Roepke Lecture in Economic Geography
Venture Capital in the "Periphery": The New Argonauts, Global Search, and Local Institution Building

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Key words:
venture capital
institutions
regional economic development
diaspora
high technology

abstract

This article examines the growing importance of global, or external, search networks that firms and other actors rely on to locate collaborators who can solve part of a problem they face or require part of a solution they may be able provide. We focus on the creation in emerging economies of venture capital—an institution that is organized to search systematically for, and foster the development of, firms and industries that can, in turn, collaborate in codesign. The article examines the case of Taiwan, where first-generation immigrant professionals from U.S. technology industries have collaborated with their home-country counterparts to develop the context for entrepreneurial development. It refers to the members of these networks as the new Argonauts, an allusion to the ancient Greek Jason and the Argonauts, who searched for the Golden Fleece. We also argue that the most significant contributions of these skilled professionals to their home countries are not direct transfers of technology or knowledge, but participation in external search and domestic institutional reform. The new Argonauts are ideally positioned to search beyond prevailing routines to identify opportunities for complementary "peripheral" participation in the global economy and to work with public officials to adapt and redesign relevant institutions and firms in their native countries. They are, therefore, exemplary protagonists of "self-discovery"—the process by which an enterprise or entrepreneur determines which markets it can serve—and of a microlevel institutional reform that can, diffusing and cascading, ultimately produce wider structural transformations.

84(4):379–394. © 2008 Clark University. www.economicgeography.org

Acknowledgments

The Roepke Lecture in Economic Geography was established to honor the late Professor Howard G. Roepke, who served on the faculty of the University of Illinois at Urbana-Champaign from 1952–85. The original lecture series ran at the Annual Meetings of the Association of American Geographers (AAG) from 1986–94. Economic Geography, *the University of Illinois, and the AAG Economic Geography Specialty Group decided to resurrect and co-sponsor the lecture series in 2007.*

The origins of this article lie in the Roepke Lecture in Economic Geography that the first author delivered at the 2008 AAG. It has evolved significantly since the original presentation, thanks to the contributions of many colleagues and friends. Thanks especially to the organizers and supporters of the Roepke Lecture, as well as to Yuko Aoyama and the other editors at *Economic Geography*, for their insightful contributions. The article now has a coauthor, and both authors owe special thanks to Yevgeny Kuznetsov, who contributed many of the ideas developed in the newer versions. The usual disclaimers, of course, apply.

The emergence of technology entrepreneurship and innovation outside, but closely connected to, the advanced core of the world economy is one of the most striking features of contemporary capitalism. Israel and Taiwan, both small, peripheral agricultural economies in the post–World War II period, became home to dynamic clusters of entrepreneurial experiments in the 1980s and 1990s. Today Taiwan's specialized producers define the state-of-the-art logistics and flexible manufacturing of low-cost, high-quality electronic systems. Israel, with a population of just over 6 million, is home to more than a hundred Internet security and software-related technology companies that are listed on NASDAQ, more than any other country outside North America. In both countries, venture capital systemically encourages the proliferation of companies that, in effect, codesign specialized components or subsystems for firms in the core economies.

The more recent emergence of clusters of, for example, software firms in mid-income developing economies like China and India is more striking still. Vital urban hubs like Bangalore and Hangzhou are not only peripheral to the world economy, but are also located in large national economies that—partial liberalization of trade policy aside—lack most of the institutions that economists view as preconditions for growth: the rule of law, secure property rights, good corporate governance, flexible labor markets, transparent capital markets, and so forth. If it is surprising that firms in the "periphery" can codesign crucial components with firms in the core, then it is at least as surprising that institutions that are good enough to permit and sustain continuing growth can be built locally before such governance institutions are installed nationally, if at all.

This article looks at yet another surprising, but less understood, aspect of these cases that grows directly from the connection of the first two: the increasing importance of global, or external, search networks that firms and other actors rely upon to locate collaborators who can either solve part of a problem they face, or require part of a solution they may be able to provide.[1] We focus here on the creation in emerging economies of publicly supported institutions—venture capital in particular—that are organized to

[1] See Sabel (2005), which argues that search routines offer an alternative to the hierarchical decomposition of tasks as a solution to the problem of bounded rationality in organizations.

search systematically for, and foster the development of, firms and industries that can, in turn, collaborate in specialized codesign.

The emergence of venture capital in the periphery sheds light on current discussions in development economics of "self discovery"—the process by which an enterprise or entrepreneur determines which markets it can come to be able to serve (Hausmann and Rodrik 2002). The success of the new high-technology clusters strongly suggests that production is decomposable in ways that allow for the decentralized codesign of parts and their periodic reintegration into complex wholes. Enterprises in these clusters systematically look for collaborators who are already solving parts of the problems they face, rather than trying to elaborate comprehensive solutions on their own.[2] At the same time, as production is becoming more collaborative, relying more and more on codesign, so, too, is the process of self-discovery. Firms and entrepreneurs that seek to enter a new market must demonstrate not just the ability to produce a certain component or product, but also the ability to improve its design or the process by which it is produced in cooperation with potential customers and their suppliers (Sabel and Zeitlin 2004).

