級，此則隱含組織與認知鄰近性彼此互補。

● 社會的鄰近性（Social proximity）

社會鄰近性基於信任和約束會刺激互動學習，但是，過度的社會鄰近性基於閉鎖效應和低估投機之風險，而可能對互動學習有所損害；而依據 Uzzi 所指，一個兼具市場關係（即保持社會距離）與著床關係（即具有社會鄰近性）之網絡，會規避此些問題且提高其創新績效。事實上，此並非與其他向度之鄰近性沒有關係，例如，社會鄰近性在一段時日後會降低夥伴間的認知差距。一如前述，漸增的認知鄰近性會刺激互動學習，但也降低了互動學習的潛力；而組織鄰近性也依循社會鄰近性所欠缺的，因為人們之間的關係並非立基於信任之上。然而，組織鄰近性與社會鄰近性雖然其中牽涉到不同的機制，但二者皆由夥伴間強烈結合來呈現其特徵；空間鄰近性最易刺激社會鄰近性，因為緊鄰的空間距離有助於社會互動和信任的建立。

四、新竹地區女性科技人才創新活動研究分析

(一)新竹地區創新環境分析

1980 年以前新竹地區整體的聚落發展主要是以舊城區市中心為主要的發展；在產業上，玻璃與照明相關等產業則是從日據時期便興起發展的重點項目延續至當時。整體的發展上，新竹地區由於緊鄰高速公路和交流道的節點便利，許早已有工業進入裡面，廠商數目不多，並多為勞力密集性工業。新竹科學園區在設立之前，新竹地區的產業結構主要是以塑膠製品、成衣製品與食品業的從業人員為最多，當時電子業雖尚未興盛，新竹地區已具有工業規模，而當時的產業取向為傳統勞力密集產業仍具有極大優勢。

1981 年以後規劃新竹科學園區設置，早期設置的目標有三：第一是再工業化—透過科學園區引發全面的發展方向；第二是促進健全自主的工業發展；第三是改善科技工業園區的發展及其投資環境。，此外，考量到當時國內的產業發展及新竹地區的地方特性，因此將發展重點放置在放射技術、電子技術、玻璃製造、食品製造等方面。在設立的初期僅有 17 家廠商與新竹地區並無太大差異。

新竹科學園區在規劃時期，依據『新竹科學園區發展十年計畫』(1981-1990 年)將科學園區發展分為三階段，第一階段（1981~1982 年），著重引進廠商科技與製造經驗，為科學園區的宣傳階段；第二階段（1984~1986 年），確立國際市場的競爭力，並培養研發人材及專業技術，將零件及材料供應網加以建立，與學術及研發單位相配合，增加就業機會，確立園區發展方向；第三階段（1987~1990 年），主要鼓勵國內企業將資本投資於更高階及更專門的產業類別，並建立自有品牌及生產網絡，為科學園區的自立階段。

新竹科學園區的設立帶動新竹地區產業環境的改變，新竹科學園區歷經萌芽期以及發展期長達近逾十年的發展，所帶動的成長除了區域的發展之外，最明顯的莫過於整體產業營業額呈現倍率的增加，主要的還是以積體電路、電腦週邊、光電與通訊產業等產業為整體營業額的最大貢獻者，而進駐的廠商家數至 2007 年底也已達 416 家，產值 11462 億元。此時，六大產業型態已相當穩固，但此時周邊舊有工業區已面臨衰退之趨勢，新竹地區的製造業出現以電子業來支撐地區產業的現象。雖然傳統產業遷離，但在園區外圍的新興產業，主要是對園區做原料的供應以及產品的加工。

由於有先前十年努力，對於創新環境空間中聚集的過程存在這一些不確定性，直至 90 年代，因為全球化競爭的推擠以及國家政策的高度著重等環境的優勢，使得 1991~2000 這一個十年的週期成為快速發展的成熟期，園區內的專利數核准數件與六大產業的營業額亦同時成長，使得新竹科學園區的成功不僅奠定了在台灣科技產業的先驅外，也是國際上競相爭取模仿的科技園區成功案例。

新竹科學園區內科技產業大量發展之後，隨著科技環境變化快速，高科技產業迅速成長，然而受到廠商將業務和部分製程外部化的影響，過去製造業依靠的物質、土地、資金等要素，已被知識、技術、科技、創新、研發等觀念所取代。新竹科學園在研發上的質與量逐漸改變，加上近

幾年來中國及東南亞一些其他已開發中國家經濟的快速發展以及相對容易獲取的廉價原、物料和勞動力成本，逐漸吸引原來投注於科學園區廠商的投資外移，並影響外來投資的意願。故此，面對全球化和產業的開發以及國家經濟之下，未來科學園區的方向如何降低彼此間之競爭態勢並強化其合作關係，在網絡、創新以及信任之間提高資源使用之效率，是再生期階段中相當重要的關鍵課題。

在新竹市的整體聚落發展中，在園區尚未正式設置之前是以舊城區市中心為主要的聚集地；在園區開始設置的階段，則帶動起人口定住以及住宅的需求，使得鄰近科學園區、清大、交大、等產業暨學研機構與高速公路一帶的聚落和快速成長。直至近年來，新竹市在多年科學園區的發展之下，科學園區所帶動的效應不僅是區域間發酵，更在空間發展中可一見創新、生產網絡所帶動的現象。

未來提昇新竹科學園區整體發展再創高峰，即不受限於現今的發展模式為新的經濟發展目標，所以希望透過廠商聚集及網絡連結，與相關公私立學術研發機構，利用研發創新來帶動科學園區再生，由原來的代工生產走向創新研發。

(二)新竹地區女性科技人才創新績效之分析

本研究之抽樣樣本為科學園區廠商、工研院、清華大學創新育成中心、交通大學創新育成中心及中華大學創新育成中心，總共發放 150 份問卷，有效回收問卷為 55 份，總回收率為 36%。

在 55 份受訪者問卷中，受訪者產業類別多為電腦及周邊、積體電路等電子類相關產業，工作性質多為技術研發及管理階層約占整體受訪者 6 成。

1.女性科技人才 V.S.網絡關係之建構

隨著社會與產業型態的改變，男女的角色地位逐漸產生變化，逐漸產生變革的過程中，讓男女之間的教育機會平等，且工業化所帶來複雜的分工及職業結構轉變，使得女性就業比例開始增加，讓女性在社會角色逐漸開始面臨轉變，而勞動力市場需求增加且多元化，提升了女性參與就業市場的機會。

對於女性科技人才在網絡關係建構之面向上，對於其在工作與其他個人相關協調上有正面的效益。因此在科學園區的創新環境氛圍中，科學園區藉著合作與競爭產生網絡關係所建構的基礎技術能力與技術創新，對外產生向上提升的推力，對內部產生穩定的力量，女性科技人才在網絡關係中產生的面對面互動，也不再受到空間鄰近性侷限，其改變主要原因為可能來自交通網絡可及性提升，如高鐵通車後縮短南北互動距離。

從調查中顯示女性科技人才有 70%願意花至每週 1-2 小時以上來進行合作關係的建立，交通成本考量上也有 74%願意花費每週 1000-2000 元以上，這都顯示因交通網絡可及性提升，網絡關係隨之擴大，讓創新網絡版圖不斷更新中。其次，與 Hu et al.(2008)的研究相較顯示，女性和整體科技人才在網絡關係的建構上，頻率與意願上仍有相當差距，但另方面也顯示女性科技人才在網絡中之角色地位已有顯著的提升。

網絡關係構面

建立合作關係			
開發新客戶與拓展業務		衡量鄰近組織的合作關係	
容易	不容易	容易	不容易
85%	15%	76%	14%
建立網絡關係成本考量			
時間距離		交通成本	
時/週		元/週	
1-2		1000-2000	

2.女性科技人才 V.S.研發活動與創新

整體環境中，除了學術研發機構和政府單位之外，最重要的即為廠商在整體空間面向及實質面向上所組合而成的生產網路，在這個生產網絡存在於個體廠商之間的鏈結，而隨著廠商與廠商之間的發展、大環境的影響與資源、彼此技術合作關係等因素，逐漸強化產業的競爭力。

在研發活動網絡中，創新機構本身扮演著極重要的創新生成媒介，透過其建構出一完善的環境基礎，而配合學研機構的結合，提供園區週邊的創新生成輔助，並且透過網路連結，產生聚集效應後在週邊吸引更多的創新研發機構。

創新的產生在部份產業上的型態，應可有相關政策提出配套措施，專殊的技術與研究都要倚靠在特定的環境下才能生成，可以全面性的針對各產業進行因應制度，以改善創新環境的平衡發展。從各產業中廠商間研發合作之技術合約類型分析，發現主要以技術授權與技術移轉為主，其次則為成果移轉、技術合作與專利授權，其研發合作對象以新竹地區之學研機構為主，亦即工研

