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Leading, Following or Cooked Goose: Explaining Innovation Successes and Failures in Taiwan's Electronics Industry

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Introduction

This paper evaluates the ability of Taiwan to become a technological innovator as it shifts from the process of catch-up to process of developing new technologies as becomes its position as a new member of the club of advanced industrial nations. However, rather than ask the older question of how can Taiwan develop or, in this case, innovate, this paper asks the more focused and critical question of in which technologies can Taiwan succeed in becoming an innovator and in which technologies are Taiwan's prospects of attaining innovation quite limited. From an analysis of Taiwan's attempts to compete in three high-technology product segments of the electronics industry, this paper argues that Taiwan can become an innovator in those product areas sharing the following characteristics: granularity of the production chain, no need for large amounts of patient capital , volume production (understood here as the opposite of craft or small-batch artisanal production made famous in German and Italian industrial districts) and manufacturing-based. The fact that technologies possessing these characteristics seem to be successful in Taiwan is no accident as these characteristics depend on certain underlying strengths in Taiwan's economy. However, a discussion of the relationship between these characteristics and Taiwan's economic structure will be postponed to the end of the paper.

While government initiatives and foreign technology transfers may have been necessary conditions for much of the innovation taking place in Taiwan to actually occur, the comparison of the three segments below shows that foreign technology transfer and government initiatives are not sufficient to determine success or failure to innovate. While it may be true that all of these production segments originally received some technology from abroad and thus at a bare minimum receiving this technology transfer is criterion that must be met, the nature of the technology transfer in terms of the motivation of the foreign counterparts suggests that this is a relatively low hurdle to jump. The foreign firms transferring the technology were interested in unloading maturing technologies faced with declining profit margins onto the Taiwanese. Receiving these maturing technologies was the easy part, the hard part was using these technology transfers as a base from which to innovate. Indeed, the case studies detailed below demonstrate some segments were able to build from these humble origins and some segments were not.

Borrowing Akematsu's imagery of the flying geese pattern of East Asian technological development, this paper attempts to assess in what segments of the electronics industry Taiwan has moved from the position of technological catch-up, the follower goose position, to one of technological innovation, the lead goose position. Many scholars have taken issue with the assumption shared by the product cycle theories of Akematsu and Vernon that the follower countries will naturally be able to grasp those technologies that the lead countries no longer find profitable to produce.   Making use of these critiques, this paper will discuss another critical issue that had generally escaped discussion in debates on development in East Asia until the financial crisis brought a torrent of criticism down on every aspect of economic policymaking in Asia, the problem of the cooked goose i.e. the problem of wasting resources on segments in which one may not even be able to perform as a follower goose let alone move into the lead goose position.

Comparing Taiwanese efforts in the CMOS logic DRAM and AMLCD technologies, this paper argues that Taiwan has succeeded in becoming a globally recognized innovator in CMOS, is emerging as the classic follower in AMLCDs and is in a precarious position in the DRAM segment, a potential cooked goose. What has differentiated the successful case of innovation in CMOS from the other two examples? The Taiwanese were able to take advantage of the technological trends in this segment to create a whole new business model, one suitably adapted to the emerging technological trends and to the characteristics of Taiwan's own industrial structure. Necessary but not sufficient factors to account for Taiwan's success in innovation in CMOS included the critical influx to Taiwan of returnees from the United States, the state's role in actively training personnel for the industry and the state's role as capitalist for the principal Taiwanese ventures in this field and the necessary infrastructure for the industry. Furthermore, what has made the DRAM venture so precarious in the case of Taiwan. Principally, the Taiwanese economic structure was ill suited to meet the scale requirements needed in this segment. In other words, the general lesson to be drawn from these case studies is that Taiwan can be successful in those product segments that have the characteristics previously mentioned. First, we will take a detailed look at each case and then the reasons behind these characteristics being the criterion for success will be discussed.

CMOS Logic: Organizational Innovation to Carve out a Niche

Starting in the late 1960s, the Taiwanese government realized that microelectronics would be an important factor in electronics in the coming decades and that further growth of Taiwan's electronics industry would probably depend on developing this segment. After canvassing various foreign experts and organizing a team of Taiwanese Americans involved in the semiconductor industry in the US to serve as advisors, the Taiwanese government signed an agreement with RCA of the US to transfer CMOS technology. The reasons behind the willingness of RCA to transfer CMOS technology were similar to those of later technology transfer partners with which the Taiwanese would deal. Competitive pressure eroding profit margins, the high capital demands necessary for production and the idea that the transferring firm could best use its own resources to invest in R&D in product areas with potentially higher rates of return were all factors in the decision to transfer the technology to the Taiwanese.

