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Comparing the ICT industries of Silicon Valley and Route 128: What has law got to do with it?

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Abstract Silicon Valley's legal foundation in recent years has surfaced on the radar of policy planners who model Silicon Valley's information and communication technologies (ICT) industry. Precisely, the prohibition of covenants not to compete (CNCs) is linked to firm-to-firm knowledge spillovers by way of mobile workers positioned as nodes in a system of innovation. Meanwhile, traditional frameworks support enforcement of CNCs as a way to encourage R&D activities to the worker and to prevent the worker's tacit knowledge and know-how from fleeing. Amidst the battle for the restraint or release of human capital, we present an industrial approach to reconcile the ostensible strife between enforcement and prohibition frameworks. Theoretically, we contend an industrial approach can maximize the policy tools of discorded planners. Moreover, this article newly compares the ICT industries of Silicon Valley and Route 128 to argue that California's law is a unique factor in the greater success of Silicon Valley firms.

Keywords Covenants not to compete, ICT industry, knowledge spillover, labor mobility, non-compete law, Silicon Valley

I. Introduction

Silicon Valley firms account for roughly a quarter of NASDAQ's 8.5 trillion dollar market cap (Exchanges, 2014). Most firms belong to the information and communication technologies (ICT) industry, which the Organisation for Economic Co-operation and Development (OECD) defines as the "compromise, limited to those industries which facilitate, by electronic means, the processing, transmission and display of information, and it excludes the industries which creates the information, the so-called content industries." The OECD uses the International Standard Classification, but generally the Standard Industry Classification system and the North American Industry Classification System (NAICS) are used to categorize US firms.

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Silicon Valley is unique because its firms dominate the ICT industry under any classification. It is also unique because unlike most regions or clusters, covenants not to compete (CNCs) are prohibited. In most places and in most industries, CNCs are a routine part of worker contracts that restrict a worker's ability to compete with the firm for the duration of the work contract and at times even for a period after the termination of a work contract (Leonard, 2001; Schwab and Randall, 2006). CNCs operate as long as an employer has a reasonable business interest and as long as the restraint is reasonable in scope, geography, and time (Restatement of Employment Law, 2011).

In California, CNCs are void as a matter of public policy except when the worker has ownership interests in the firm he is absconding (Cal. Bus. & Prof. Code § 16600, 2009). The law allows workers to move freely from firm to firm within California. Knowledge spillover, then, occurs as workers transfer tacit knowledge gained from a previous job to a new job. Several studies suggest California's CNC law is a potent weapon for Silicon Valley firms to attract talent, and that it is an important factor in the innovation of Silicon Valley (Gilson, 1999; Bishara, 2006; Marx et al., 2010; Samila and Sorenson, 2011; Timberman, 2014).

Despite Silicon Valley's success, the traditional literature suggests CNCs promote and protect human capital investments and adds another layer of intellectual property (IP) protection (Glick et al., 2002; Nicola, 2009). Most states follow traditional frameworks and favor restraint of workers, which leaves California and Silicon Valley in the minority view. The chasm between tradition and the success of Silicon Valley is disconcerting for planners who can decide between restraint and firm interests or mobility and employee interests. Ostensibly, the choice is a zero-sum game with winners and losers. To the best of our knowledge, this article's first contribution to the literature is to advance a framework that considers the optimal need of different industries.

Moreover, this article argues Silicon Valley's CNC policy is a major advantage against other ICT regions such as Route 128 that have an enforcement policy. Unlike other studies, we offer a recent comparison of the employment and firm data of the ICT industry in Silicon Valley and Route 128, which is the second contribution of this article. This article is structured as follows: Section II describes the literature review and Section III gives the analytical framework. Section IV defines the ICT industry, which is the focus of this study. Section V compares Silicon Valley and Route 128 and Section VI discusses implications and limitations and concludes this article.

II. Literature Review

1. Silicon Valley and Route 128

Silicon Valley is without peer in strength of ICT firms. However, historically, Route 128 had all the advantages over Silicon Valley; it had greater venture capital, world-class universities, and some of the largest tech firms in the country. Yet by 1975, Silicon Valley had greater hi-tech employment and by the early 1980s drew more venture capital investment (Saxenian, 1996a). Silicon Valley's success as compared with Route 128 has been attributed to networks and culture (Saxenian, 1990), technological path dependence (Kenney and Von Burg, 1999), and legal infrastructure (Gilson, 1999).