院以及交大清大為核心；而其技術合約類型，則多屬技術移轉、次為技術授權。

基於市場競爭力的考量，安排相關教育與訓練活動可以提升女性科技人才的專業能力與學習力量，同時增加研發與創新的機會成本；隨著新知識學習比例的增加，創新績效的投資報酬越高。換言之，當女性科技人才的學習能力愈高時，市場投資報酬率、創造新產品與增加市場優勢的機會成本相對也愈高。於調查中顯示，女性科技人才逾 8 成認為學習專業知識或新知識對研發能量的提升相當重要，因而約有 54%者每月安排 2-3 次之相關教育與訓練活動；而如此的研發與創新活動，對女性科技人才在創新績效提升上，主要係在市場優勢的呈現上。

研發活動與創新構面

研發能量提升			
學習專業知識或是新知識		安排相關教育與訓練活動	
容易	不容易	≦1 次/月	2-3 次/月
82%	18%	46%	54%
創新績效提升			
技術發展	市場優勢	應用研究	
26%	52%	22%	

五、研究成果

隨著社會文化的改變，教育水準的提昇、經濟自由的競爭及女性意識抬頭等多重因素下，女性逐漸肯定自我的才能與能力。在工業化的結果，使得科技與資訊的社會開始不斷地擴張，讓女性工作者開始走出家庭，在勞動市場中逐漸佔有重要的比例。

在科技產業環境中，女性科技人才若需要長時間投入自身建立的工作網絡關係與創新活動中，就有必要加強對於女性的人力資本之投資，像是欲提升女性科技人才的創新績效，必須從新知識的教育投資和職業訓練等多方面著手，同時仍加強對於女性科技人才對於工作以外的成本支持(如照顧小孩與老人服務)等，讓女性科技人才購買服務以便進入就業市場，有充足的時間與機會可以建立自我的網絡關係，進而在工作上獲得成就，達到雙贏的局面。

六、計畫成果自評

1.研究內容皆依原計畫書進行
2.與計畫之預期目標相符
3.適合於學術期刊發表
4.後續研究

研究過程中限於許多各種文獻資料不足及地方資料難以取得問題，在整體研究成果上呈現上仍有很多地方須加以補充，但整體研究內容仍主要依據原計畫書進行，因而，與原計畫之預期目標大致相符，所獲得之初步成果也值得在學術期刊中發表。而研究過程中發現的議題或現象，值得作為後續的研究方向，建議如下：

(1)利用外部與內部社會資本探討影響因子

女性科技人才在面臨個人與環境因素考量下，如何這在樣的互動工作網絡中，探究內部與外部社會資本對於其所在產業網路鏈中所產生的影響，將是接下來研究的方向。

(2)比較區域產業創新環境差異

在研究的過程中，女性科技人才如何與周邊(跨縣市)的產業環境是怎樣的互動事實上是比較少探討的，因此在後續的研究發展應該針對這個部份再加以深入探討，比較女性科技人才在不同的創新環境中如何扮演自己的角色，以建立自己的最佳創新網絡與工作模式。

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行政院國家科學委員會補助國內專家學者出席國際學術會議報告

97 年 8 月 21 日

附件三

報告人姓名	陳淇美	服務機構及職稱	中華大學建築與都市計畫學系講師
時間 會議 地點	97 年 8 月 21 日至 8 月 23 日 韓國，全州	本會核定 補助文號	NSC 96-2629-H-216-001
會議名稱	(中文) 2008 年台日韓國際研討會 (英文) International Symposium on City Planning 2008		
發表論文題目	(中文) (英文) From Science Park to High-Tech Region：An Overview of Hsinchu		

報告內容應包括下列各項：

一、參加會議經過

本人此次參加 2008 台日韓國際研討會，今年由韓國主辦。會議日期從 97 年 8 月 21 日至 8 月 23 日，地點在韓國，全州市國立全北大學舉辦。專家學者提出超過 70 餘篇研究計畫。8 月 22 日早上 9:00-10:00 邀請韓國 Chung-An 教授進行”東亞都市新興的規劃課題專題演講。10:00-18:00 進行各個主題的報告。8/22 日上午開始環境規劃研究議題、景觀規劃議題、都市設計議題、都是在生意題等的論文發表，本人發表之論文排在 8/22 下午 203 會場的第三場，Sesion Chair 是 Chonbuk University 大學 Hong Bae Kimi 教授，報告之後由 Hon Sok Kim 教授提問有關方法論使用上的相關問題。當天發表的論文尚有關於產業空間、住宅供應與居民成長多目標規劃方法學的應用等多篇論文共同進行討論。研討會會議在 8/23 傍晚圓滿閉幕，8/24 搭機回國。

二、與會心得

此次會議為本人第二次參加國際研討會，會議中與日本、韓國、香港、台灣等大學教授面對面接觸，除能拓展視野、增加見聞之外，對於專業領域中的新思潮、新觀念並有耳濡目染之效。此外，面對面的學術交，由於可以當場提出問題，因此要比印出來閱讀來得更有效，同時在別人問問題時，有時可以幫助思考一些自己沒考慮到的問題。

三、考察參觀活動(無是項活動者省略)

8 月 23 日 上午參觀位於全州的韓國傳統村落(Hanok Village)，此區建於 1930 其建築型式與附近的日式建築型式形成對比，顯示出有趣的城市色彩意象。下午參觀 Semangeum 填海計畫，此計劃範圍有 40,100 公頃，其海岸線有 33 公里長，範圍含概 Gunsan, Gimje 與 Buan 等地。

四、建議

個人覺得此研討會所發的論文集印刷太大本（A4 size）並且太厚，不是非常方便攜帶與收藏。此外，又沒有附加攜帶與收藏方便的光碟版。

五、攜回資料名稱及內容

1. 會議資料：包括議程、作者個人基本資料
2. 研討會論文全集一本

六、其他

From Science Park to High-Tech Region: An Overview of Hsinchu[δ]

Chi-Mei Chen[1], Tai-Shan Hu[2], Hung-Nien Hsieh[3]

Abstract

The Hsin-Chu Science-Based Industrial Park, established in 1980, has been central to the development of the Taiwanese economy. HSIP has promoted not only the development of related industries in surrounding area, but also the creation of technopolis. The Hsin-Chu technopolis has experienced rapid population growth over the past two decades. Accordingly, the population structure and distribution, industrial patterns, and innovation environment have all changed significantly. The spillovers of innovation and knowledge creation, and changing production patterns among local industries stimulated by the development of the high-tech industry, form a special industrial network in Hsinchu.

This paper provides an overview of its evolution from three perspectives on Hsinchu technopolis: socioeconomic transformation, relationships of innovative activity and interactions between technology community and industrial clustering, and development of producer service. The paper first reviews the evolution of Hsinchu technopolis with respect to socioeconomic dimension, such as population, industrial production space and innovation environment. Then the paper discusses in depth on how interaction between technological communities and industrial clustering influences the innovative activities in Hsinchu. Finally, the authors analyze the interactions, geographic transformation and distribution between HSIP firms and producer services in Hsinchu technopolis, and the coordination of HSIP firms with research institutions. The findings summarized in this paper provide a comprehensive examination of the development of Hsinchu technopolis and are beneficial to international comparative analysis regarding technopolis development, industrial district planning and management and the formation of production networks and knowledge-intensive business services.

Keyword: Hsinchu, science park, high-tech region**,** technology community, producer services, innovation and production network

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1. Introduction

Technopolis is a regional innovation strategy that generates sustained and propulsive economic activity through the creation and commercialization of new knowledge. Asian countries frequently follow policies of using strategic investments, typically by central government, to create technology-based clusters or cities to serve as growth engines for their respective regions. Science parks are generally perceived as local or regional growth centers (Bass, 1998; Hu et al., 2005; Lin, 1992; Oh, 1995). Investments in science parks promote industrial advancement and simultaneously spur local development of related industries and businesses. Famous examples of this development model include Taedok Science Town in Korea and Nagaoka Science Park City in Japan. A technopolis is not merely a concentration of high-technology firms or research and development organizations. At the center of the technopolis is the creative process of developing new technologies and translating them into commercial products or processes (Casstells and Hall 1994). But, a frequently raised question so far has been how to measure the effectiveness of technopolis as an instrument of regional innovation policy to stimulate technology-led economic development.

Hsinchu Science-Based Industrial Park (HSIP) was established in 1980. This project aimed at developing Hsinchu into a high-tech research base with high quality, strong growth and high efficiency. Owing to substantial government investment, as well as rent and tax incentives, HSIP became a major force in the economic lifeblood of Taiwan. Total HSIP sales reached 28.2 billion US Dollars in 2000, increasing 43% from 1999, and represented 10% of total manufacturing output in Taiwan. Moreover, HSIP became closely integrated with regional industries and local development. The concentration of high-tech and innovative firms transformed into a regional development force, which led to the emergence of Hsinchu technopolis over twenty years.