Producers in less developed economies face distinct challenges when they seek to enter these partnerships and increasingly require bundles of inputs or services—standards, certification, de facto property rights, and specific regulations—that only public authorities can provide. Hence, self-discovery also typically entails a collaborative search with parts of a government for institutional solutions that will facilitate certain kinds of transactions. Thus understood, self-discovery shades into open-ended industrial policy: a process by which firms and governments collaborate in the identification and pursuit of promising opportunities for development (Hausmann, Rodrik, and Sabel 2008; Rodrik 2007).

This article examines the creation of venture capital in emerging economies as an illustration of the ways in which public and private actors, building on networks they "find," can construct an institution that systematically creates further networks to foster and monitor the progress of new firms and industries. We focus on the case of Taiwan, where highly skilled first-generation immigrant professionals in U.S. technology industries collaborated with their home-country counterparts to develop the context for entrepreneurial development. We refer to the members of these networks as the new Argonauts, an allusion to Jason and the Argonauts, who, centuries ago, sailed in search of the Golden Fleece, testing their mythic heroism while seeking earthly riches and glory. Although most of the evidence presented here is drawn from Taiwan, relevant aspects of analog developments in Israel, India, and China are considered as well.

Our central argument is that the new Argonauts are ideally positioned (as both insiders and outsiders at home and abroad) to search beyond prevailing routines to identify opportunities for complementary "peripheral" participation in the global economy and to work with public officials on the corresponding adaptation and redesign of relevant institutions and firms in their native countries. They are, in other words, exemplary protagonists of the process of self-discovery, or open industrial policy—although surely there are different institutional arrangements in other contexts that are as exemplary as well. We argue further that in the cases considered here, the Argonauts' contributions to domestic institution building crystallized most clearly in the development of domestic venture capital, one, if not the most important, support for technology entrepreneurship.

[2] If this were not the case, it would be impossible for high-technology clusters to emerge in developing economies by specializing in complex components or special-purpose software and to grow by collaborating more and more closely with their customers in the elaboration of successive, more sophisticated, generations and generalizations of the original specialties.

Venture capital is itself a powerful search network; it is an institution for identifying and combining pieces of companies—finance, technical expertise, marketing know-how, business model, standard-setting capacity, and so forth. Once integrated, these enterprises succeed by becoming nodes in the search networks for designing and building products in their domain. By supporting a diverse portfolio of ventures and combining hands-on monitoring and mentoring with market selection, investors in developing countries are thus institutionalizing a process of continuous economic restructuring—and learning about how to improve restructuring itself—that transforms the domestic economy by linking it to the most demanding and capable actors in global markets.

The New Argonauts are therefore both the product of search networks among the professionals and companies for whom they have worked and with which they associate and—in collaboration with parts of governmental and other domestic public institutions—the coarchitects of further networks that extend and adapt the web of relations they already know to home-country conditions.

Networks of overseas professionals are central to this story, so we begin with the role of diasporas in development. The second section reviews the current debates to claim that the most enduring contributions of skilled professionals to their home countries are not direct transfers of technology or knowledge, but participation in the process of external search and domestic institutional reform. We argue that the focus on the high-skill diaspora as an asset has obscured processes of microlevel reform that, diffusing and cascading, can ultimately produce structural transformations.

The third section illustrates this argument with the example of the creation of the venture capital industry in Taiwan, which provided the context for entrepreneurial growth in high-technology clusters.[3] The fourth section situates search networks with respect to current debates about the structuring principles of the new, global economy. We show that these networks are based on and transmit knowledge that is more formalized than is knowledge that circulates in the local networks that are typical of clusters (where it is, at the limit, purely tacit), but less complete than the knowledge that is said to flow in modular global production networks (where it is assumed to be fully explicit). The final section draws early conclusions for understanding the process of institutional reform and economic development.

Diasporas and Development

In spite of the outpouring of research in the past decade, there is limited evidence that diaspora networks, taken as various forms of intellectual capital or as "knowledge networks," have a positive impact on economic development. Diasporas are not new phenomena, nor is the interest of policymakers and scholars in their developmental potential (see, for example, Westcott and Brinkerhoff 2006; Kapur and McHale 2005; Kuznetsov 2006a, 2006b; Leclerc and Meyer 2007; Lowell and Gerova 2004; Lucas 2005; Saxenian 2006; Solimano 2008). What is new, or relatively so, is the focus of recent research and policy on the highly educated migrants who have long been viewed as a serious loss to poor economies (the brain drain). Low transportation and communications costs now allow those who go abroad for further training or in search of work to interact and collaborate with their home-country counterparts far more extensively than was feasible in earlier eras of emigration. A small but growing number of migrants have even become fully "transnational"—with dual citizenship and residences in both their home and their adopted countries.

[3] Research for this article involved dozens of open-ended, qualitative interviews with key actors in the private and public sectors in Taiwan and Silicon Valley, as well as in China, India, and Israel in the past decade.