However, the technology transfer of CMOS technology to the government laboratory, ERSO (Electronics Research Service Organization), was not simply one in which the Taiwanese were passive recipients. ERSO, its parent organization, the Industrial Technology Research Institute (ITRI), the Ministry of Economic Affairs (MOEA), the Science and Technology Advisory Group, higher ranking party and government officials such as Premier Sun and Minister without Portfolio Kuo-ting Li, the most prominent Taiwanese technical universities and several state or KMT-owned banks all cooperated to promote the industry. Actions taken that specifically promoted the CMOS technology in Taiwan were: 1) active R&D to improve and advance the technology undertaken by the new Taiwanese entrants into the IC industry 2)

ERSO/ITRI with the help of other government agencies served as a locus of R&D support for new firms and was the organization from which many of the new Taiwanese IC companies were spun-off including UMC, Winbond and TSMC and 3) by creating the Hsinchu Science-based Industrial Park (HSBIP) in 1980 and related infrastructure services developed in ERSO, such as Taiwan Mask, clustering was fostered to create the requisite infrastructure needed for a world-class IC industry. Furthermore, an upgrading of human capital was pursued by luring back Taiwanese from the US IC industry and by training provided by the major technical universities as well as further post-graduate training provided within ERSO/ITRI.

These policies to promote the Taiwanese industry were necessary to ensure that the private firms could innovate on their own and leave behind technological dependency on foreign licensing. However, what separates the story of success in CMOS logic from the other segments of the Taiwanese electronics industry examined here is the presence of new innovative business model. When the Taiwanese first started to create private IC firms in the early 1980s, the IC industry was dominated by IDMs (integrated device manufacturers) that vertically integrated the production of ICs from the design segment to fabrication through to the test and assembly stages. Led by returnee, Morris Chang, TSMC experimented with a new type of IC firm organization that took advantage of several emerging technological opportunities. Chang conceived of a firm that would focus on fabrication of the ICs leaving the design and the test and assembly stages to other firms. While this decoupling of the IC design and fabrication segments was demonstrated initially by some university/DARPA projects and led to the formation of MOSIS, which essentially provided technical proof of the concept, the risk was high for this new model for making chips as it had not really been practiced anywhere so there was no idea if it would really work. The decoupling of the IC design and fabrication stages was made possible by the ability to codify knowledge of device characteristics in computer models using CAD technology. TSMC actually may have over-anticipated this trend by trying to have use this model in the late 1980s when complete computer modeling of the interaction was not possible until about 1993-1994. Nevertheless, TSMC definitely reaped the advantages of being the first mover in this field as the technological trends justified this new type of fabrication-only firm, the pureplay foundry, and TSMC outstripped its Taiwanese rivals to become the largest IC producer in Taiwan in **1994.**

The pureplay foundry model succeeded not only because the trend of de-coupling led to the emergence of a large number of fab-less design houses in search of fabrication services, but also was able to capitalize on the benefits of focus. Pureplay foundries devoted their energies to increasing the sophistication of their wafer production rather than having their energies and R&D budgets split between product innovation and fabrication process innovation. The pureplay foundry model was also ideal for firms that were technologically behind because they could learn from their customers primarily through customer feedback. While this type of learning through customer feedback continues to this day, the feedback mechanism and more direct demands and technology transfers were critical in the early stages to be able to catch up to the technology of advanced firms. For example, VLSI Technology transferred specifications for 1.2 micron technology to help TSMC upgrade to that level of process technology (Mathews and Cho, p.172). The Taiwanese foundries with TSMC in the lead soon became world leaders in being able to produce multiple products with multiple processes within a single fab and in achieving extremely high production yields. Today, there are credible reports that the leading Taiwanese foundries are almost even with the industry leader, Intel, in process technology, and TSMC and

UMC may be the first two firms in the world to have mass production 300mm fabs up and running. However, it must be acknowledged that the Taiwanese foundries recently have also been able to take advantage of the trend of greater amounts of process technology being embodied in the capital equipment to keep up with the technological frontier.