Between 1982, when Hsinchu City became a self-governing municipality, and 2000, its

population increased by over 110,000 persons. This population growth exceeded the average in Northern Taiwan. The average rate of social increase in Hsinchu is 1.21% from 1982 to 2000. These statistics exhibit a strong trend of inwards migration in Hsinchu. According to the 2000 statistics of the Hsinchu Science-Based Industrial Park Bureau (HSIPB), the development of HSIP has contributed significantly to local employment. Notably, thirty percent of Hsinchu's manufacturing workforce was employed in HSIP in 2000. Moreover, despite rising unemployment in Hsinchu during the past decade, Hsinchu maintains a low unemployment rate and high labor force participation rate compared to the rest of Taiwan.

With the rapid development of HSIP, the total number of employees increased to over 100,000 by 2001, while the total number of companies increased to approximately 300 (Figs. 1 and 2). Most of these employees are highly educated and highly paid. HSIP transformed the local industrial structure, represented a new urban development pattern, and altered population composition. Restated, the age structure in Hsinchu has altered significantly during the past two decades. Notably, growth rates in the 30 to 40 and 40 to 49 age groups, are 87.41% and 74.21%, respectively. This growth trend clearly demonstrates that HSIP has not only influenced the local economy, but also the local population structure.

The effect of the long-term development of HSIP on a locality results mainly from a development model different from that used by traditional industries, plus the continuous input of new knowledge, helping sustained market competitiveness[1]. The success of science parks is related to local educational institutions, technological infrastructure, and R&D funding (Westhead and Batstone, 1998). Direct costs can be minimized through collaboration between science parks and R&D institutions. Furthermore, companies located in science parks can benefit from developing and sharing new information and applying it in their businesses. The convenience provided by science parks encourages the agglomeration of high-tech industry. Collaboration among science park companies, research institutions and universities is essential to science parks.

The characteristics of innovation, on which the knowledge economy depends (Audretsch, 1998; Feldman et al., 1994), emphasize spatial proximity, localized learning network, and face-to-face interactions. These characteristics promote the agglomeration of high-tech industries around HSIP, creating a localized innovation environment. Additionally, the Industrial Technology Research Institute (ITRI) began establishing laboratories and innovative incubators in HSIP since 1995. Over 80% of the incubated companies chose to locate in the Hsinchu area or the nearby Lung-Tan area (i.e. in the northeast of Hsinchu area), expanding the production space around HSIP to include traditional industrial production space, demonstrating how high-tech industries agglomeration caused a reform of production space.

The agglomeration of high-tech industries, the local production network created by the technological infrastructure in the vicinity, and the related knowledge and informal information flow generated by local universities, form a continuously strengthening agglomerative economy, which has become the force increasing the production capacity of the Hsinchu technopolis. The success of HSIP and the formation of Hsinchu technopolis demonstrate that Science/Technology Park is an effective tool for integrating industry and regional development. This paper reviews the development of Hsinchu technopolis (Fig. 3) from the perspectives of socioeconomic transformation, interactions of technology community, and the development of producer services. This paper intends to provide an overview of the formation and evolution of a technology-based metropolitan area and its innovative environment. The authors hope the findings in this paper will provide valuable information for international comparative analysis on technopolis, industrial district planning and management and the formation of production networks.

2. Socioeconomic Evolution of Hsinchu Technopolis

During the past ten years, HSIP has grown significantly and brought a large technical labor force that is highly educated and highly paid to the Hsinchu, along with other population to

support this technical labor force. This industrial production capability has also become a driving force for attracting related industries to HSIP and the surrounding area. The subsequent entry and establishment of related business service industries have further transformed the overall industrial structure of Hsinchu, and simultaneously restructured its urban space and led to the formation of Hsinchu technopolis. Three development stages were defined for HSIP, namely the initial stage from 1984 to 1988, the stable development stage from 1989 to 1993, and the rapid growth stage from 1994 to 1998.

2.1 Changes in Population around HSIP

Cities in Northern Taiwan have maintained positive population growth with growth rates ranging from 0.79 to 2.89% in 1980-98. Comparing population growth rates of major cities in Northern Taiwan, the Hsinchu districts (1.44-6.44%) exhibited more significant growth from 1986 to 1998 than the average of the entire Northern Region. These high growth rates correspond with the structural changes recently experienced by Taiwanese industry, namely, the prosperous development of the high-tech industry, the successive establishment of high-tech companies in HSIP and the consequent employment wave in HSIP. Relationship between industrial development and population growth demonstrates the influence of HSIP on population growth in nearby cities.

2.1.1 Spatial Distribution of HSIP Employees

HSIP has attracted migrants from all over Taiwan, as evidenced in the employment statistics of the HSIPB (Table 1). The number of new residents in Hsinchu area also increased with the rapid increase in the number of HSIP employees. Meanwhile, the number of HSIP employees originally from the Hsinchu area decreased. Just 33,300 HSIP employees moved to the Hsinchu area in 1997, compared to approximately 60,000 in 2000. Because of the recent

aggressive expansion of HSIP companies, a significant number of current HSIP employees migrated to the Hsinchu area from other parts of Taiwan. Simultaneously, the number of employees who chose to commute to HSIP also increased by approximately 14%. Furthermore, Table 2 presents that commutes to HSIP mostly originated from the Eastern District of Hsinchu City (36%), followed by Chu-Tung and the Northern District of Hsinchu City. This distribution indicates that HSIP employees mostly resided in the Eastern and Northern Districts of Hsinchu City, as well as Chu-Tung, Chu-Pei and Pao-Shan. The following section compares this distribution of the residential locations of HSIP employees with the population distribution in Hsinchu.

2.1.2 Relationships between Population, Population Growth and Population Density

From the statistics of the HSIPB, initially HSIP employees mostly came from Taipei. Even in 1984, 40% of HSIP employees lived in the Taipei Metropolitan Area. Then, the population of Hsinchu City increased by 17,000 between 1984 and 1988, and population concentration began to occur around HSIP (Fig. 4). Furthermore, the population increase in the vicinity of HSIP totaled 30% of the total population increase in Hsinchu City. The above statistics indicate that the population concentration triggered by HSIP only occurred after 1985. Therefore, the authors concluded that, during this stage, the influence of HSIP was limited to the Long-Shan area where is close to HSIP.

From 1989 through 1993, the numbers of companies and employees in HSIP grew steadily. Especially, the semiconductor industries exhibited strong demand for educated labor with high school, vocational school and college degrees. This demand stimulated business service industries in the Hsinchu area. However, This situation highlighted the shortage of vocational school or higher educated workers for meeting the demand of HSIP companies. Consequently, educated labor was rapidly brought in from outside the Hsinchu area. Many of these migrants chose to reside close to HSIP, but others resided elsewhere (Fig. 5), for example in southern

Hsinchu. Additionally, many migrants moved in to Chu-Pei, which had good accessibility to HSIP and relatively low real estate prices.

During the rapid growth stage, the high growth rate of HSIP gradually led to saturation. Traditional industries could not compete with high-tech industries for production space. Consequently, these traditional industries began to leave the Hsinchu area in favor of areas with cheaper production space. Owing to the rapid expansion of HSIP companies, HSIP faced a serious shortage of land for further expansion. As a result, locating related industries outside HSIP or contracting out HSIP company operations became increasingly common. These activities prompted the adjustment of production space in the vicinity of HSIP and stimulated more population migration. Consequently, population began to concentrate in the Chu-Pei and To-Fen areas, which have good transportation accessibility to HSIP and relatively low housing prices (Fig. 6).

2.2 Changes in Industrial Production Space

From the above analysis of the relationship between population growth and neighborhood evolution, this authors found out that the establishment of HSIP significantly influenced neighborhoods of Hsinchu City and County (Fig. 7). Besides the influence of HSIP on population growth, the authors further intend to determine whether the changes in the industrial production space around HSIP resulting from the establishment of related industries also influenced employee-housing choices.

Looking at the process of industrial growth in HSIP, the first professional semiconductor manufacturer in Taiwan emerged with the creation of Taiwan Semiconductor Manufacturing Company in 1987. This development marked the beginning of formal cooperation between semiconductor design companies and manufacturers in Taiwan. After 1991, a mutual dependency developed between innovative technology from Silicon Valley and the mass

production facilities in Hsinchu. However, global competitive pressure led both design companies and related service companies to locate in HSIP to facilitate the rapid resolution of any issues arising during the manufacturing problems. The extensive production capacity at HSIP further attracted more companies to locate there. By 2001, HSIP had reached saturation over 300 companies being located there. Consequently, some companies that could not move into HSIP ended up located in the area around HSIP or elsewhere. These companies generally required sites with mass production facilities in the general area of HSIP. When choosing a factory site, companies generally prefer HSIP to other locations because of its rent and tax incentives, plus the advantage of innovative interactions with other companies. The second most popular choice of location is the industrial area around HSIP.