Saxenian (1996b) emphasized Silicon Valley's open culture for the mutual adjustment and learning between horizontally networked firms, whereas Route 128 was based on secrecy and corporate loyalty in vertically networked firms. Silicon Valley workers entered and exited small and agile firms and Route 128 workers expected long and stable career jobs. This difference in culture she argues is why Silicon Valley has been able to continuously innovate and why Route 128 has found it difficult to re-innovate.

Kenney and Von Burg (1999) argued new firm creation is the reason for Silicon Valley's hurdle past Route 128. They claimed technological path dependence of both places resulted in their relative success. Silicon Valley grew from semiconductors and Route 128 grew from minicomputers; they observed that the technological trajectories conditioned the possible organizational forms that arose to exploit that technology, such as consumer electronics, even suggesting that if William Shockley were to have located in Route 128 that the Fairchild story would have occurred there.

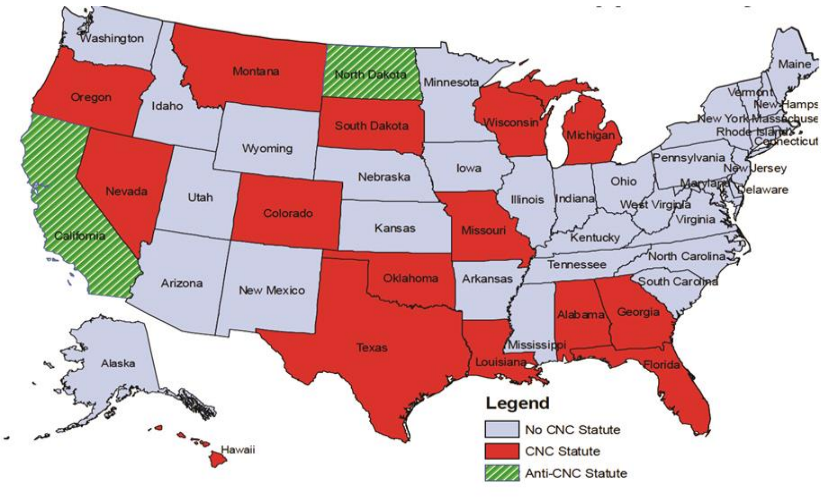
Saxenian (1999) argued Kenney and Von Burg did not establish why technological trajectories formed or by what mechanisms was the path dependency formed. She noted it is nonsensical to argue that the flourishing industries in Silicon Valley such as software, biotech, and Internet applications stem from the same family tree as semiconductors. Indeed, some of Silicon Valley's largest firms such as Yahoo, Google, and Facebook follow a different genealogy.

Gilson (1999) agreed with Saxenian's account but emphasized labor law. He pointed out the difference in CNC law in Silicon Valley and Route 128. Silicon Valley prohibits CNCs, whereas Route 128 enforces CNCs. According to Gilson, this difference is the reason for Silicon Valley's job-hopping and open culture. He argues that prohibition of CNCs encourages movement of workers causing workers to spill knowledge and diffuse techniques in design, production, and marketing. For Gilson, Silicon Valley's law is the major reason for the development of that kind of culture.

In addition, he extends Saxenian's account by crediting labor mobility for the constant resetting of product life cycles in Silicon Valley. He explains that under Massachusetts, where CNCs are enforced, workers would be risk-averse in changing employers or in organizing a start-up, for the fear of breaking the law, which led to the culture of stable careers and vertical integration as described by Saxenian. Another fact that Gilson mentioned is that many of the large firms such as DEC in Route 128's heyday emerged from universities or government run research labs where CNCs were unsecured.

2. Legal Literature on CNC

US CNC policy is rooted in the early fifteenth century English common law (Dyer's Case, 1414). Enforcement of CNCs had only begun to take hold in the early eighteenth century around the time capitalism took hold based on contractual theory (Mitchell *v*. Reynolds, 1711). California, currently, is one of only two states that prohibit worker restraints (other being North Dakota) and is the only state with hi-tech clusters. For more details on California's law, refer to Gilson (1999), Trossen (2009) and Timberman (2014).