Could the Taiwanese have achieved these process innovation achievements without resorting to this new model? The evidence indicates that it was unlikely. The Taiwanese firms that have continued upon the IDM path have not experienced the same level of revenue growth as the foundries. More importantly, they do not appear to be leaders in either process or product innovation. Leaving aside the DRAM case to be discussed below, the firms which decided to attempt to pursue the IDM model fall into three categories: failed or small firms (of still existing firms, HMC), firms which were converted to the pureplay foundry model once that model proved so successful (UMC, the Acer subsidiary in its various permutations and Holtek) and several firms struggling to simultaneously design higher value-added products and invest in production facilities, Macronix (MXIC) and Winbond.

However, it is worth reiterating that the invention of a new model is not the criterion for success. Rather, the new model of the pureplay foundry was able to capitalize on the characteristics that play to Taiwan’s strengths. The model avoided the problem of the need for lots of patient capital by not trying to do everything, the expensive IDM route, and, conversely, benefited from focus through granularizing production chain and picking one part of the chain in which to specialize. The problem of entering a patient capital segment will be amply demonstrated by the DRAM case presented below.

The Taiwanese pureplay foundries are not only the acknowledged manufacturing leaders in terms of process technology, yield and running multiple products and multiple processes in the same fabs. They also continue to maintain their first mover advantage in the critical manufacturing logistics of the foundry business. Reports indicate that their closest (but still quite distant) rivals in the pureplay segment, the Singaporeans, have encountered trouble meeting the logistics requirements of their customers. Furthermore, the newest tactic to propel forward the process frontier is to use the most advanced process technology to fabricate their chips e.g. customers are being encouraged to have their chips be produced on the newest process lines of .13 microns rather than on lines using the still advanced but not cutting edge .18 microns process.

DRAM: The Failure to Innovate

Starting with the agreement between Acer and TI in 1989, Taiwanese firms began to enter the DRAM market. While the new entrants benefited from the same background conditions that helped the CMOS logic segment in terms of the same human capital resources, the continued support of ITRI and the Taiwanese state in general in terms of facilitating the deepening of the infrastructure and R&D efforts, the DRAM ventures never went beyond passive acquisition of technology from foreign partners. The foreign firms transferring the DRAM technology were not motivated in ways different from those that motivated the firms involved in the CMOS transfer. Indeed, it could be argued that the competitive pressures were higher and the margins were being eroded faster in DRAM. In this case, one would predict more rapid exit by the advanced firms and more generous terms for technology transfer. While after 1995, the state did not embark on any large-scale spin-offs of firms, most of the DRAM entrants still have had R&D relationships with ERSO and the fate of the last spin-off, the DRAM firm, Vanguard, does not suggest that the spin-off of more firms would be the answer. Indeed, one of the reasons for the state's retreat from large-scale projects was that both industry executives and technology policy wonks in Taiwan argued that the government's role as R&D facilitator and infrastructure-builder was no longer needed on such a large scale given the maturation of the industry in Taiwan. Furthermore, Taiwanese conglomerates, such as the Formosa Plastics Group and Walsin Lihwa (to the extent that Winbond is considered a DRAM firm), founded some of the new DRAM ventures. It had been precisely this type of firm that had been reluctant to invest in the earlier stages of the Taiwanese industry's development; thus necessitating the state's role as venture capitalist.

Given that the similarity in the necessary background factors that supported both CMOS logic and DRAM technology development, what was the primary difference that accounted for the inability of the DRAM firms to advance the technology on their own? The scale problem is even more intense in DRAM than in other IC product areas because of the high capital costs for production capacity, the razor thin margins and the extreme business cycles. Given the nature of the DRAM business, to be able to generate enough profits to meet the capital costs and the R&D costs to develop the next generation of DRAM, a firm typically needs 15-20% of the world market according to industry insiders. Thus, to succeed in becoming a leader in the DRAM business as it is structured today, a new entrant would need lots of patient capital. No Taiwanese firm has this level of capacity yet. Frankly, it is unlikely that any of the Taiwanese firms on their own will be able to develop this level of capacity because the high capital costs and extreme cycles dictate the need for type of patience capital that does not exist in Taiwan. With these constraints, the Taiwanese DRAM manufacturers have never been able to generate sufficient profits to fund new fabs and technological development. Thus, they have been dependent on repeated infusions of technology from foreign firms for each successive generation of DRAM. These constraints hold despite the fact that by some accounts the Taiwanese are the low-cost manufacturers in this segment just as they are in foundry (Benny Tseng and Charles Kau interviews).