The area around HSIP changed significantly with the rapid growth of HSIP. Major areas around HSIP include the Hsinchu Hu-Kao, Chu-Tung and Chu-Pei Industrial Districts, and South Hsian-Shan and Chu-Nan. Among these areas, the Hsinchu Hu-Kao Industrial District, linked to HSIP by the Freeway 1, initially focused on traditional industries, such as ceramics, glass, beverage, and chemical manufacturing. In 1991, the chemical and plastics manufacturing industry accounted for 23% of the total 337 companies involved in this district, metal and mechanical industries accounted for 20%, and electronics accounted for just 15%. Meanwhile, by 1999, electronics companies represented 30% of the 352 companies. Among these electronics companies, semiconductor companies accounted for 40%.

Furthermore, the Taiwan Highway 1 Corridor area south of HSIP, situated between Hsinchu Hsian-Shan and To-Fen Mixed-Master, originally focused on traditional industries such as chemical engineering, paper manufacturing, and so on. However, from the Miao-Li County Industrial and Business Survey in 1996, although the metal product and mechanical industry still accounted for 24% of the 498 companies in this area at this stage, electronics companies had increased the presence to a total of 59 companies (12% of the total number). Most of the

electronics companies were located along Taiwan Highway 1, between South Hsinchu and the Chu-Nan Industrial District. A major driver of such development, besides the involvement of HSIP, came from the provision of key technology infrastructure nearby in the form of ITRI.

Moreover, many large companies in the Chu-Pei Industrial District also engaged in transformation of the industrial structure, including the development of privately developed science parks such as Tai-Yen Science Park. Additionally, many spin-off innovative companies chose to locate in the Chu-Tung and Hsinchu Industrial Districts on the east and west sides of HSIP because of their proximity to universities, research institutions and HSIP itself. These companies then tried to move into HSIP, or else sought alternative locations in the surrounding area. This phenomenon led to the construction of office and factory buildings around the Hsinchu Interchange of Freeway 1 in the vicinity of HSIP. These buildings provided space not only for new innovative companies, but also producer service industries serving HSIP.

2.3 Emerging of Innovative Environment in and around Hsinchu

Knowledge-based economic activities or innovative activities usually cluster in areas with rich base of scientific knowledge related to specific industries (Baptista, 1996), which is why companies capable to utilize new knowledge in production and commercialization are only located in a handful areas of the world. Furthermore, the more R&D is inputted into a clustered space, the faster new technologies and products can be released, the greater the profits from new technologies and products will be, and the more innovative outcomes will be stimulated. Examining total corporate spending on R&D in the Hsinchu District in 1990 reveals that only 56% came from companies located in HSIP. However, by 1998, this figure has increased to 84%. From 1990 through 1999, the R&D capital input of companies in HSIP increased 10 fold, exceeding not only that of companies in the wider Hsinchu District, but also exceeding the national average. This phenomenon was further evidenced in the dominance of information technology hardware of publicly traded semiconductor companies in the U.S. software patents

registered by Taiwanese companies, revealed in the statistics collected by the Industrial Development Bureau, Taiwan Ministry of Economic Affairs. Among these companies and institutions, 70% were located in Hsinchu District.

R&D capital input level further stimulates competition among companies or agents, as demonstrated clearly by the number of patents generated by companies in HSIP and ITRI. From 1994 through 1999, the number of overseas approved patents originating from Taiwanese companies grew 53%. During the same period, the number of overseas patent approvals originating from Taiwanese companies located in HSIP increased 6.7 fold. Additionally, while HSIP companies owned only 2% of the total number of patents in Taiwan in 1994, this number grew to 10% by 1999. Moreover, HSIP companies control 12% of the total overseas approved patents owned by Taiwanese companies[2]. These data demonstrate that, in terms of competition for the timely release of new products and procedures, information and technology flow in the cluster drives innovation.

Likewise, ITRI and United Microelectronics Corp. not only own the highest numbers of U.S. approved patents in Taiwan and are important members of the local electronic industry, their roles as technology transfer agents are also essential. The technology transfers originated by the Specialized Science Technology Projects of ITRI focused on the information electronics industries in the Hsinchu District, in terms of both number of companies and amount of capital (Table 4). The focus of technology transfer for information electronics industries was also on the Hsinchu District. For example, in 1994 only 22% of the capital, in Taiwan, involved in technology transfer in the information electronics industries occurred in the Hsinchu District. However, by 1996, 42% occurred in the Hsinchu District. This increase shows that the clustering of related or similar industries in a particular geographic location benefits the accelerated release of new discoveries or the acquisition of market share information. Consequently, the speed and intensity of innovation increases. The cluster of R&D capital input

not only increases innovation energy, but also boosts profits from industrial activities that rely on new knowledge. For example, 70% of the 78 publicly traded electronic companies in the Hsinchu District had average EPS exceeding 1 from 1996 through 1999, and only 11% recorded deficits. In contrast, more than 30% publicly traded electronic companies in Taiwan recorded deficits during the same period.

3. Innovative Activity Fostered by Interactions Between the Technology Community and Industrial Clustering

After twenty years of development, HSIP has grown significantly, especially in the last ten years. Annual production has increased ten fold during the past ten years, the number of companies has increased 150%, and the number of employees has tripled. As summarized earlier in this paper, the vicinity of HSIP also experienced major changes parallel to HSIP's rapid growth. All these developments contributed to the formation of Hsinchu technopolis. The third part of this paper will provide a more in depth analysis of the innovative activity fostered by interactions between the technology community and industrial clustering in Hsinchu technopolis.

The author first attempts to analyze the development of local clustering by addressing innovative activity and interactions within production chains in industrial clusters in the Hsinchu area of Taiwan. Then, on an individual level, the authors address the relationships within technological communities that follow from high-tech talent mobility[3]. The geographical relationship between high-tech talent mobility and the innovative activities of industrial clusters is also clarified.

3.1 Innovation and Production Chains in Industrial Clusters

During the second decade of rapid development in the HSIP (1990-1999), approximately 25% of the 171 new firms established at the HSIP were spin-offs established by ITRI. These spin-offs constituted the original local technological infrastructure. Of these spin-offs, ten firms

were successfully developed by ITRI's Incubation Center, which was established in 1996. Moreover, during 1996-2003, approximately 80% of the firms developed by the Incubation Center chose to locate in the Hsinchu area (including 40% in the HSIP and 38% elsewhere), establishing a local innovation chain that begins with research and development, is followed by incubation and results in the spinning-off of a new company.

Second, during the government-sponsored ITDP from 1994 to 2000, almost 90% of partner firms in the IT and electronics industries were in northern Taiwan. Within the Hsinchu, most technology transfers, in terms of both frequency and value, occurred in the IT and electronics industries. The financial value of technology transfers in the Hsinchu represented approximately 40% of the value of all such transactions in northern Taiwan (Table 3). Over 80% of all technological transfers in all industries[4] in the Hsinchu were in the IT and electronics industries.

In relation to Taiwan as a whole, and even to the northern region in which IT/electronics is concentrated, firms in the Hsinchu area are highly specialized. However, this situation begs the following question - does this specialization and centralization create a realistic and close-knit industrial network? Consequently, besides addressing transfers of technology under government-sponsored ITDP and production and cooperation among firms, this work also discusses the area production chain based on the collected company prospectuses, with reference to firm investment in production and the spatial distribution of production.

Technological cooperation among firms in various industries involves five main types - contracted technical cooperation, involving licensing or transfer of technology, which together comprise most cooperation. These types are followed by achievement transfer, technological cooperation and patent licensing. Table 4 reveals that most cooperating R&D partners in the integrated circuit, computer and peripherals, telecommunications and opto-electronics industries, already mentioned, as well as in other industries, are research or academic institutions in the Hsinchu area, with ITRI at the center and National Chiao-Tung University and National

Tsing-Hua University at the periphery. This arrangement is the same as for ITDP-related technology transfers, mentioned earlier.

Moreover, most contracts governing technological cooperation involve technology transfer. The second largest number involves technology licensing. In contrast, most technological cooperation contracts between local and other firms are in the integrated circuit industry (over 70%). Furthermore, most contracts for technological cooperation involve foreign firms, followed by firms from northern Taiwan. Domestic research institutions represent most firm contracted technological cooperation partners, with nearby institutions comprising the largest fraction. Furthermore, technological relationships among local firms are weaker than those with domestic research institutions, even among firms in the same area.

Additionally, the production and trade network of firms within the HSIP is such that interaction, including critical investment and product sales, with firms in northern Taiwan is quite extensive (exceeding 70%). Meanwhile, the production and trade network involving firms outside the HSIP but within the Hsinchu area is relatively weak. Accordingly, combining the previously mentioned ITDP technology transfers, technological cooperation contract relations and production trade networks yields the initial results of this work, indicating that northern Taiwan is a complete and comprehensive local industrial cluster[5] characterized by clustered trade interaction and weak innovating interactions.

However, the results also indicate that the Hsinchu area is characterized by spatial proximity or interaction with overseas firms in innovative technological interaction. Furthermore, new firms tend to cluster in the Hsinchu area. On maturity, around 40% of these corporations are likely to expand further in northern Taiwan following three to five years. Some firms might even, after five to eight years, go beyond their current cluster to form links with other clusters, especially clusters in Mainland China.

