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# From Creativity to Innovation

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**Abstract**

Talent is the bedrock of a creative society. Augmenting talent involves mobilizing culture and tradition, building institutions to increase the stock of human capital, enhance its quality and instill values favoring achievements and initiative. The productivity of this talent in the form of ideas can be raised by nurturing wikicapital – the capital arising from networks. Translating creativity into innovation is a function of multiple incentives and sustaining innovation is inseparable from heavy investment in research.

Finally, the transition from innovation to commercially viable products requires the midwifery of many services providers and the entrepreneurship skills of firms small and large.

# From Creativity to Innovation

By Shahid Yusuf*

Commercially viable innovations are becoming the hinge of success in global markets and by helping to raise total factor productivity, they now account for a significant share of growth in advanced and industrializing economies.[1,2] Innovation can take many forms among which product innovation is but one. Design and incremental process innovations are more common and in recent years, myriad innovations are being introduced by providers of services.[3] Innovation is changing the structure and enhancing the capabilities of organizations.[4] Moreover, institutional innovations are sharpening market incentives for entrepreneurial activity and technology trading which take new ideas, products and practices into the commercial domain.

In certain areas such as genetics, climatology and the social sciences, innovative uses of computing power are making research more productive by automating the framing of multiple hypotheses and their testing using advances in data processing and in evaluative algorithms (Glymour 2004). Needless to say, the significance of innovation for economic performance and living conditions can scarcely be overemphasized in the face of the opportunities presented by globalization, and the multiple challenges arising from resource scarcities, the dire predictions of accelerating climate change and the threat of pandemics caused by new organisms.

Innovation springs from the creative application of knowledge. Thus, it has two essential ingredients – creativity - artistic, scientific or other[5] - and the stock of knowledge. Knowledge and the "functionalities" it supplies is the essential raw material

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[1] Smil (2006) provides an enlightening tour of the innovations which transformed the twentieth century.

[2] See for instance OECD (2006, II, ch3); and Phelps (2007) who attributes the "root problem" of the European economies as being the low rate of commercially successful innovations.

[3] Innovations in financial, retailing, wholesaling and IT based services have stimulated the growth of productivity in the U.S. over the past decade (Solow 2001).

[4] Since the mid-1980s, the crafting of new business models and organizational forms has become a flourishing industry which has encouraged firms to experiment so as to pare costs, increase flexibility and raise productivity.

[5] Mokyr 2005b provides a historical perspective on creativity and how the competitive market for ideas which emerged in seventeenth century Europe contributed to it.

but it is the creative act which is the basis for an innovation. Often the initial invention or deep insight[6] is the first of several stages before an innovation is fully realized, a process which can require the accretion of new knowledge.

Many innovations, however ingenious, have no market potential.[7] Those which appear promising must be refined and tested and modified before they are deemed to be commercially ready. This can be a protracted process sometimes, almost as critical as the initial creative act itself. Frequently successful commercialization is a function of organizational capabilities and the coordinated use of multiple skills – managerial, financial, marketing and legal – which themselves draw support from a variety of institutions.

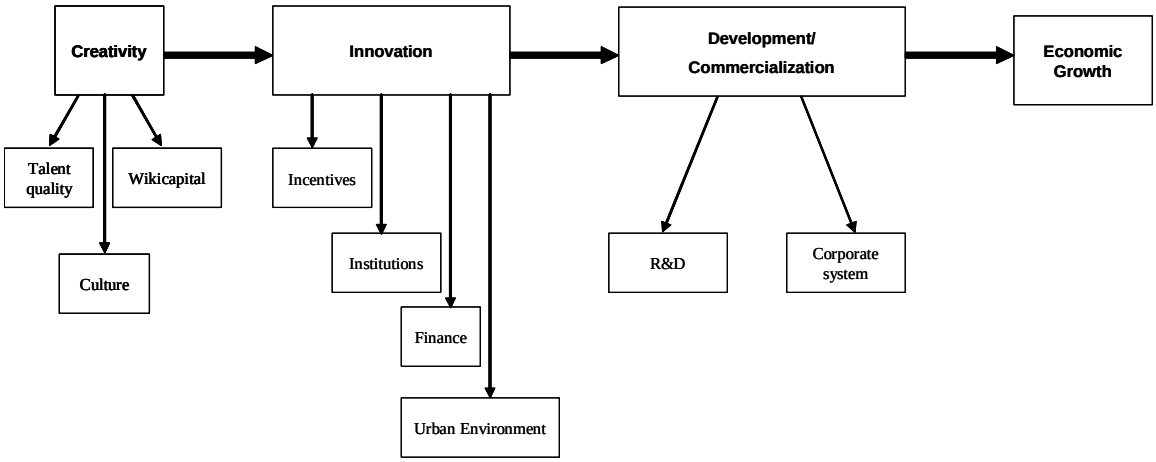
What then makes a society creative and how does this translate through innovation into superior economic performance? A vast and multistranded literature grounded in several disciplines has yielded many clues but the conditions that induce innovation are necessarily complex, many are not easily altered by policy and some are the result of history and cultural evolution which are beyond the reach of policy. What follows, sketched in Figure 1, opens an inevitably partial and highly synthetic window on this literature.