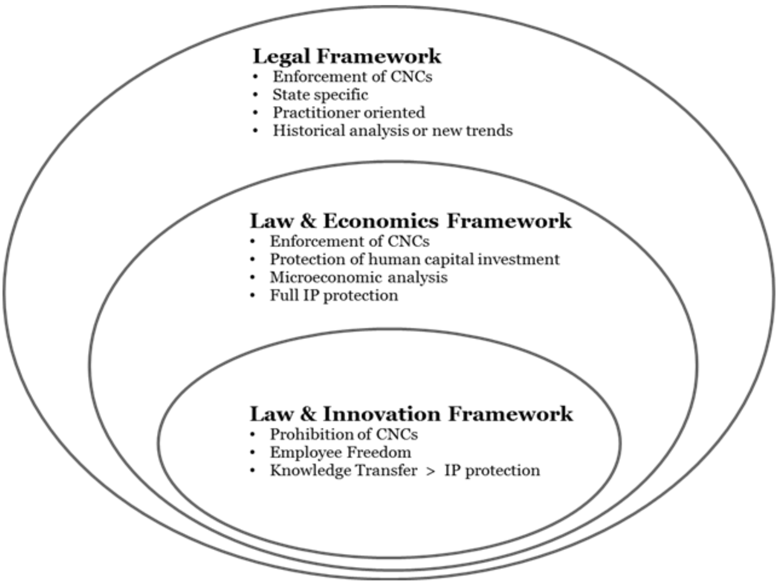


Source: Bishara (2006).

Figure 1 CNC in the U.S.

Enforcement of CNCs find much support: the literature asserts securing human capital investments of firms (Rubin and Shedd, 1981; Gillian, 2001; Bar-Gill and Parchomovsky, 2009; Nicola, 2009) and the efficiency and benefits of CNC enforcement (Posner et al., 2004; Garmaise, 2009). Under classical economics, CNC contracts are efficient in the absence of market failure and are voluntary accords that are beneficial to both parties since it is Kaldor-Hicks efficient or wealth maximizing; it is wealth maximizing because an employer's net gain outweighs the worker's net loss in the event the worker fulfills their legal obligation (Glick et al., 2002).

Gilson (1999) sparked the new stream of literature by arguing California's prohibition on CNCs is the reason for Silicon Valley's growth past Route 128. Several studies now link California's ban on CNCs to worker mobility, spin-offs, spin-outs, and innovation. Fallick et al. (2005) using the US labor data found greater mobility in the California computer industry; Franco and Filson (2000, 2006) offered an economic model to explain the higher success of spinouts and linked CNC to mobility; and Samila and Sorenson (2011) using panel data from 1993 to 2002 demonstrated that worker mobility aids the effects of venture capital on innovation, even suggesting enforcement of CNCs can impede innovation.



Source: Timberman (2014).

Figure 2 CNC literature

However, Marx et al. (2009) added the greatest support using the US patent database: Michigan had a similar CNC law of California but inadvertently reversed its policy in 1985 providing a perfect experiment to test the impact of CNC enforcement on mobility; the study showed that mobility of inventors dropped 8.1% and 15.4% for "star" inventors after the change in Michigan's law. Marx et al. (2009, 2010, 2011) further showed brain drain from CNC enforcement zones to California and found by extensive surveys that workers in enforcement states often took career detours or avoided work altogether to avoid potential CNC lawsuits.

Accordingly, Fallick et al. (2005), Franco and Filson (2000, 2006), Samila and Sorenson (2011), and Marx et al. (2009, 2010, 2011) demonstrated that CNC law has a visible impact on the mobility of workers, especially in hi-tech industries. The analytical framework of this study is discussed in the following section.

III. Analytical Framework for CNC

Legal and economic theories wrangle over prohibition or enforcement of CNCs. Bishara (2006) reconciled the literature from a framework based on worker status: "creative" or service." He defines creative workers as scientists and engineers and service workers as bankers and lawyers along with others. Under his analysis, service workers should be restrained because enforcement would encourage human capital investment and non-enforcement of service workers would lead to negative spillover and disincentive firm investment. On the other hand, restraint would hinder innovation for creative workers; therefore, creative workers should be set free from CNC law to spillover knowledge.