Early research on diaspora contributions investigated remittances or direct investments, which can provide a stable source of finance and alleviate poverty, but typically have a limited long-term impact. The recent literature, by contrast, suggests that skilled migrants can alter the developmental trajectory of a poor country through the diffusion of knowledge and/or technology transfers—as, for example, in the shift from a brain drain of talent away from the home country to "brain circulation" between the home country and the core economies (Saxenian, Motoyama, and Quan 2002). Despite this attention to positive developmental impacts, much of the newer literature (and the public policies with which it is in dialogue) continues to treat the diaspora as an asset, valuable insofar as it adds to the home country's stock of capital not through remittances, but in intellectual property or reputational capital or related forms of wealth. There is, however, little evidence that diasporas have contributed substantially to development in this way.

The most direct mechanism for transferring intellectual capital to the home country would be for the highly educated migrants to return to it to work. Yet in spite of the aggressive recruitment efforts of home-country policymakers, and some evidence of rising return rates (from a low base) in places like India and China, there is no evidence that educated migrants to the United States and other advanced economies are substantially more likely to return permanently to their home economies than they were a decade or two ago. Nor is there evidence that the brain drain has abated, except in small countries that have experienced rapid growth, such as Taiwan.[4]

Some researchers have suggested that there is a diaspora effect in scientific collaboration by documenting how knowledge, as measured by patent citations and coauthorship, flows disproportionately among members of the same ethnic community, even over long distances (Kerr 2007a, 2007b; Jin, Rousseau, Suttmeier, and Cao 2007; Agrawal, Kapur, and McHale 2004). Yet efforts to demonstrate that diaspora scientific collaboration contributes to economic growth in the home country remain unconvincingly incomplete. Above all, they have not identified a causal mechanism by which the findings of collaborative research are usefully transferred to firms and other domestic actors.

Research in related areas has yielded similarly promising but incomplete findings. Studies have found, for instance, that ethnic networks in the United States increase trade with the home country, suggesting that a diaspora can help to reduce reputational and informational barriers to trade (Kapur 2001; Rauch and Trindade 2002; Lucas 2005). Similarly, case studies have indicated that diaspora members can, for the same reasons, help direct corporate investments or contracts toward their home country. However, the most significant findings from both quantitative studies and extensive case studies have come from a small number of Asian countries, particularly China and India (Lucas 2005; Lowell and Gerova 2004). As critics have pointed out, there are many more cases of failed attempts to mobilize diaspora contributions to development, from Armenia to Argentina, that remain unexplained in current frameworks.

The rise of dynamic clusters in the periphery and the experience of the new Argonauts, in general, suggest that the debate on diasporas and development has been misdirected. The increased salience of diaspora networks to economic development lies not in the direct contribution of assets, but in the role of these networks in the design and construction of new institutions in their home countries. Although these contributions are often incremental, thus difficult to detect and even more difficult to quantify, over time they have the potential to create a context that supports self-sustaining growth.

[4] Ironically, there is now concern in policy circles in Taiwan that they have lost the "bridge" to Silicon Valley as a result—recognizing, at least implicitly, the importance of the diaspora as a search network.

In part because of the treatment of diasporas as assets, discussions have focused on the macrolevel: the relation of "the" diaspora to "its" home country. They have overlooked the internal heterogeneity of the diaspora, as well as the heterogeneity of the economy and the public sector in developing (as well as developed) nations. The new Argonauts, for example, are only a subset of the diaspora, normally first-generation emigrants who work with ease in the institutions and environment of their home country, where they continue to have friends, family, and colleagues. (Second- or third-generation immigrants, even if they speak the language of their country of origin, have greater difficulty doing business there because they lack these personal connections and firsthand knowledge of local institutions and culture.)

The spatial differentiation of economic activity that is typically linked to industrial specialization (another manifestation of heterogeneity) means that a focus on national indicators and institutions can obscure critical transformations that occur at the subnational level.[5] Likewise the state, in developing as well as in developed countries, is not a unified whole, but rather consists of multiple, differently organized, units with various political and economic resources, jurisdictions, and interests. Yet it is precisely this heterogeneity that permits innovation and growth within a generally hostile context (Kuznetsov and Sabel 2007).

The new Argonauts bring to their home countries expertise in specific industries that are located in a small number of urban areas or regions, and they collaborate only with a subset of domestic entrepreneurs and policymakers. Thus, economic and institutional change begins in certain locations and/or domains and advances through partial and incremental (microlevel) reforms that aggregate into larger-scale transformations only with time. Only by disaggregating the diaspora and its interactions with parts of the equally differentiated public and private sectors is it possible to see whether and eventually how they are building or rebuilding the institutions of economic development.

A small example from India illustrates how microlevel reform can facilitate the matching of collaborators and can diffuse. In the early 1990s, Indian products in general were suspect because of their reputation for low quality. Quality problems in software were an important obstacle to collaboration between local suppliers and customers in world markets. In software, the problem was not particular to India. Since the beginning of large software development projects, such as the operating system for the IBM 360 in the 1960s, it has been well known that quality problems can arise from the very partitioning of tasks that allows different groups to work on separate parts of programs simultaneously. Fixing performance specifications for each "chunk" or module of the program introduces ambiguities that come to light as defects only when the parts are finally connected to each other (Brooks 1995). Long-range collaboration can only be expected to exacerbate a problem that is inherent to software production (and latent, as we will discuss later, in production and design generally).