To be fair to the Taiwanese firms that entered the DRAM market, there is no clear alternative to the current DRAM business model. In DRAM, the design and the fabrication processes are still relatively tightly linked. On top of this, with such low margins, this product area is not a very desirable one in which to be a fabless design house. However, given the financial practices of Taiwanese industry in general, Taiwanese capitalists should have probably steered clear of a product area requiring large infusions of patient capital.

Fitting the Follower Type: The New Active Matrix LCD Industry in Taiwan

Since 1997, a number of Taiwanese firms have begun to enter the AMLCD industry. At the time of writing, there are six firms with fabrication facilities producing AMLCDs and a seventh firm with the technology to do so. Six of these firms have technology transfer relationships with foreign firms, primarily Japanese ones. Two of these firms were computer manufacturers and another was a CRT manufacturer so they had a direct stake in the new display technologies either as a downstream user of the displays or as manufacturers of competing display technologies. The other firms had no direct connection to the display industry. All of these firms have been concentrating on producing large-screen panels (13 to 18 inch screens) for notebooks computers and desktop PC monitors. Again, the motivations behind the technology transfer to Taiwanese firms were similar to the previous cases. However, the AMLCD case appears to fall in between the two other cases. While the Taiwanese firms by their own account are not innovators, they appear safely ensconced in the role of followers without being dependent on continual technology transfers from abroad.

The AMLCD industry has been able to take advantage of the human capital built up for the electronics industry in Taiwan and there have been training and small R&D projects run by ERSO. However, as this industry developed in the late 1990s, there seemed to be little need for the state to directly set up firms as in the past. Established firms including Walsin Lihwa, Chung-hwa Picture Tubes, Acer, Quanta, UMC and ChiMei were willing to enter this sector as they found technology sources and saw large market opportunities. Also, returnees did not play such a critical role, as the US did not have a large developed AMLCD industry from which Taiwanese researchers could return to Taiwan though there are some exceptions such as David Sarnoff **Laboratories**.

The firms have not confronted the need to invest in continuous product R&D because unlike many IC products, there is not a rapid generational turnover requiring technological innovation. For the AMLCD industry, scaling up from 13-inch to 18-inch panels does not require the significant technological development needed to develop the next generation of DRAM let alone the next generation of microprocessors. As one manager from one of the new Taiwanese entrants put it, “We are a firm that has made money from mass producing commodity products on low margins. These displays are no different. We will make money from producing a lot of the low margin AMLCD panels." (ChiMei VP)

In contrast, the Japanese have reduced investment in production capacity in order to concentrate their resources on developing high value displays for new markets, such as the next generations of PDAs and cell phones and new markets such as automobile displays. The Japanese have taken a strategy to avoid head-to-head scale competition with the Koreans and with the newest entrants, the Taiwanese, in the area of large panels for computer displays. The Koreans have essentially taken their traditional approach of heavy capital investment and have spent some R&D on higher value-added displays, but as of present, have remained in the same computer-oriented markets as the Taiwanese. (Interviews with Hyundai and Samsung)

Thus far, the AMLCD industry appears to be one that does not require continuous innovation for firms to continue to produce products that generate some profit margin. The generational turnover has not been very rapid for the AMLCD panels and to increase panel size, one of the important characteristics for competing in the notebook and desktop display markets, is relatively easy to do.   Thus, the Taiwanese firms can follow the model of passive acceptance of foreign technology without worrying about needed relatively constant infusions from advanced country partners to stay afloat. The strategy taken in the AMLCD sector fits the classic model of Taiwan (and Korea) receiving technologies that Japan abandons as it creates newer products though in the Korean case the Koreans pushed their way into the large screen AMLCD market before the Japanese had entirely retreated to higher value-added displays.

The Critical Factors

In the end, what has separated the tremendous success of Taiwan's CMOS logic pureplay foundries from the bleak outlook for Taiwan's DRAM producers are the match of the CMOS logic pureplay foundry to the characteristics that utilize the strengths of Taiwan's economy and the mismatch between the DRAM segment and these characteristics. CMOS logic pureplay firms have met the criteria of granularity and no need for copious streams of patient capital whereas DRAM has met neither of these criteria. Both segments have met the criteria of being high volume and manufacturing-based segments. If the Taiwanese had stuck with the IDM model when trying to develop CMOS logic, they would probably have faced many of the problems faced in the DRAM segment in terms of being constrained by limited resources from simultaneously developing the requisite process and design technologies as well as the necessary scale of production. Unfortunately for Taiwanese DRAM producers, there does not seem to be a good alternative model in DRAM at this juncture. Indeed, the lesson is that the Taiwanese should not go into any segment in which they cannot leverage all of their strengths.