Table 1 Analytical framework for CNC

Perspective	Law and innovation	Law and economics
Region	Silicon Valley	Route 128
CNC	Prohibition	Enforcement
Worker	Freedom	Restraint
Human capital investment	Highest bidder	Protectionist
Tendency	Spillover > protecting IP	Secrecy and IP protection
Industries	Computer Services (proven) Biotechnology Software, Scientific Research Venture Capital	Oil and Mining Low-tech Manufacturing Defense, Aerospace Banking and Insurance

Source: Author's design.

This work is influenced by Bishara's framework but sets forth a prescription for the development of hi-tech districts. Hi-tech districts have particular traits: firstly, workers rapidly change positions and careers and regulation can prove to be an administrative obstacle. Secondly, giving some workers freedom while denying others can lead a boss to explain "knowledge spillover is good for our region so the law allows our creative members to work wherever they want but not you." Naturally, this type of communication can potentially harm firm's atmosphere. Finally, mobility of workers may benefit hi-tech industries but harm others.

For finance and insurance industries where confidentiality is important, planners would favor enforcement (Bishara, 2006). An enforcement regime may also better suit oil and mining industry, because there are few players in the industry as well as a high barrier to entry. For industries related to national security or industrial secrets, enforcement may be essential if not critical. Even hi-tech industries such as aerospace can favor enforcement because firms choose to invest in substantial long-term R&D projects to the worker or team in the hopes of achieving radical innovations (Conti, 2013). Ultimately, an industrial approach is familiar to policy planners and is specific enough to regulate and monitor policies.

IV. Definition of ICT

This article is a comparison of the ICT industries of Silicon Valley and Route 128. To compare the two, the focus was on hi-tech employment and ICT firms in each region. To compare hi-tech employment, government data were gathered from County Business Patterns of the US Census Bureau. Saxenian (1996a) in an earlier study used similar data to compare the two regions, but this study gathered more recent statistics from 2000, 2004, 2008, and 2012. ICT employment data were analyzed under NAICS code 31-334 Computer and Electronic Product Manufacturing; code 51-511 Publishing Industries (including software); and code 54-5415 Computer Systems Design and Related Services.

To count employment along geographical lines, this article defined Silicon Valley as by San Jose, Sunnyvale, and Santa Clara even though other cities can be said to form a part of Silicon Valley; Route 128, on the other hand, was defined using Essex, Middlesex, and Norfolk counties, of which Route 128 was historically a part of. Despite the large gap in population, a clear difference in the strength of the ICT industry is shown. This article considers hi-tech employment and the market value of firms as proxy variables to the innovation of the region, because firms hire workers to achieve profits and market value considers performance and potential of the firm.

Table 2 ICT industries covered under codes 31, 51, and 54

31: Manufacturing	334 Computer and electronic product manufacturing
	33,411 computer and peripheral equipment manufacturing
	3,34,112 computer storage device manufacturing
	3,34,118 computer terminal and other equipment
	3344 semiconductor and other component
51: Information	511 Publishing Industries (Except Internet)
	511 publishing industries (except Internet)
	51,111 newspaper publishers
	51,112 periodical publishers
	5112 software publishers
54: Professional, Scientific and Technical Services	5415 Computer Systems Design and Related Services
	5,41,511 custom computer programming services
	5,41,512 computer systems design services
	5,41,513 computer facilities management services
	5,41,519 other computer-related services

Source: County business patterns (2014).

To compare Silicon Valley and Route 128 firms, data were gathered from the NASDAQ and NYSE. Only firms in the technology sector related to computer industries were included. California had a total of 177 firms related to our criteria of which 136 have headquarters in Silicon Valley and Massachusetts had a total of 28 firms on the stock exchanges of which 26 belong to Route 128. Our sample of ICT firms from both regions are all in industries that fall under NAICS codes 31, 51, and 54, and hence, relate to the data on employment.

Table 3 population

Silicon Valley		Route 128	
San Jose	982,765	Essex county	787,744
Sunnyvale	146,197	Middlesex county	1,552,802
Santa Clara	119,311	Norfolk county	687,802
Total	1,248,273	Total	3,028,348

Source: US census bureau (2014).

V. Comparison of Silicon Valley and Route 128

1. Employment Data

Owing to Route 128's population size being roughly three times that of Silicon Valley, Route 128 has more workers overall in those industries. Yet, of the industries analyzed, both regions have their greatest strength in the computer industries, which is the subject of this study. Under NAICS codes 31, 51, and 54, both regions have the largest sub-industries: computer and electronic product manufacturing within code 31; publishing industries to include software within code 51; and computer systems design within code 54.