Anticipating this problem, an Indian engineer from the Software Engineering Institute (SEI) at Carnegie-Mellon University traveled to Bangalore to speak at software firms about SEI's recently introduced capability maturity model (CMM) for improving the

[5] The literature on national institutions and development overlooks the evidence from India, China, and many other cases that suggests that parts of economies grow rapidly and reliably even if the wholes to which they are connected do not have the institutions that are thought to be necessary for growth. The evidence indicates that the institutions of governance that are sufficiently "good" to permit and encourage sustained growth can be built piecemeal, in particular sectors of the economy and in the regions in which they are located, in advance of comprehensive, national reform. No one looking only, say, at national legislation (or its absence) regarding property rights in China would have been able to predict the country's growth.

software engineering process. The core of the CMM is the periodic peer review of development "pieces" to ensure, by ongoing clarification of specifications, that the rate of error detection is higher than the rate of "error injection." Many firms immediately picked up the idea and sponsored conferences and consultations on the topic. By the end of the decade, virtually all large Indian software companies had adopted the CMM. Today India is widely recognized for its high-quality software development processes; the country has more SEI-CMM Level V (the top level) certified companies than any other.

The development of a globally competitive software services and technology industry in Bangalore involved a multiplicity of similar microlevel reforms, both within the cluster and externally. In this case, the best practice in software engineering processes was transferred to Indian firms as soon as the processes were developed. Indeed, the most extensive and practical guide to the use of the quality model today is a study of its application and development at Infosys, one of India's largest and most successful software firms, and published by the SEI (Jalotte 2000). Such changes occur incrementally, and there is no guarantee that they will continue. But, as we discuss in detail in the next section, when they accumulate, they have the potential to alter the institutional fabric of the economy.

Institutionalizing Venture Capital: The Taiwan Case

The collaboration of overseas Chinese professionals with governmental officials in Taiwan to create a venture capital industry exemplifies the contribution of global search to domestic institution building. The institutionalization of venture capital was a critical turning point for Taiwan. It ensured that a few, isolated early entrepreneurial successes were followed by growing investment and collective learning in the electronics-related industries. Ultimately, it supported the creation of a self-reinforcing cluster, or critical mass, of firms.

The creation of venture capital in Taiwan also shows how such institution building is enabled by, and helps encourage, new political alliances that are rooted in the incipient forms of cooperation that it fosters. The reform was initiated by an entrepreneurial ex-finance minister, who leveraged both the search capabilities and the political influence of the diaspora to mobilize support for initiatives that were strongly opposed by older-line policymakers and traditional industries.

Last, but perhaps most important, the collaborative construction of venture capital in Taiwan shows how search networks can transform and give new meaning to the institutions they connect to and "import." Venture capital in Taiwan was as much a means of reorienting the country's emerging high-technology economy from competition to collaborative complementarity with Silicon Valley firms and of redirecting investment by old-line industry and cautious commercial banks and family networks as it was a tool for providing finance to start-ups that otherwise could not find it.

In the 1970s, Taiwan was a poor, agricultural nation. Its economy was controlled by a combination of state-owned enterprises (in finance and strategic industrial sectors) and risk-averse family-owned and run businesses.[6] The "high-technology" manufacturing sector consisted mainly of low-end, labor-intensive firms that manufactured calculators and electronic components almost exclusively for foreign customers. Intellectual property rights were notoriously disregarded, allowing in the early 1980s for the reverse engineering and production of "clones" of the IBM PC and Apple's MAC. Few would have predicted that entrepreneurs in this peripheral economy would compete in the most

[6] Taiwan's per capita gross national product in 1962 was $170, on par with that of Zaire and the Congo.

technologically advanced sectors of the world economy. Yet by the end of the 1990s, Taiwan was a leading center of technology entrepreneurship; today its specialized semiconductor and computer-related firms define the state-of-the-art logistics and manufacturing of low-cost, high-quality electronic systems.

Scholarly accounts of the growth of Taiwan's technology sector typically focus on a farsighted development strategy focused on industrial "catch up," particularly the transfer of leading-edge semiconductor technology through the creation of institutions like the Industrial Technology Research Institute, a public-private research agency, and the Hsinchu Science-based Industrial Park (HSIP) (Amsden and Chu 2003; Mathews and Cho 1999). Yet they leave a puzzle. How did domestic policymakers manage to identify and supply precisely the institutional pieces that were required to support entrepreneurial growth in a highly competitive global economy—particularly when many other nations, often far better endowed, tried and failed to develop venture capital and technology industries in the same period?

The answer to this puzzle is that the growth of the sector was only partly a planned or designed process, and the part that *was* designed was aimed less at moving Taiwan to a well-defined technology frontier than at creating institutions for identifying and pursuing appropriate economic opportunities—search networks. An unplanned but crucial part was the decision by tens of thousands of Taiwan's most talented university students to pursue graduate degrees in engineering in the United States in the 1960s and 1970s. The majority of these immigrants took jobs in the United States after graduation because the professional and economic opportunities in regions like Silicon Valley far exceeded anything then available in Taiwan. Policymakers complained bitterly about these losses and even sought to control them. None foresaw that the "brain drain" might prove advantageous.