The case of AMLCDs more closely fits the classic formulations of Vernon and Akematsu in which the receivers of technology can benefit simply by receiving the cast-off technology of the global technology leaders. Granted, the Koreans used their cheap capital to push into both the DRAM and AMLCD sectors forcing the Japanese and others to unload these technologies in a manner that does not resemble the passive acceptance of technology discussed by Vernon and Akematsu, but the general idea from Vernon and Akematsu that the advanced countries shed lower value-added technologies to the follower technologies fits the AMLCD case. The

Taiwanese have not innovated in this sector, but unlike DRAM, they do not face the pressure of rapid generational turnover of products making their current production and product technology quickly obsolete. The jury is still out on the prospects for future innovation in the AMLCD segment in Taiwan because it is unclear if there are the necessary technological possibilities for granularity. One indication that there are some moves toward granularity is the apparent move by some Taiwanese firms to concentrate on one small part of the whole AMLCD process, such as color filter production.

The Connection Between the Necessary Characteristics Observed and Taiwan's Underlying Economic Strengths

Taiwan's need for granular production and inability to succeed in segments needing patient capital are two side of the same coin. Taiwanese firms need to innovate in a manner which does not consume large quantities of capital continually over long periods of time because Taiwan's financial system has not been set up to sustain such types of patient capital investments. The Central Bank has traditionally had autonomy from the rest of the government, including those officials involved in industrial promotion. The Central Bank's mission is to fight inflation and the financial system has been run accordingly. Debt-to-equity ratios are kept at very low levels. The debt-to-equity ratios are similar to those of the US (cite Fields) though the US industrialized quite early on so it is not surprising that the US did not rely on patient capital to grow as most late developers have done (cite Gerschenkron).

Taiwan on the other hand developed quite late (the term late late developers has been applied to Taiwan and the other East Asian NICs to emphasize how very late they industrialized relative to the advanced world), and, despite this history, in a radical departure from other late developers in Northeast Asia, such as Korea and Japan, Taiwan eschewed the use of high debt-to-equity ratios to develop. These patient capital using countries used the patient capital to scale up to a level at which further R&D needed for innovation could be supported, the classic Schumpeterian approach. Between 1983 and 1986, Korean firms spent 1.2 billion US dollars to invest in semiconductor production. During the same period, the Taiwanese barely managed to scrounge together 120 million US dollars (Mathews and Cho, p. 126). Furthermore, Hyundai managed to become one of the biggest DRAM producers in the world in the 1990s despite having suffered ten straight years of losses in the semiconductor industry during the 1980s (Mathews and Cho, p. 108). Even in 1997, the scale of Taiwan's IC industry was not large. The total sales revenue for all eleven of the Taiwanese IC manufacturers combined was not quite as large as the fourteenth largest IC producer's, Hyundai, sales revenue. With this option of innovating through the lifeline of large continual transfusions of capital cut off, the Taiwanese had to granularize production to create narrow segments in which they could use their limited funds and their narrow focus to reap the maximum possible rewards. Despite the fact that Taiwan's industry was not large nor were its largest firms large by international standards, the Taiwanese, already long recognized as leaders in terms of the yield ratio (the essential measurement of manufacturing efficiency in the IC industry), were right on the heels of the best of the large international firms in terms process technology, the area of the Taiwanese focus, in 1997 and are even with them today. Thus, the inability to leverage patient capital in Taiwan, has essentially dictated that Taiwanese firms that wish to be innovators seek out those segments that do not have this type of capital requirements.