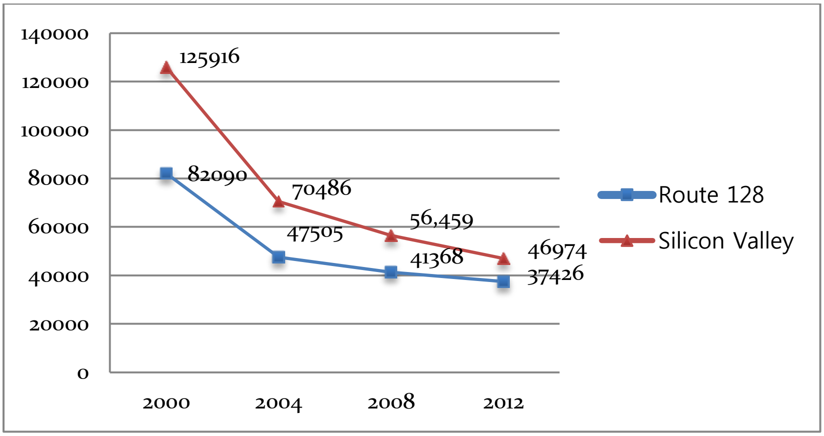


Figure 3 Computer and eloctronic product manufacturing industries (Code 334)

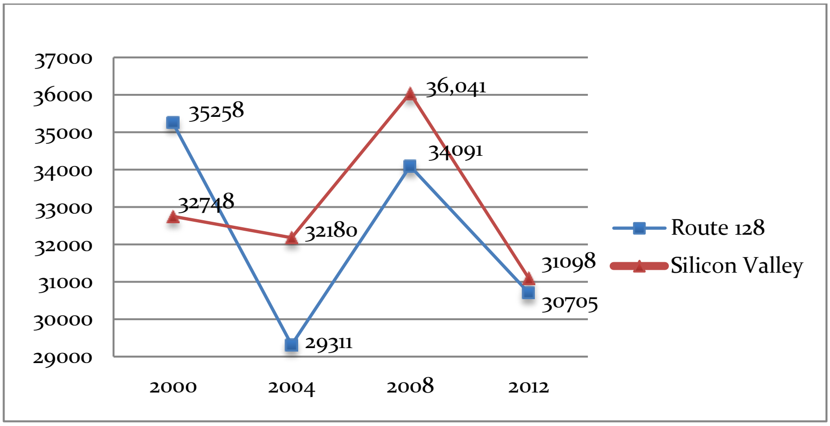
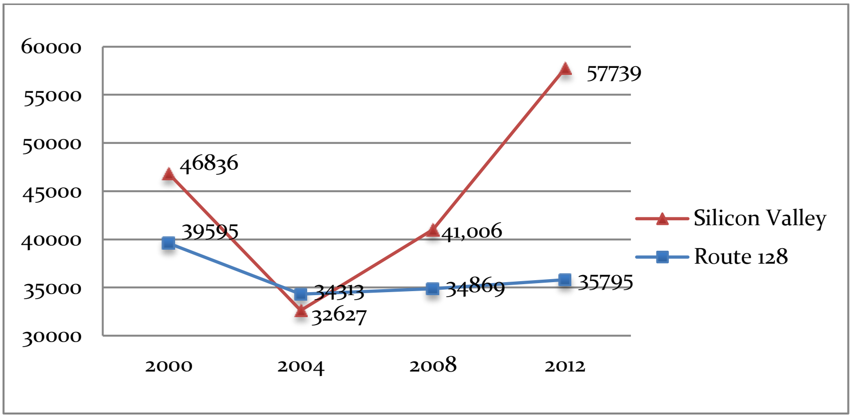


Figure 4 Publishing industries including software (Code 511)

However, in 2008 and in 2012, Route 128 had more jobs within scientific research and development services than computer systems design within industry code 54. For example, in 2008, Route 128 had 43,336 jobs in scientific research and 34,869 jobs in computer systems design and in 2012 had 37,854 jobs in scientific research and 35,795 jobs in computer systems design. This goes to show that Route 128 has a more diverse economy than Silicon Valley, which is heavily centered in ICT; this is not surprising considering the population size of Route 128 and the number of top universities established there. Overall, both regions under codes 31, 51, and 54 have the maximum jobs in computer-related industries, staying true to their historical reputations as hi-tech districts.