Recently, almost 30% of firms in the HSIP have already opened offices in or shifted

production to Mainland China. Consequently, innovation and production links that have developed in the Hsinchu industrial cluster hide specific interactive factors that have attracted firms to the area to compete for economic agents with endowments of new knowledge, high-tech personnel, knowledge, information and other interaction advantages, while simultaneously becoming magnets attracting high-tech talent to the area. Consequently, this investigation analyzes how the high-tech talent interactions influence innovative activities.

3.2 Innovative Linkages within Technological Communities

The analytical results of this investigation indicate that in-house R&D, local academic and research institutes, and foreign companies are the three main sources of technology for firms in the HSIP. R&D cooperation or product design cooperation among firms represents below 30% of all responses. R&D cooperation is mostly on different hierarchy in related industries. This situation is consistent with firms having different technological cooperation contracts, as displayed in Table 4. Of the almost 30% of high-tech personnel that engage in R&D cooperation or product design cooperation with another personnel, 26% claimed that they engaged in face-to-face interaction at least three times weekly during cooperation, while 28% said that this face-to-face interaction occurred at least once weekly (Table 5).

This high frequency of face-to-face interaction follows mostly from the fact that high-tech products have decreasing life-times and thus any problems must be solved quickly and efficiently. Furthermore, problems of design or engineering technology are best solved through face-to-face interaction. Those high-tech personnel who participate in cooperative R&D or cooperative design tend to participate more frequently and in more numerous research projects, training sessions and seminars than others, thus strengthening their innovation abilities and promoting innovation via such interaction (Table 6).

However, in expanding their own personal professional networks (Table 5), individuals who interacted face-to-face on at least a weekly basis developed their networks mostly through

informal personal contact or social gatherings (about 30%). Similarly, most skilled personnel who were not involved in R&D or design cooperation activities tended to expand their personal professional networks informally via personal contacts or social gatherings; however, the frequency of their interactions was significantly lower than that of personnel involved in cooperation activities.

Most firms in related industries are in competition with one another. The primary reasons for these firms concentrating in the Hsinchu area are ease of obtaining information, availability of industrial support, presence of economic agents, and other reasons related to better understanding of their competitors. Firm cooperation usually takes the form of international alliances with foreign companies, but cooperation with other firms around the HSIP also occurs in the form of horizontal collaboration across related industries or vertical integration, such that relations between firms are simultaneously competitive and cooperative, creating a firm competitive advantage for the HSIP and surrounding area (Hu et al., 2002). Thus, interactive networks between local firms make a crucial contribution to the development of specific innovative activities.

Second, although firms within the HSIP and in surrounding areas contribute to the production chain, their contribution is limited to short-term, non-systematic production networking, and thus their involvement in the local economy is weak. Restated, double-edged relationships between cooperation and competition prevent firms with such relationships from establishing deep roots in the local economy. This situation differs significantly from that described by most relevant studies, which see innovation and production networks as rooted in the high-tech region. However, innovation production networks can be confirmed to motivate innovative industries to cluster in a certain area.

4. Development of Producer Services

After the previous overview of socioeconomic transformation and innovative activity in Hsinchu technopolis, this paper reviews the development of producer services that have become an integral part of the industrial development model of Hsinchu technopolis. The definition of producer services, the authors adopted a broader definition, i.e., any service functions that can be operated for the consumption of companies and organizations, including 1) transportation, logistics, communication, 2) finance, insurance, real estate, and 3) business services.

The emergence and expansion of innovation increasingly depends on new technology and knowledge. New technology and knowledge are not just created in companies' internal R&D labs but can also be derived through intensive interactions, communication and exchange of information among companies and academic research institutions. Producer services appropriately play a key role in this interface. They serve as a bridge and exchange center between technical and business experts and localized knowledge and capabilities. This role led to producer services being seen as shared innovators of small to medium size companies.

The cross-border division of labor in high-tech industries resulting from globalization inevitably reconstructs production methods, organization and geographic structure. In the two decades of development of HSIP, HSIP's vicinity gradually formed a distinctive and strong network including production, incubation and R&D activities (Hu et al., 2002). Within this network, producer services not only provide a crucial interface between the supportive environment and technological infrastructure but also effectively fill the role in linking Hsinchu to the external network.

Before the establishment of HSIP, the Hsinchu area's industrial structure was dominated by secondary level industries. The establishment of HSIP in 1980 led to the innovation and advancement of manufacturing industries in Taiwan, which further attracted more firms moving to HSIP. The activities in HSIP also stimulated the industrial and economic development of its vicinity and formulated a new industrial network in Hsinchu technopolis. In order to meet the

service demand of new technology and to serve firms in and around HSIP, the level of service industries was also gradually elevated and certain related service industries, such as banking, insurance, storage, logistics and transportation, and information technology, began to cluster around HSIP. These specialized service businesses provide numerous resources and services to satisfy their customers in HSIP and the Hsinchu area. The activities of these businesses further brought about numerous benefits including changes in job creation and the accumulation of capital and information.

4.1 Geographic Transformation of Producer Services in the Hsinchu Technopolis

Interactions in Hsinchu Technopolis include primarily production, R&D, innovation, information exchange and other related activities. The host city of HSIP, Hsinchu City, responding to the impact of clustering of industries, began to integrate various resources and professional service industries to enhance the development of the local industrial network. As shown in Figure 8, the number of companies in producer services gradually increased since 1986 and stabilized in 1991. Among producer services, finance, insurance and real estate industries enjoyed the most significant development. Before 1991, there were only a small number of new companies (about three to twenty five) that joined these industries annually. After 1991, there was an increase of 80 to 100 annually.

The three types of producer service industries discussed in this study experienced different transformations in their geographic locations. Finance, insurance, real estate and business services in particular show a very different development pattern. Hsinchu City is the center of the Hsinchu metropolitan area and finance, insurance and real estate industries in Hsinchu City had already been influenced by the local industrial network before its impact reached Hsinchu County. As early as 1988, significant growth had already been seen in finance, insurance and real estate industries in Hsinchu City. During the same period of rapid growth, these industries

grew in Hsinchu City at a rate two to three times that of Hsinchu County. Financial institutions were mostly located in the northern and eastern districts of Hsinchu City, and along the Taiwan Highway 1 toward Chu-Pei (in Hsinchu County). The clustering effects were clearly evident in the transformation of Chu-Pei's industrial production environment, development of private business parks, and transformation of Hu-Kao Industrial Zone.

Since 1986, there has been a significant increase in the number of business services in Hsinchu City. The fastest growing periods were first between 1989 and 1991, and later after 1995. Among business services, the information and software service industry grew the most, followed by advertising, marketing, consulting, and product design. The growth in Hsinchu County, however, was not significant until after 1992, when the growth rate reached 40 new companies per year. Cheaper land in Hsinchu County provides space for leasing industries, therefore, the growth of construction machinery leasing industry was the most significant in Hsinchu County, followed by consulting, marketing and information services. In summary, business services chose different geographic locations because of different characteristics of Hsinchu City and Hsinchu County.

In summary, we found two peaks in the development of producer services in the Hsinchu area (Figure 8). The first peak was the development of host city Hsinchu when the interactive effects of HSIP industries and producer services began to emerge around 1991-92. The second peak was the development of accessible areas through the expansions and connections of local industrial production networks, which attracted more producer services and increased interactive activities around 1999-2000. As evident in the Hsinchu area, producer services in Hsinchu City expanded to accessible areas such as Chu-Pei, Hu-Kao, and Chu-Nan via major transportation thoroughfares[6].

4.2 Development of High-Tech Industries and Producer Services in the Hsinchu

Based on the research discussed previously, this study attempted to analyze the development

and evolution of professional, scientific and technical services, as categorized by the 2001 Taiwan Industry, Commerce and Service Census. Industries studied in this category are knowledge intensive services industries[7]. The number of companies in these industries grew at a pace of 10 to 20 new companies in the first decade of HSIP's existence (1980 to 1990) in the Hsinchu area. The growth rate began to increase dramatically in the second decade, adding 30 to 50 new companies. The fastest growing period was between 1996 and 2000. During this period (1996 to 2000), the business services, also called professional, scientific and technical services in The Report 2001, grew faster than transport and finance.

Geographically, these services industries are mostly located in the host city of HSIP, Hsinchu City. About 70 to 80% of the companies were located in Hsinchu City every year. After 1990, the number of companies and the operating revenue in Hsinchu area grew significantly, particularly after 1996 (Figs 9 and 10). The geographic locations of these companies echoed the development of HSIP and its vicinity. From the growth of the number of companies and the annual sales volume, this study reached a preliminary conclusion that the growth of HSIP to over 100 companies in 1993 and its significant increase in sales volume since 1994 resulted from the active participation of ITRI and spin-offs of industrial clusters since 1986. These interactions accumulated and led to the increasing demand for and dependency on producer services, particularly KIBS industries. With such demand for a variety of professional services, a network of business services began to emerge, as concluded by Feldman and Florida (1994).