The initial adjustment of the job seekers to their new environment was also spontaneous. As outsiders in Silicon Valley, the immigrants created technical associations and alumni networks that allowed them to find one another, as well as to stay in touch with their counterparts at home. Some participated in government-sponsored policy discussions or gave talks at universities and technical conferences in Taiwan, but few considered returning home permanently.

The decision not to return home was as self-evident as the decision to go abroad in the first place: in the early 1980s, Taiwan's personal computer industry was small and fragile, in spite of sizable public investments in higher education and technology research and the efforts of the handful of entrepreneurs who did go back. The HSIP opened in 1980, but was unable to find tenants in spite of aggressive efforts to lure multinationals, including those run by Chinese.

The turning point and the beginning of a deliberate policy—in the sense of a strategy for building institutions to fix and revise strategies—came in the following years, when Minister without a Portfolio Kuo-Ting Li, formed an alliance with a group of foreign advisors, including members of the diaspora, to establish a venture capital industry in Taiwan. An engineer who headed both the Ministry of Economic Affairs (1965–69) and the Ministry of Finance (1969–76), Li is widely regarded as the architect of Taiwan's technology strategy. He had met regularly with Chinese engineers and entrepreneurs in Silicon Valley during the 1960s and 1970s (many his college classmates) to seek their advice on making Taiwanese industry more globally competitive. Li was especially impressed with the newly emerging U.S. venture capital industry and the institutional support it created for entrepreneurship.

While serving as the minister of finance, Li had hired a team of U.S.-educated engineers to develop a plan for creating and organizing private industrial investment companies in

Taiwan. The team members concluded that Taiwan should import the venture capital model from the United States, and their conclusions resonated with those of then-minister of economic affairs, Li-Te Hsu, as well as Stan Shih, the CEO of Acer, a leading personal computer (PC) maker, both of whom had also visited the United States to study its new high-technology industries. During this period, an IBM executive based in Silicon Valley, Ta-Lin Hsu, also used his status as a leading figure in the diaspora and an "outside" expert to promote new policy measures to support technology entrepreneurship by contacting key individuals in various governmental units.

By 1982, Li was able to convince the Ministry of Finance to introduce legislation to create, develop, and regulate venture capital in Taiwan, including comprehensive tax incentives and financial assistance. The concept of venture capital, uncontroversial today, was foreign to the Taiwanese of the day, whose family members closely controlled all the financial affairs of a business. Leaders of traditional industries, such as chemicals and textiles opposed Li's ideas. So did an influential consultant to the government, Dr. Simon Ramo (a pioneer of systems engineering and a cofounder of the company that eventually became TRW), who argued that Taiwan lacked the capabilities to develop a venture capital industry.

Supporters of the project understood that venture capital would play a different role in Taiwan than in the United States and that the difference would help redirect the developing economy in a crucial way. They argued that rather than try to replicate the high-level research and technological innovation of places like Silicon Valley, Taiwan should exploit its own strengths: a supply of relatively low-cost, high-skilled engineers. In this view, Taiwan would position itself to develop commercial applications that were derived from U.S. innovations, and lower-skill, mass production could be carried out elsewhere. Li envisioned the HSIP as the place for Taiwanese entrepreneurs to undertake this commercialization, collaborating with each other and with foreign companies. The availability of venture capital and the networking and mentoring that it provides in addition to finance would be key to this strategy.

Proponents of Li's vision recognized that the conservatism of Taiwan's established financial institutions was a major hindrance to the incubation of high-technology ventures. Most financial institutions at that time were commercial banks that provided only mortgage or debt financing. The risk aversion of the governmental officials who managed the public "Development Fund" and other financial-incentive programs limited the ability of these capital sources to spawn risky new technology enterprises. Only a publicly supported venture capital industry would provide sufficient capital for such high-risk, high-return ventures.

In addition, Taiwan's businesses were overwhelmingly (95 percent) small- and medium-sized enterprises, and most, as we have noted, were family run. Family-owned and managed enterprises of this type were typically oriented to survival, rather than to growth, and had little incentive to adopt modern management techniques. Policymakers believed that a venture capital industry could help promote the introduction of modern financial and management skills by institutionalizing the separation of ownership and control. Finally, proponents understood that the introduction of venture capital would entail the development of a public capital market that provided an exit option for investments in start-ups.

Close scrutiny of the U.S. experience had taught Li's group that Taiwan could profit from domestic venture capital but lacked the relevant institutional know-how to start a venture capital industry and the incentives to draw local actors into the process. Policymakers therefore organized collaborations with large U.S. financial institutions to facilitate the transfer of relevant financial and managerial expertise. For example, young

Taiwanese were sent to the United States to be trained in venture capital management. The Ministry of Finance created tax incentives to encourage domestic firms to enter the venture capital industry; 20 percent of the capital invested in strategic (technology-intensive) ventures by individual or corporate investors was tax-deductible for up to five years. The Ministry also offered substantial matching funds through a "seed fund" with NT$800 million (approximately $25 million) from the Executive Yuan Development Fund. In addition, regulation governing security and exchange was modified to support the development of a public capital market.