This paper is divided into three parts. The first presents some of the conditions which are correlated with creativity. The second defines factors which can lead from creativity to innovation. The third summarizes those conditions which contribute to the commercialization of innovations.

[6] Inventors according to Arthur (2007, p.258), may start with a pressing need or a novel phenomenon and "think in terms of achievable actions and deliverable effects – functionalities – and they combine these in solving problems. Functionalities … are also the currency of standard technological design. But what differentiates invention is that the overall problem has not been satisfactorily solved before, that the challenges may run several recursive levels deep, that the solutions of these may be far from standard, that novel phenomena and unusual effects may have to be used and that the overall principle is new to the purpose in questions …. What are common to originators is not genius or special powers. Rather it is the possession of a very large quiver of functionalities".

[7] This is reflected in the huge numbers of 'dark patents' which lead to no useable outcomes.

**Figure 1 – Creativity and Economic Performance**




***Achieving Creativity***

It almost goes without saying that culture and traditions strongly influence creative interests, the degree of creativity and the forms it can take.[8] Not all societies have gravitated towards or sustained a culture of systematic scientific enquiry grounded in formal rules of logic, of proof, and of the empirical validation of hypotheses. Creativity in some societies might be expressed in other ways through art, music and crafts for example or through institutions which ensure survival in harsh environments. While many forms of creativity can be valuable, the economic yardstick favors creativity which leads via innovations ultimately to commercial results. By and large, the scientific approach has proven to be overwhelmingly more fruitful in generating useable knowledge which has served as the springboard for creative leaps to fruitful innovations.[9] Such an approach is essential for a competitive economy and must be supported by large numbers of creative individuals imbued with the scientific ethos.

The ratio of creative people in a society is likely to be higher if three conditions are fulfilled:

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[8] Feinstein (2006 p.74) notes that "Our creative interests are a vital, central link connecting our creative endeavors with our culture including our cultural heritage".

[9] The scientific revolution in Europe, the encouragement it gave to the sharing of knowledge, to empirical testing and its Baconian orientation and to improving mankind's material circumstances, are discussed by Mokyr (2005a). The contrast between the pursuit of scientific knowledge by the west in the eighteenth and nineteenth centuries and the relative absence of such a search and of institutions to support the cumulative process of finding and learning in China are examined by Landes (2006).

First, the society attaches a high value to learning and promotes talent by means of cultural reinforcements such as a stable, nurturing family environment from early childhood through the formative years. An analysis of the scores obtained from the Trends in International Math and Science Study (TIMSS)[10] suggests that such an upbringing (and the adequacy of nutrition) strengthen cognitive and analytic capabilities, as well as motivation which are critical to scholastic performance. The cultural environment of the home needs to be buttressed by the quality of schooling provided from primary all the way through tertiary levels.[11] Better schooling is becoming a priority as technological advances and computerization have increased the demand for workers capable of superior problem solving skills, the capacity to convey complex information and to work effectively in groups (Murnane and Levy 1996; Autor, Levy, and Murnane 2001). Quality is partly a function of lab and classroom facilities and the enlightened use of IT to stimulate learning, to pique curiosity, and to enhance the ability to solve problems without recourse to rules. More importantly, it depends on the caliber of teachers (Hanushek 2004) and on how classroom instruction is reinforced by encouragement and supplementary tutoring at home.[12] These factors overshadow class size or the length of the school year (Hanushek 2002).

Second, a creative society is one which attaches equal importance to the building of human capital through better health, again starting from childhood when good nutrition and care have profound and lasting implications for learning capacity in later life (Glewwe, Jacoby, and King 1999; Bloom 2000). Physical health is one part of the picture, mental well being is a second and equally significant complement. The burgeoning interest in gross human happiness, while still in its infancy and beset by problems of measurement,[13] is pointing to a correlation between perceived happiness of societies and their ranking according to indicators of international economic

[10] The details of this analysis and a survey of related literature can be found in Yusuf and others (2003, ch5).

[11] The close relationship between the quality of education and economic outcomes is analysed and empirically supported by Hanushek and Kimko (2000) and Hanushek and Wößmann (2007).

[12] Finland, which ranks high on student achievement scores, is noted not for the length of the school year but the emphasis on home tutoring and support. After – school learning of math, reading and communication skills is also underscored by Murnane and Levy (1996).