As discussed above, KIBS industries began developing after the rapid growth of HSIP. Initially these industries were concentrated in the host city Hsinchu, but as Hsinchu built-out and accessibility to Hsinchu's vicinity such as Chu-Pei improved, KIBS industries began to expand to other areas. Furthermore, the geographic transformation in the production environment also indirectly stimulated the geographic transformation of KIBS industries. More noticeable is the development of industrial-zoned districts in Chu-Pei and Hsinchu Industrial Zone in Hu-Kao,

which attracted HSIP related companies to locate to the north of HSIP and in turn bring in KIBS. Among professional, scientific and technical service industries, this study took a closer look at computer system design services, specialized design services and data processing and information supply services (Appendix). Before 1993, there were less than 15 companies in computer systems design services in the Hsinchu area, mostly located in Hsinchu City. This industry did not grow much until after 1993. Its rapid growth in Hsinchu City was during 1996 and 2000 and in Hsinchu County, after 1998.

Specialized design services in Hsinchu area grew more significantly after 1997, while the growth in Hsinchu County became more apparent between 1999 and 2000. There were a small number of data processing and information supply services since 1993 in Hsinchu City. They grew slightly starting in 2000 and a small number of companies began to locate in Hsinchu County since 2000.

According to Appendix, KIBS industries had very slow growth in annual operating revenue in the first decade of HSIP from 1980 to 1990. However, the growth in the second decade since 1993 had reached almost US$ 30,000 thousand. The growth rate was most rapid between 1996 and 2000.

5. Conclusions

This study aims to identify the effectiveness of Science Park policy to innovation environment formation through reviewing the evolution of regional technology-based development policy in Taiwan with particular reference to HSIP. The research interest, particular, is focused on the analysis of three major aspects of technopolis development and impact on regional innovation. Through the case study, it is identified that development from pure science park to technopolis have had good impacts on regional development based on the regional innovation and production networks. The research results show us two decades of development began with the establishment of the HSIP in 1980, aiming at mass production, followed by the

gradual inwards migration of a technical labor force, stimulating the development of the area around the HSIP and the establishment of related industries (Figure 11). Moreover, because the development of the knowledge economy depends on innovation to enhance competitiveness, spatial proximity was utilized to create a business environment, and a technological infrastructure oriented towards incubating research and development activities was established to strengthen the competitive advantages of HSIP companies. The accumulated spin-off effects of innovative production networks were also reflected in the evolution of the local socioeconomic environment.

Such industrial evolution has not only influenced the structure of production space, but has also promoted the transformation and development of the local population structure and residential communities. Consequently, the growth of HSIP shaped the formation of Hsinchu technopolis. Simultaneous with the continued agglomeration of high-tech companies, functional space also emerged for local industrial network components, that is, mass production, R&D, and incubation. Moreover, support industries and space for these three types of functional space also began to materialize. Consequently, in terms of related industries, the establishment of HSIP contributed significantly to the development of local support industries, especially the rapidly growing producer service industries and KIBS.

Two peak periods were found in the overall development of producer services in the Hsinchu technopolis. The first peak was when interactions between HSIP industries and producer services emerged. The second peak occurred after the local industrial network gradually impacted accessible areas in the vicinity of HSIP and further stimulated interactions and the establishment of producer services. Consequently, producer services in Hsinchu City expanded to other accessible locations through major transportation thoroughfares.

The authors also found that the industries in the Hsinchu technopolis pursued more compartmentalized and specialized production methods as industrial activities in the Hsinchu technopolis became more diversified. From invention and production to sales and marketing,

such processes require the support of many different professions. A sustainable industrial development environment requires various resources, in order to establish an integral industrial network. Such interactions in the vicinity of ITRI and HSIP led to the demand for and dependency on a variety of producer services, particularly KIBS industries. Consequently, a network of business services also began to emerge.

Moreover, although communication costs have decreased considerably because of globalization and the improvement of communication technology, face-to-face interactions remain essential for the spatial agglomeration of high-tech innovation owing to the ambiguity and uncertainty of new innovative knowledge. Therefore, location remains a key factor. The local innovation and production network formed by the HSIP, the surrounding area and technological infrastructure not only strengthened the local agglomeration economy, but also became a major force for enhancing the competitive advantage of local industry.

The authors also found that the spatial proximity of firms clustering within the HSIP strengthens the interaction among high-tech personnel and the expansion of their professional networks, as a result, innovative R&D activities are effectively promoted. The geographical proximity of firms also facilitates rapid mobility of high-tech human resources within the industrial cluster and even encourages the spinning-off of work teams. It is found that the aforementioned interaction process has directly and significantly improves innovative activity in the cluster and the establishment of industrial innovative networks. Moreover, interaction among high-tech talent is particularly significant in promoting innovation activities of small and medium high-tech firms.

Considering factors such as the intentions of R&D investment and activity, technology transfers, human resource spin-offs, production and trading interactions, and so on, the authors also concluded that the northern region of Taiwan comprises a complete innovation environment, that is from science park to high-tech region. During the early stages of new production and the

spinning-off of a new firm, firms in the northern Taiwan area tend to locate around ITRI and the HSIP. When these firms have developed mature and extensive relationship networks, as demonstrated by an analysis of their production and trade interactions, they tend either to put down roots and remain in an appropriate location within the northern Taiwan industrial cluster or alternatively establish connections with other clusters in order to integrate cross-boundary resources. Additionally, the synergies achieved through the linking with ITRI (the first R&D park) and HSIP (the first Production and R&D park) in Taiwan also promoted the formation of an innovation cluster in Hsinchu technopolis, and expanded the production cluster over the northern region of Taiwan. Furthermore, the innovation cluster was then reinforced by the technological infrastructure, ITRI.

Moreover, following the emergence of the new linkage of the United States, Taiwan and China during the mid-1990's, the establishment of cross-border interactions among clusters has attracted considerable interest of high-tech firms and researchers. Cross-border interactions among clusters have significantly changed the conventional perspective of cluster dimensions and geographical connections. However, firms still rely on spatial proximity, establishing their R&D centers in the Hsinchu or northern Taiwan, to fulfill the practical requirements for face-to-face interaction and reduce the risks associated with uncertainty and technological infrastructure costs. Local innovative clusters with close spatial relations and deep interactions within the technological community enjoy advantages in knowledge competitiveness.

Notes

1. Park companies accounted only 56% of total research and development funding in Hsinchu area in 1990. By 1994, it has increased to 56% and by 1998, 84%. Between 1990 and 1999, research and development funding of Park companies grew ten times, exceeding that of Hsinchu area, and even the funding of the entire nation.
2. In 1999, there were a total of 11,092 oversea approved patents in Taiwan. Out of this number, 1,276 were owned by companies located in HSIP. (Source: 2000 Indicators of Science and Technology, Taiwan)
3. The survey questions mainly dealt with three areas - frequency of interaction among high-tech personnel and

mobility of high-tech talent. The firms were in the integrated circuit, computer and peripheral, telecommunications, and opto-electronics sectors. Some 600 questionnaires were distributed and 243 usable responses were returned.

4. All types of industry include agriculture, forestry, fishery, animal husbandry and mining, manufacturing, water, electricity, fuel and natural gas, metal and mechanics, IT and electronics, chemical engineering, household trades, service and others. (Source: ITRI's Technology Service Center)
5. Technological cooperation contracts and trade networks that originate at the HSIP show that the degree of industrial clustering in the Hsinchu area is highest in the integrated circuit and opto-electronics industries, while the computer and peripherals, and telecommunications industries, tend to cluster throughout the entire northern region. Kung (1999) addressed the agglomeration of spin-offs in these four industries by analyzing the family trees of enterprises in the area.
6. Chu-Nan Science-Based Industrial Park (CSIP) is located in Miao-Li County, adjacent to Hsinchu City. Its construction began in 1999 and 66 companies submitted their lease/purchase applications in 2000. However, the size of CSIP is still quite limited. There are 16 companies already undertaking mass production activities in CSIP in the end of 2003. (Source: Planning Division, HSIPB)
7. Including legal and accounting, architectural and engineering technical, specialized design, computer system design, data processing and information supply, consultation, advertising and other related industries.