Source: County business patterns (2014).

Figure 5 Computer systems design services (Code 5415)

2. Firm Data

The difference in hi-tech innovation is not easily comprehended just from employment data. Once Silicon Valley firms surpassed Route 128 firms around the mid-1970s, there has been no turning back. Silicon Valley has a greater number of firms exceeding a billion dollars in market cap as well as a greater number of firms overall.

Table 4 Market value of public ICT firms (Billion USD)

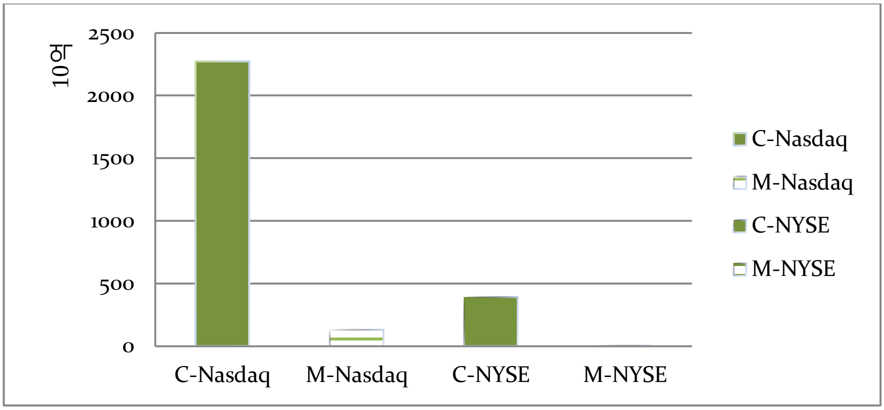
Index		California		Massachusetts	
		B	M	B	M
NASDAQ	No. of firms	69	71	16	10
	Sum	2251	19.9	127.1	2.5
	Mean	32.6	0.28	7.9	0.25
NYSE	No. of firms	22	15	2	n/a
	Sum	385	6.5	3.1	
	Mean	17.5	0.43	n/a	

Note: B, market cap exceeding a billion dollars; M, market cap less than a billion dollars.
Source: NASDAQ and NYSE (2014).

Table 5 Industrial structure of public ICT firms

Industry	California		Massachusetts	
	NYSE	NASDAQ	NYSE	NASDAQ
Total firms	37	140	2	26
Semiconductors	6	58		6
Software	12	34	1	11
Electronic data processing	12	20	1	7
Computer communications equipment	4	10		
Computer peripheral equipment	3	7		1
Computer manufacturing		5		
Electronic components		5		1
Business services		1		

Source: NASDAQ and NYSE (2014).



Note: C, California; M, Massachusetts.
Source: NASDAQ and NYSE (2014).

Figure 6 Market cap of computer firms

3. Initial Public Offerings

Historically and in recent years, data confirmed that Silicon Valley has a much greater rate of IPOs. There were 33 IPOs in 1996-2000 for California firms right up to the dot.com bubble but even more IPOs occurred in 2011-2015 increasing to 52. Another surprising finding is that the NYSE had a total of 29 IPOs in 2011-2015, which is more public offerings than all previous years put together. Some factors on the renaissance of tech IPOs on the NYSE have been speculated (Ludwig, 2013). The number of IPOs by California firms in recent years suggests that the ICT industry in Silicon Valley is yet again undergoing a cycle of growth.

Table 6 IPOs by year

IPOs	California		Massachusetts	
	NYSE	NASDAQ	NYSE	NASDAQ
1970–1975	0	1	0	0
1976–1980	0	1	0	0
1981–1985	2	4	0	0
1986–1990	0	9	0	0
1991–1995	0	11	0	4
1996–2000	0	33	0	4
2001–2005	1	11	0	0
2006–2010	3	12	0	5
2011–2015	29	23	2	4

Source: NASDAQ and NYSE (2014).

VI. Discussion, Limitation, and Conclusion

1. Discussion

Employment data confirmed that Silicon Valley has a greater number of hi-tech workers in computer-related industries, despite the large difference in population size.

However, in Route 128, computer-related industries still took up the greatest number of jobs in the manufacturing, information, professional, scientific, and technical services industries. This finding suggests that Route 128 is still a computer-centric hi-tech district.