But even with these incentives, development was hesitant. When Acer founded Taiwan's first venture capital firm in 1984 as a joint venture with the old-line Continental Engineering Group, there were at first no followers. Li invited the overseas Chinese community to establish venture capital businesses in Taiwan. In response Ta-Lin Hsu, a prominent diaspora member and policy advisor, set up Hambrecht & Quist (H&Q) Asia Pacific in 1986. Hsu reported that it was not easy to raise the initial $50 million fund: Li "twisted lots of arms" to raise $26 million from leading Taiwanese industrial groups, such as Far East Textile, President Enterprises, and Mitac. The balance (49 percent) came from the government (interview with Ta-Lin Hsu, San Francisco, 1 June 1997). The first general manager in H&Q Asia Pacific's Taipei office, Ding-Hua Hu, was a classic returnee. After earning a Ph.D. in engineering at Princeton University in 1970, Hu had played a lead role in building Taiwan's semiconductor industry as the first general director of the Electronics Research and Service Organization and as a professor of electrical engineering at the elite Chiao Tung University.

In 1987, two other overseas Chinese engineers, Peter Liu and Lip-Bu Tan, responded to Li's invitation, establishing Taiwan's second U.S.-style venture fund, the Walden International Investment Group (WIIG) as a branch of the San Francisco-based Walden Group. Both H&Q Asia Pacific and WIIG (along with Peter Liu's spin-off firm, WI Harper) were able to raise capital for Taiwanese funds with relative ease from the networks of overseas Chinese in Silicon Valley who were familiar with venture capital.

It was only after these investments showed returns—after companies like Acer and Microtek (a scanner company started by an engineer who returned from the United States in 1980) were publicly listed on the Taiwan Stock Exchange in the late 1980s—that the venture capital industry in Taiwan took off. The seed fund with matching grants for venture investments was depleted, and the Executive Yuan Development Fund committed another NT$1.6 billion (approximately $50 million) that was also allocated quickly. Domestic information technology firms began to create their own venture funds, including D-Link, Macronix, Mosel, Taiwan Semiconductor Manufacturing Company, SiliconWare, UMAX Data Systems, UMC, and Winbond. Old-line firms in traditional industries like petrochemicals that had been reluctant earlier to get involved in the "new economy" also began investing in technology-related venture funds and businesses.

The emergence of Taiwan's venture capital industry and the early successes of venture-backed start-ups attracted a growing number of overseas Chinese to return from the U.S. to start businesses. Miin Wu, a Stanford University graduate who worked in Silicon Valley for more than a decade before he returned in 1988 to start Macronix International, one of Taiwan's first semiconductor companies, in HSIP with funding from H&Q Asia Pacific, is a well-known example. The availability of venture capital finally transformed HSIP into a fertile environment for the growth of indigenous technology firms. By 1996, more than 2,500 engineers and scientists had returned to work in the Science Park, and 40 percent of the 203 companies that were based in the park were started by returnees. The industry remained highly localized as it grew, with the PC industry in the greater Taipei region and

semiconductor and component firms in Hsinchu creating a corridor that was roughly the same size as the Silicon Valley cluster.

The availability of venture capital in the 1980s also distinguished Taiwan from the rest of Asia: outside Taiwan, capital was then available in the region only to large corporations with ties to governments or wealthy families. One measure of the success of Taiwan's venture capital industry is the performance of venture capital-funded firms in public capital markets. Ten of the 32 new ventures that were started in the HSIP in 1996 received funding from local venture funds. By 1998, more than 130 venture-funded companies were listed on the Taiwan Stock Exchange, and some 40 were listed on the NASDAQ.

The new Argonauts have influenced policy in other developing nations, using best practices and models from Silicon Valley to lever open and animate discussion of institutional reform in their home countries. The experience of the coalition of policymakers and overseas entrepreneurs and engineers that created Israel's venture capital industry from the mid-1980s to the mid-1990s is a striking example: in Israel, as in Taiwan, the introduction of venture capital linked, in an economically viable way, the capabilities or firm fragments (e.g., research outputs, managerial talent, engineering skill, and market knowledge) that had been created by the government's earlier investment in national defense and technological development. In Israel, these capabilities took the form of policy "experiments" that fostered commercial applications of military high-technology and research and development cooperation between Israeli and foreign firms.[7] As in Taiwan, early initiatives faced considerable opposition, and success grew from improvements on failures. Thus, the first effort to institutionalize venture capital through a government insurance fund, Inbal, failed: under the program, the state insured 70 percent of the initial investments, but, in effect, limited the investors' rights to capital appreciation—and so attracted venture capitalists who were more interested in minimizing risk than in increasing returns by selecting and monitoring porfolio firms. Inbal's successor—Yozma—was a success. This time, the state bought minority stakes in competing, private venture capital firms, structured as limited partnerships between Israeli venture capitalists and their foreign counterparts, thus ensuring connections to global as well as local networks (Avnimelech and Teubal 2004). Indian and Chinese Argonauts have similarly participated in the creation of institutions for venture capital in their home countries (Saxenian 2006). Each has not only transformed domestic institutions, but also altered the developmental trajectory for those that followed.