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Appendix Annual Increase in Operating Revenue and Newly Established Units of Knowledge-Intensive Services in the Hsinchu Area

		Grand Total	Legal and Accounting Services	Architectural and Engineering Technical Services	Specialized Design Services	Computer Systems Design Services	Data Processing and Information Supply Services	Consultation Services	Advertising Services	Other Professional, Scientific and Technical Services
Hsinchu Area	2001	13111	170	620	3448	6574	447	1261	367	224
		(66)	(4)	(4)	(12)	(21)	(5)	(11)	(5)	(5)
	1999	42771	441	2357	9870	26135	50	2682	636	600
		(97)	(4)	(13)	(18)	(23)	(2)	(14)	(10)	(13)
	1997	27116	205	196	16638	4552	942	396	2405	1783
		(63)	(3)	(4)	(15)	(9)	(2)	(7)	(8)	(15)
	1995	26600	956	4403	104	13969	133	1768	4221	1045
		(49)	(13)	(6)	(1)	(9)	(2)	(7)	(9)	(7)
	1993	6847	652	119	2378	1661	134	1008	47	847
		(38)	(10)	(2)	(4)	(4)	(2)	(4)	(3)	(9)
	1991	40058	1006	37261	219	817	0	66	116	574
		(30)	(11)	(6)	(1)	(1)	(0)	(1)	(3)	(7)
	1989	3760	104	130	291	1416	0	76	0	1743
		(18)	(6)	(2)	(1)	(2)	(0)	(1)	(0)	(6)

	1987	413 (7)	426 (8)	0 (0)	0 (0)	0 (0)	0 (0)	0 0)	21 (3)	214 (2)

Note: ( ) indicates the annual number of newly established units.
Source：The Report on 2001 Industry, Commerce and Service Census, Directorate-General of Budget Accounting and Statistics, Executive Yuan, Taiwan

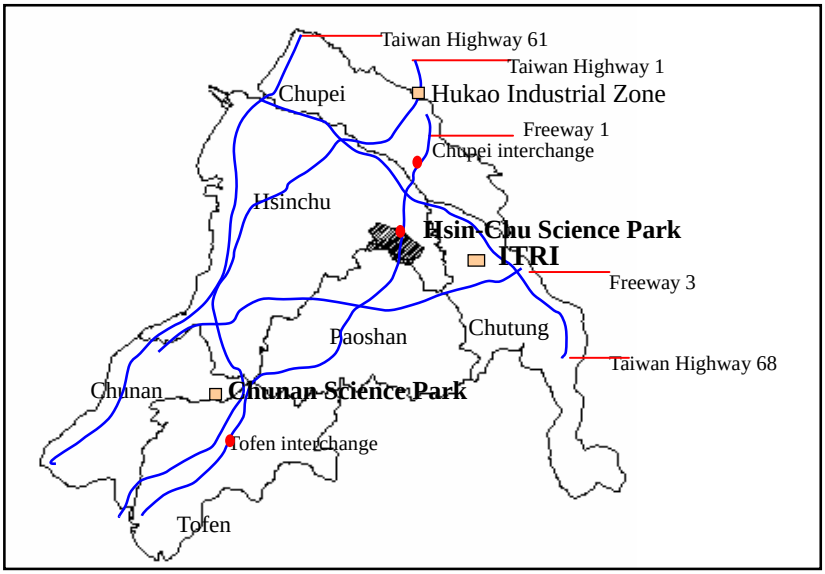


Figure 3 Hsinchu district: location and major infrastructure and urban characteristics

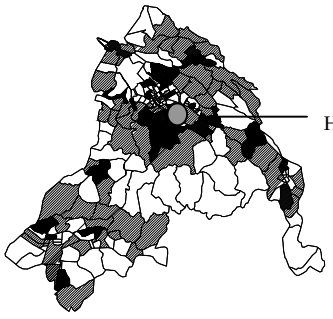


Figure 4 Consolidated Population Distribution*, 1984-88

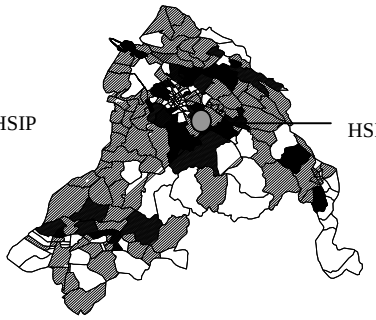


Figure 5 Consolidated Population Distribution, 1989-93

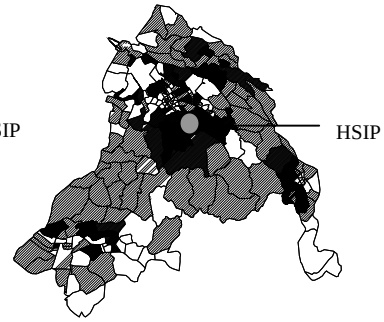
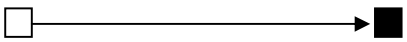


Figure 6 Consolidated Population Distribution, 1994-98

*Consolidated Population Distribution includes analyses of total population, population growth and population density



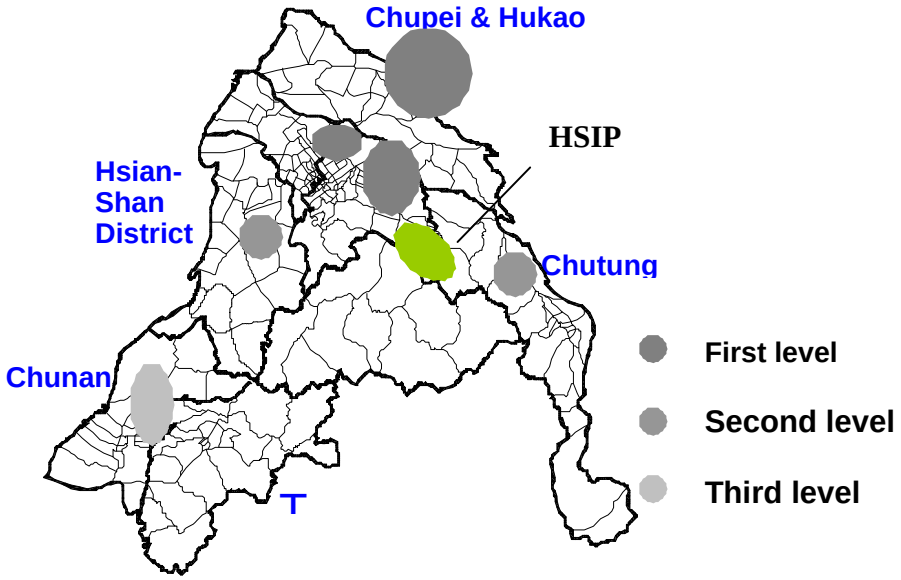


Figure 7 Impact in Industrial Production Space

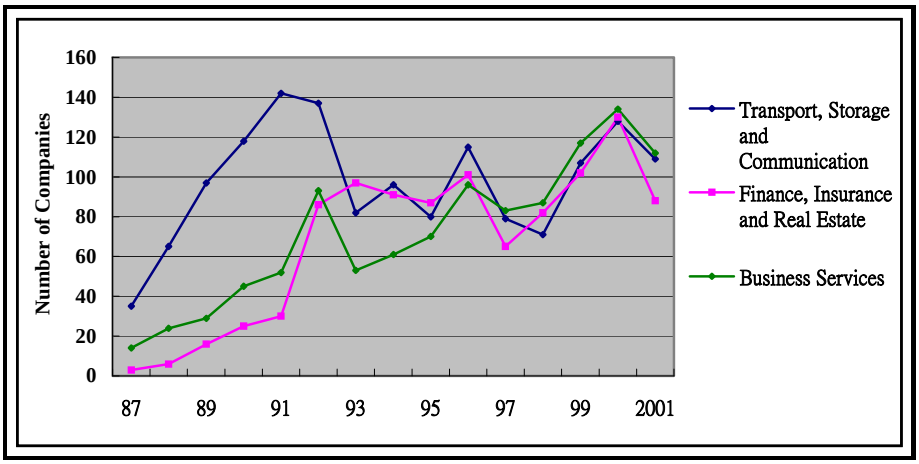


Figure 8 Annual Increase of the Number of Companies in Producer Services in the Hsin-Chu Area

（Source: The Report of 2001 Industry, Commerce and Service Census）

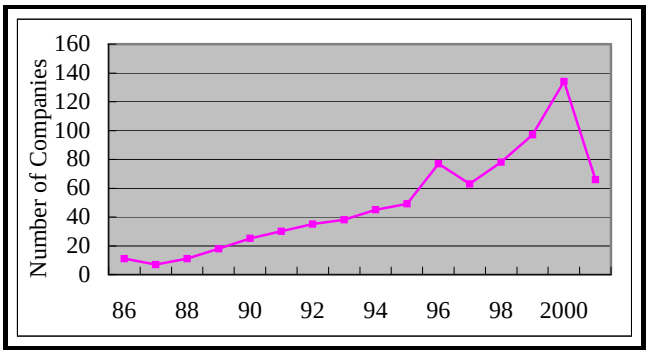


Figure 9　Annual Increase of the Number of Knowledge Intensive Services Companies in the Hsinchu Area