Data confirmed that Silicon Valley has a greater number of computer-related firms than Route 128, in addition to having more firms exceeding a billion dollars in market cap.

Data confirmed that Silicon Valley has a far greater number of IPOs than Route 128, historically and in recent years.

Route 128 had all the advantages: early stage and abundant venture capital, world-class universities, well-funded government labs, and pioneering computer firms. Yet, Silicon Valley leapt forward Route 128 and never looked back; this begs the question, what does Silicon Valley have that Route 128 lacks? An interesting anecdote is the story of Facebook. It was established in Boston but developed in Silicon Valley like many other hi-tech firms. One thing that is different about Silicon Valley is the CNC law that affects the movement of human capital. For Asian planners, Silicon Valley's unique legal framework may be the missing sauce to add to the other ingredients such as venture capital, world-class universities, research institutes, and technology.

Around the world, the power of firms to restrain the worker is the tradition and norm. Yet, in terms of innovation, tradition does not always hold true. For example, IP law fails to protect the fashion industry, but instead of deterring innovation, copying of fashion just accelerates new innovation as copied clothing goes out of fashion, leading to faster product cycles by fashion designers (Raustiala and Sprigman, 2006). Similarly, laws failing to restrain workers accelerate the innovation of firms in a region, particularly in the hi-tech industries.

In addition, laws may shape culture. In Silicon Valley, firms encourage workers to network with competitors and learn, so they can bring back value to the firm; likewise, workers expect to utilize their network and knowledge at firm A to possibly advance their careers in firm B (Hoffman et al., 2014). This culture of workers who are treated like alumni is a paradigm shift from most other places, and it occurs in a place such as Silicon Valley where workers are unrestrained.

This article contributes to the literature by comparing employment data, firm data, and IPOs in the ICT industries of Silicon Valley and Route 128. One distinguishing factor of Silicon Valley from Route 128 and other hi-tech districts is the prohibition of CNCs. We posit that the right CNC policy can shape culture of firms, give workers incentive to innovate, and advance the knowledge spillovers by workers positioned like nodes in a system of innovation. To address the divided literature, we propose an industry approach to spur innovation in certain industries while protecting the concerns of other industries. To the best of our knowledge, an approach by industry has not been previously adequately exposed.

2. Limitations and Suggestions for Future Research

This article lacks analysis on the trade secret and IP law violations made possible by workers going from firm to firm. Gilson (1999) pointed at the reputation damage of a Silicon Valley firm if they sued a worker for an IP violation and the slow procedural and substantive legal battle to prove the worker violated the law as reasons for why knowledge spillovers work despite IP law considerations. However, our model on knowledge spillover is not based on workers violating IP law and trade secrets. Rather, it is about the delivery of tacit knowledge, human network, and experience to aid the development of a new product or service into the future.

Moreover, most workers would be afraid to cross the psychological Rubicon of violating IP laws for the sake of helping a new firm. Likewise, firms would be inclined to avoid an expensive and lengthy IP law suit based on what IP or secrets they could get from a poached worker. Despite these lingering considerations, we believe prohibition of CNCs allow much spillover to occur, without violations in IP or trade secret law.

Another limitation of this article is the difficulty of empirically pinpointing prohibition of CNCs as the sole reason or biggest factor for the dominance of ICT firms in Silicon Valley. Silicon Valley is a mosaic of factors that are all important in creating its success. This article just points at the law factor for its success. As with other factors, we suggest that pinpointing of one factor as the greatest factor is a difficult standard to meet. Regardless, the prohibition of CNCs is a unique law not yet implemented in many regions, especially in Asia.

Here are a few suggestions for future research: Where does the law stand on CNC contracts in different Asian regions and nations? What is the current speed and rate of labor mobility in Asian hi-tech districts? Exactly how can a prohibition of CNCs affect the mobility of workers in Asian hi-tech districts?

3. Conclusion

This article shows consistency with the broader empirical and theoretical findings that link Silicon Valley's CNC law to its labor mobility, knowledge spillover, and innovation. A previous study compared the hi-tech employment for both regions using data prior to 2000. This study compared hi-tech employment using more recent data and added the comparison of publicly traded ICT firms. In conclusion, we suggest that some industries reap greater gains by restraining the worker, whereas others, especially in the ICT industry, reap greater gains by encouraging knowledge spillover.

Acknowledgements

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