Policymakers and entrepreneurs in Taiwan and elsewhere clearly learned from the Silicon Valley model; some even believed that they were replicating it. But solving problems of domestic economic development by adapting venture capital to domestic contexts, they changed both the model and the contexts themselves. Indeed, as the next section shows, they also helped transform Silicon Valley, in ways that suggest the broad generalizability of these experiences to other industries and settings.

Global Search Networks and Cross-Regional Collaboration

In focusing on connections between the new Argonauts and Silicon Valley, the discussion so far invites the objection that the construction of second-order search networks—an open industrial policy to foster self-discovery—is founded on, and is therefore limited to, the prior, "natural" occurrence of tacit knowledge of technologies and persons that are associated with industrial clusters or professional and technical

[7] Avnimelech and Teubal (2004, 88) wrote explicitly of "business experiments" and "policy experimentation" in this period.

"communities of practice" in general (Brown and Duguid 2002; Lave and Wenger 1991). Indeed, one pole in current discussions of the nature of links among firms in the emerging global economy sees that economy as a shift from coordination by managerial hierarchies in vertically integrated firms toward informal coordination among networks of independent companies. These relations are said to be long term and grounded in "informal restraints on self-interested behavior" (Lamoreaux, Raff, and Temin 2003, 62). This view generalizes to the economy at large the stylized experiences of the industrial districts or clusters, based on local cultures of trust, and the codesign relations among Japanese automobile firms and their subcontractors, based on an ethos of reciprocity, as these were understood in the 1990s. At the limit, this view suggests that the information that is needed to initiate, engage in, and judge the performance of collaboration must be so deeply embedded in particular social relations that it is possible to foster collaboration institutionally only when social connections have become so dense and reliable that it is almost superfluous to do so.

However accurate this view of the tacit or "cultural" coordination of flexible networks of firms may have been in past decades, it ignores the extent to which the formalization of key aspects of collaboration is not only possible but necessary to sustain the codesign relations prevailing today. Recall the CMM method of improving the software engineering process and its use of peer review of development "pieces" to reduce errors. The CMM is just one of a wide array of similar devices for creating information-pooling regimes in which cooperating firms can teach each other to be better collaborators even as they monitor one another's capacities and intentions to do so.[8] Thus, it is routine in contracts between, for instance, producers of computers or automobiles and suppliers of key components to specify not only acceptable levels of quality but target rates of price reduction; procedures for jointly and regularly reviewing progress toward all these goals; agreeing on joint action, when necessary, to achieve the goals; and periodic consultation on emergent features of the next-generation components. Analogous regimes are common between firms that are codeveloping new drugs or innovative computer hardware or software.

These regimes do not, of course, eliminate the need for personal connections between buyers and sellers. But they do make a firm's capacities and disposition to cooperate much more accessible to both current and potential partners than the informal, tacit view of linkages suggests. Because the regimes make it easier for firms to scan the world, they make it easier for a firm to find partners; by scanning successfully, the firm becomes known for its ability to search, and the regimes make it more attractive to potential partners (Gilson, Goldberg, Sabel, and Scott 2008). Thus, the new nature of interfirm networks facilitates, rather than obstructs, the creation of higher-order search networks and open industrial policy, formalizing the information exchange that gives rise to the metrics on which venture capital and like institutions depend in monitoring the performance of firms with which they are engaged.

The prevalence of these collaborative, information-pooling regimes also casts substantial doubt on the modular view of interfirm links at the opposite pole of current discussions of the global economy. In this view, collaborative knowledge is not tacit and informal but fully explicit and formalized: new design and production tools allow for the development of technical standards and design rules that standardize the interfaces

[8] On "pragmatist" mechanisms, such as benchmarking, simultaneous engineering, and the detection and correction of "root cause" errors, see Helper, MacDuffie, and Sabel (2000). All of these mechanisms generate information for collaborative improvement or design innovation by triggering "routine questioning of routines."

between organizationally separate stages of production. This standardization so drastically reduces the volume of information that is required for interfirm coordination that products can be decomposed into distinct and further decomposable modules, each produced in virtual isolation from the others (Langlois 2003, 374; Sturgeon 2002).

Some codification of this kind is obviously necessary to allow specialist producers to focus on their specializations. But too much codification just as obviously becomes a barrier to systematic innovation, locking manufacturers of components and those that combine their products into more complex wholes into potentially obsolete product architectures (Sabel and Zeitlin 2004)—hence the prevalence, among all but the least sophisticated producers, of the information-pooling regimes just noted, whose goal is the continuing elaboration of product and process specification and the consideration of alternatives, not the clarification of fixed standards. So common are regimes of this type that *their* organization—the way in which quality control information is to be collected and evaluated—has itself been standardized.