（Source: The Report of 2001 Industry, Commerce and Service Census）

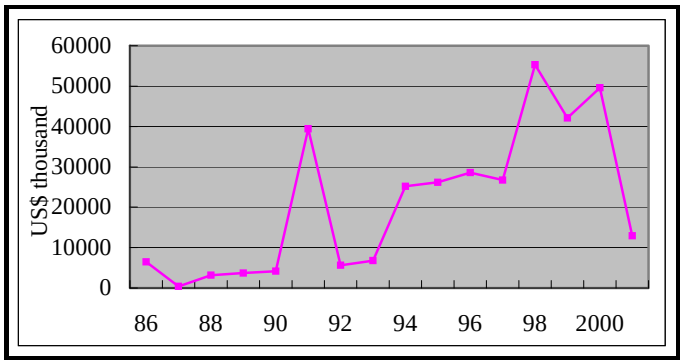


Figure 10　Total Annual Operating Revenue Increase of Knowledge-Intensive Services in the Hsinchu Area

（Source: The Report of 2001 Industry, Commerce and Service Census）

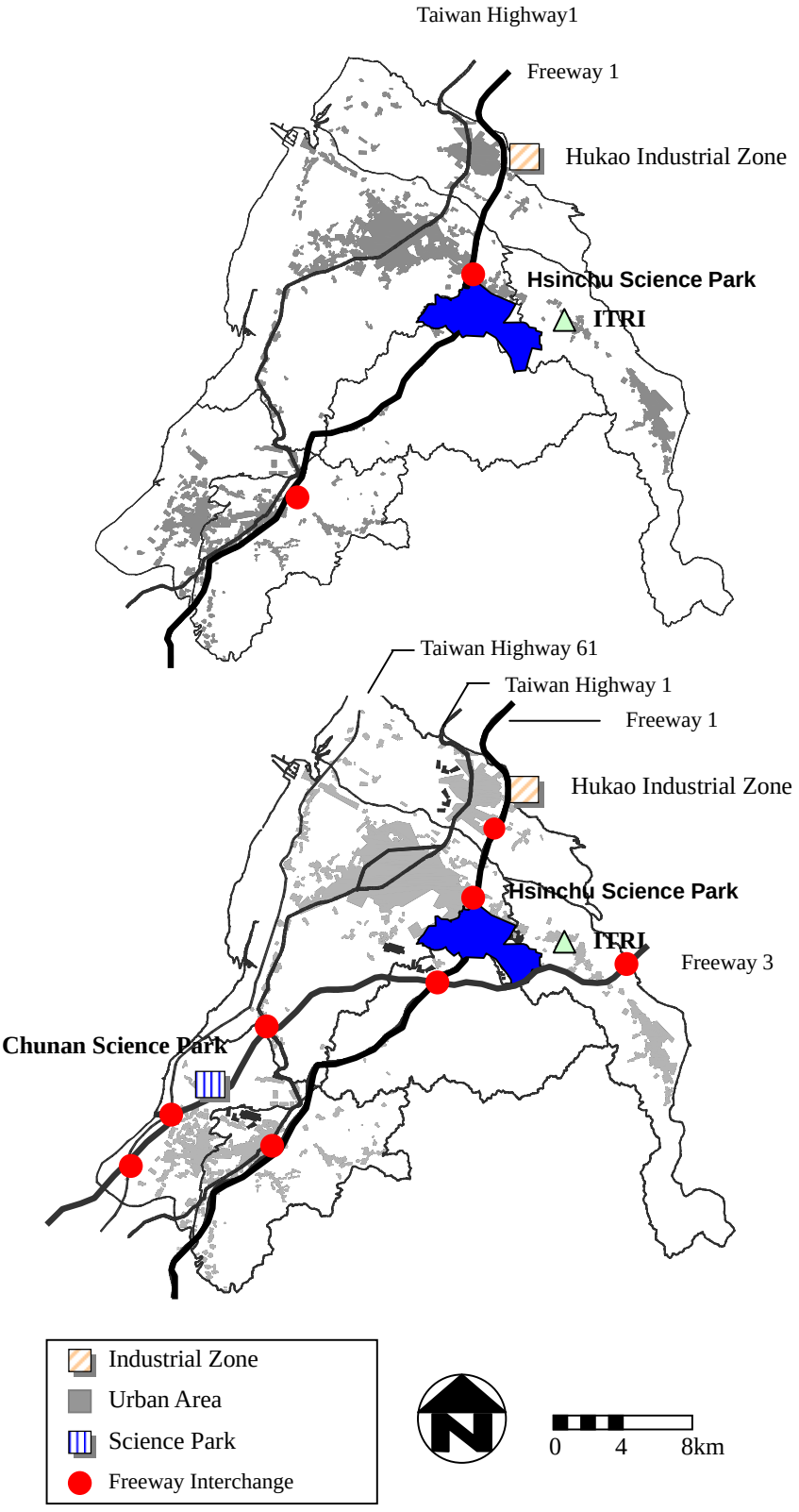

Taiwan Highway1
Freeway 1
Hukao Industrial Zone
Hsinchu Science Park
ITRI
Taiwan Highway 61
Taiwan Highway 1
Freeway 1
Hukao Industrial Zone
Hsinchu Science Park
ITRI
Freeway 3
Chunan Science Park
Industrial Zone
Urban Area
Science Park
Freeway Interchange
0
4
8km

Table 1 The Spatial Distribution of HSIP Employees Unit: Person

	1990	1997		2000		2003
	Number of employees who originally came from: (%)	Number of employees who originally came from: (%)	Number of employees who reside in: (%)	Number of employees who originally came from: (%)	Number of employees who reside in: (%)	Number of employees who reside in: (%)
Hsinchu City	2690 (37.90)	18211 (32.62)	24442 (43.79)	24444 (24.29)	35395 (35.17)	34787 (33.42)
Hsinchu County	2107 (29.68)	15136 (27.12)	15673 (28.08)	20999 (20.86)	22687 (22.54)	22450 (21.57)
Other Cities and Counties	2300 (32.42)	22470 (40.26)	15702 (28.13)	55206 (54.85)	42567 (42.29)	46844 (45.01)
Total	7097	55817	55817	100649	100649	104081

Source：HSIPB, 2001

Table 2 The Commuting Trip Demand Distribution of HSIP Employees in 1997 Unit:PCU/hr

Hsinchu City			Hsinchu County		
Northern District	Eastern District	Hsian-Shan District	Chu-Tung	Chu-Pei	Pao-Shan
1677	4525	403	2002	889	497
13.38%	36.10%	3.21%	15.97%	7.09%	3.96%

Hsinchu County				
To-Fen	Chu-Nan	Other in Hsinchu County	Other Cities/Counties	Total
112	95	1261	1074	12535
0.89%	0.76%	10.06%	8.57%	100.00%

Source: HSIPB, 1998

Table 3 Technological transfer of electrical and electronic machinery in Hsinchu District and Northern Taiwan Region by Number of Companies and Value

	Hsinchu District		Northern Taiwan		The ratio of Hsinchu District / Northern Taiwan	
	Number of Companies	US $ (thousand)	Number of Companies	US $ (thousand)	By Number of Companies	By US $
03	53	2300	185	6250	0.286	0.368
02	67	3650	214	10750	0.313	0.340
01	46	1950	163	5030	0.282	0.388
2000	71	4500	224	9720	0.317	0.464
99	64	1840	207	5670	0.309	0.324
98	79	3280	231	6380	0.342	0.514
97	44	1350	168	2980	0.262	0.454
96	52	4650	165	6040	0.315	0.770
95	28	1000	103	2650	0.272	0.378
1994	49	1050	198	4660	0.247	0.227

Source：ITRI

Table 4 Partners and geographical distribution of R&D cooperation within industries

【% 】

	Partner		Geographical istribution			
	R&D Institutes	Firm	Hsinchu Area	Northern Taiwan	Other	Overseas
Integrated Circuits	27.6	72.4	38.8	22.9	3.8	34.5
Computer and Peripherals	88.9	11.1	88.9	0	0	11.1
Communications	80	20	60	26.7	0	13.3
Optical Electronics	73.9	26.1	65.1	8.6	4.6	21.7

Source：Prospectus of Listed Companies, Taiwan Stock Exchange Corporation

Table 5 Frequency of face-to-face interaction vs. expanding individual professional network

【% 】

	Frequency of face-to-face			
	At least 3 times weekly	1-2 times weekly	1-3 times monthly	Less than 1 time monthly
Attend project	4（0）	1.8（0）	4.5（0）	0（0.6）
Education and training	3.5（0）	5（0）	7.5（3.6）	3.4（8.7）
Attend seminar	4.5（0）	5.2（0）	8（4.6）	15（3.5）
Informal interaction or meeting	14（2.9）	16（10.2）	6.5（29.8）	1.1（36.1）

Notes: （）denotes the frequency of face-to-face without R&D/design cooperation.

Table 6 Personnel with or without R&D/design cooperation vs. expanding individual professional network

【% 】

	Attend project	Education and training	Attend seminar	Informal interaction or meeting
With R&D/design cooperation	3.1	5.8	9.8	11.3
Without R&D/design cooperation	0.4	8.6	5.7	55.7