The firms that have disregarded this constraint imposed by Taiwan's financial system and invested in the DRAM segment have never found enough capital given the volatile DRAM business cycle, which is bound to scare short-term Taiwanese investors, to do build the necessary scales necessary to support R&D. Given the reality of the close link between design and production in DRAM, they have also been unable to granularize production in this segment to be able to avoid the need for patient capital. Consequently, they have never been able to become innovators despite their reputation as efficient producers and instead are stuck in a segment in which they spend lots of money on production facilities in return for low profit margins made even though lower by the cost of licensing the required next generation of technology from abroad. Of the seven firms that have entered this segment in Taiwan (Quasel, Powerchip, Nanya, Acer, Vanguard, Mosel Vitelic (including Promos) and Winbond), three (Quasel and Acer Semiconductor no longer exist and Vanguard is gradually winding down the DRAM operations) have exited the market and the other four appear to be dependent on foreign licensing to be able to compete at the current product generation.

The characteristic of high volume has been included as a necessary condition despite the fact that all three sectors in the case study have included this characteristic. This characteristic is not really intuitive from our case studies but arrives from a general survey of Taiwan's postwar industrialization. Despite having a SME-heavy industrial structure, the Taiwanese have often pursued niche products with success, but have not pursued artisanal or craft products. This absence is most likely not an accident. Taiwan's economy does not seem to have the type of institutions in terms of independent associations of producers with lots of room for governing their affairs and the critical training institutions that have characterized craft production in Germany. Historical examinations of the rise of these craft production centers in Germany and Italy suggests that the necessary institutions take lots of time to develop and are probably more the result of the accidents of history rather than of particularly prescient planning. Thus, Taiwan is unlikely to develop this type of supporting institution and thus should shy away from craft production.

Finally, the characteristic that is probably the least robust in terms of determining success and failure in innovation in Taiwan is the characteristic of manufacturing focus. Again, all the segments under review share this characteristic and the evidence for this necessary characteristic comes from Taiwan's historical industrialization process. However, unlike the case of the institutional constraints dictating that high volume production is the most suitable path for Taiwanese firms, there is not such a strong justification for the characteristic manufacturing. Nevertheless, there is some justification in terms of educational focus and what I will call strategic heuristics. In terms of education, the engineering education is prominent in Taiwan and has a hands-on manufacturing orientation. What we mean by strategic heuristics is that the Taiwanese businessmen and engineers have spent so much time involved in manufacturing that their historically accumulated inclination (The "If we're good at something, let's stick with it" mentality reaffirmed over time by Taiwan's continued manufacturing successes) and their deep understanding of manufacturing lead them to continue to pursue this type of business and, at least in terms of experience, should also give them an advantage in pursuing manufacturing as opposed to pure design or service segments with which they have little past experience. This characteristic is much weaker constraint in determining success and failure in Taiwan because the educational system is undergoing reform that may lead to a slightly different emphasis and the strategic heuristic may weaken over time as more Taiwanese firms figure out how to compete in design and service segments. Indeed, there have been some substantial successes in certain parts of the IC design house segment, such as the design of chipsets, which show that this segments which are not directly involved in manufacturing can succeed.

The Wider Implications

Going back to the days of Schumpeter, many have argued that innovation cannot be achieved without large-scale economies to fund the necessary research and development efforts. Recently, in light of the development experiences of different NIEs in East Asia, certain scholars have once again picked up these arguments, such as Alice Amsden and Linden et al. This paper undermines these assertions about the necessity of scale economies in all technological innovation while conceding it may be an important factor in some areas, such as DRAM.

The implications of this argument about the characteristic of Taiwan as an example of a successful innovator for other countries in the contemporary period are several. Beyond what should be the obvious facts that investment in human capital is necessary and that letting your citizens temporarily emigrate to absorb technology in the advanced world, countries should attempt to look for advanced technology markets in which there is some hope of match between their industrial organization and historical development, such as Taiwan's high volume and manufacturing focused tendencies, and the market. Following upon this implication is one rejecting the concentration of capital approach followed by Korea, Japan and, in an earlier era, Germany as the sole way to achieve innovation.

Most importantly, the Taiwanese case demonstrates that the power of being able to granularize production and thereby derive the benefits of focus. Granularity is an option open to countries without the type of type of financial systems encouraging patient capital, and with the increasing internationalization of production and the greater technological possibilities to coordinate production of a product across a number of firms, granularity is becoming possible across more and more production chains. Thus, this particular lesson from Taiwan's innovation successes is widely applicable for countries that do not necessarily have the same institutional sets as Taiwan. The wide applicability of the strategy contrasts sharply with the economic prescriptions for the need for developmental states, industrial districts of craft producers or organized market economies that by their very definition of what is necessary to follow the prescription exclude most nations.