A more graphic demonstration of the limits of this view is the rapidly evolving relation between the economic core and periphery, in general, and Silicon Valley and Taiwan and Israel, in particular. The model of modular networks, with a relatively stable and hierarchical production chain dominated by global flagship producers, suggests that there is no potential for improvements and innovations in engineering at any level of the supply chain but the top. In spatial terms, there is no room in a fully modular world for indigenous entrepreneurship and innovation outside the core.

Development in Taiwan demonstrates the opportunities for innovation in the periphery, even at the lowest level of the supply chain. By the early 1990s, Taiwan had become a highly efficient and flexible producer of low-cost integrated circuits, components, and motherboards—and left the definition of new products, high-end design, and equipment manufacturing to Silicon Valley. Producers in both regions benefited from distinctive capabilities that allowed them to deepen their specialized expertise, in part by recombining it with that of other specialists. A decade later, Taiwan's firms had significantly upgraded their design and manufacturing capabilities; they were not only designing and making increasingly sophisticated and complex components, such as LCD screens, microprocessors, and miniature optical components for cameras, but were responsible for the logistics and final integration of advanced products like laptop PCs and mobile devices. During the same decade, they moved virtually all of their high-volume manufacturing to the Chinese mainland, where they could exploit economies of scale and lower cost inputs.

The semiconductor industry, in which Taiwan played an important role, corroborates the importance of venture capital to this process of technological upgrading. In the 1970s, vertically integrated independent device manufacturers based in the United States and Japan controlled the design, manufacturing, marketing, and distribution of semiconductors. When Morris Chang returned to Hsinchu in the mid-1980s after decades of experience in the U.S. semiconductor industry, he pioneered the "foundry" model by focusing Taiwan Semiconductor Manufacturing Co. exclusively on the manufacturing of chips.[9] The availability and rapid growth of Taiwan's contract foundry capacity coincided with the growth of venture capital, triggering a new generation of advanced chip-packaging, assembly, and materials firms in Taiwan and an unprecedented wave of new chip-design start-ups in Silicon Valley.

[9] This organizational innovation, which transformed the global semiconductor industry, is at direct odds with claims that Taiwan is not innovative.

Investments over the next two decades by venture capitalists in both regions, sometimes joint, accelerated entrepreneurial experimentation (and learning from failure) and innovation. New semiconductor ventures identified still more highly specialized niches, such as the intellectual property components of the design of chips, or "design foundries," with deep expertise in both fabrication technologies and design, and system start-ups incorporated the more complex, often cheaper and smaller, components into new generations of computing products. As U.S. and Taiwanese producers became increasingly sophisticated, they ceded the lower end of their markets to new generations of entrepreneurs who were based in locations like China and India.

In sum, open or external search networks, such as those that helped create venture capital in Taiwan, represent an intermediate form between the tacit networks of industrial districts and the fully explicit networks of modular production systems. Actors in these networks contribute, through intensive information exchange and comparisons, to the construction of shared, domain-specific understandings and languages (or interpretations) that allow them to search for new models of products and of organizing production, even in distant localities, and to collaborate in incorporating these new possibilities into existing practices. This process blurs the boundaries among firms, industries, and regional economies—and, perhaps what is most fundamental, between linkages and organizations that arise or are "found" and those that can be made by reflection and design.

Conclusion

The experience of the new Argonauts in creating venture capital in peripheral locations, such as Taiwan, suggests that development today is a process of experimentation and learning in particular contexts. Economic decentralization creates possibilities for entrepreneurs almost anywhere in the world to identify promising market niches and opportunities at many points along supply chains. Diasporas, especially in the form of professional communities like the new Argonauts, can begin to connect suppliers and customers, producers and policymakers.[10] But even in the presence of the social bonds and trust that grow from shared ethnic identities, the challenges of self-discovery—of identifying appropriate partners in a decentralized economy, and of ensuring the public inputs needed to work with them—remain substantial. The crucial step in reducing the obstacles to faster, more sustained, growth occurs when individuals, firms, and policymakers jointly create institutions—or search networks—that extend the connections, not least by creating more nodes and links in the currently existing networks and by connecting them to others.

We have shown that venture capital can serve as a powerful search network in developing economies when the investors have global as well as local connections. By supporting a diverse portfolio of ventures and combining hands-on monitoring and mentoring with market selection, investors are institutionalizing a process of continuous economic restructuring—and learning about how to improve the institutions of restructuring—that transforms the domestic economy by linking it to the most demanding and capable actors in global markets. In other contexts, such search networks have taken the form of publicly supported supply-chain development and quality assurance programs. In essence, venture capital is a search network that helps transform the domestic economy by itself creating search networks.

[10] The new Argonauts have contributed actively to policy reform in India and China in the areas of telecommunications regulation, science and technology policy, and reform of educational institutions as well as capital markets (Saxenian 2006).

Put another way, search networks can help link partners in microlevel innovations in public institutions and the organization of production. Over time, these changes can cumulate into or inform programs for larger-scale transformations that "endow" the economy with institutions that, in some views of development, it would have needed to grow in the first place. Learning more about how this contemporary form of economic development was possible in places where—improbable at first—it has already occurred can teach us how it may be done in settings where it now seems unimaginable.

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