[13] See Frey and Stutzer (2002) for a recent review of the methodological issues and findings from the research on happiness initiated by the "Easterlin Paradox" which came to light in the 1970s. See also Layard (2005).

competitiveness.[14] Table 1 presents 12 of the most economically competitive countries in 2006 as ranked by the Global Competitiveness Index and the World Competitiveness Scoreboard. Table 2 presents the top 12 countries ranked by surveys which measured "satisfaction with life". The overlap is significant. Happy and healthy people are more likely to be productive, to pursue knowledge more avidly and put it to more ingenious uses. To express this in more conventional terms, it is intuitively plausible that creativity will be affected by the physical, emotional and intellectual quality of human capital. Thus, one of the uppermost objectives for a creative society is to invest in human capital so as to raise both volume and quality.

**Table 1 – 12 of the Most Economically Competitive Countries in 2006**

| Global Competitiveness Index | World Competitiveness Scoreboard |
|---|---|
| Switzerland | Iceland |
| Finland | Denmark |
| Sweden | Australia |
| Denmark | Canada |
| Singapore | Switzerland |
| United States | Luxembourg |
| Japan | Finland |
| Germany | Ireland |
| Netherlands | Norway |
| United Kingdom | Austria |
| Norway | Sweden |
| Iceland | Netherlands |

Source: IMD World Competitiveness Yearbook 2006; World Economic Forum.

**Table 2 – 12 of the Top Ranked Countries by Surveys which Measured "Satisfaction with Life"**

| Satisfaction with Life |
|---|
| Denmark |
| Switzerland |
| Austria |
| Iceland |
| Australia |
| Finland |
| Sweden |
| Canada |
| Ireland |
| Luxembourg |
| Norway |
| Netherlands |

Source: Veenhoven, R., Average happiness in 95 nations 1995-2005, World Database of happiness.

[14] There is also some weak evidence of a casual relationship running from happiness to economic growth (Kenny 1999). Di Tella and MacCulloch (2006) find that both unemployment and inflation reduce happiness with unemployment having a greater effect.

Third, with knowledge growing at an exponential rate, students and researchers must become more and more specialized in order to achieve sufficient mastery over a narrow subfield to be able to advance the frontier of knowledge. This has two implications: one is that individuals make their first discoveries at later ages than was the case in the past (Jones 2005);[15] second, an increasing proportion of discoveries are made by teams brought together by bridging relationships (Fleming and Marx 2006). Some of the most exciting new findings are the result of multidisciplinary efforts which aggregate the knowledge, functionalities and insights of professionals drawn from several fields. As Feinstein (2006, p.31) observes "Creativity is making a connection between or combining two elements that have not previously been connected or combined". In fact, as knowledge deepens and becomes more variegated, human capital can be more creative when it is pooled into "wikicapital"[16] through the formation of local and global teams, partnerships, associations and learned societies which facilitate the deepening and sharing of knowledge and bring together diverse talents with different perspectives, viewpoints and spheres of knowledge.[17] Creative solutions to complex problems are becoming more feasible because wikicapital can harness a vast array of expertise and to attack a problem from many directions by exploiting the potential of heterogeneity.[18] The accumulation of wikicapital is growing because so many scientists share a common medium of communication – English and mathematics – they are increasingly mobile and have opportunities for face-to-face contact. Moreover, the opportunities for collaborative work have been enormously facilitated by ICT and the declining cost of Internet access

[15] This also reduces the productivity of innovators especially so if ability in certain fields is greatest at younger ages.

[16] As the level of collaboration has intensified, a subfield called "wikinomics" is emerging which analyzes the modalities of collaboration and its implication for innovation (Tapscott and Williams 2007). The globalization of research which has been gathering momentum since the 1990s is contributing to the accumulation of wikicapital (Carlsson 2006).

[17] Arthur (2007, p.285) observes that the Cavendish Laboratory at Cambridge was a fertile source of inventions in atomic physics because "it had built a treasury of knowings to do with atomic phenomena" and it provided an arena where new ideas could be debated, challenged and tested. The size of research teams has grown steadily as the complexity of problems has increased (see Adams and others 2004).

[18] The role of heterogeneity or diversity in helping solve knotty problems and giving rise to striking innovations deserves emphasis (see Page 2007). The literature on the "small world" phenomenon warns that "intense connectivity can homogenize the pool of material available to different groups, while at the same time, high cohesiveness can lead to the sharing of common rather than novel information". (Uzzi and Spiro 2005, p.449).

(Fleming and Marx 2006).[19] The creativity of wikicapital – of teams that combine diverse skills – has been reinforced by advances in techniques of measuring physical as well as social phenomena and the sophistication of measuring devices,[20] in the techniques for assembling and storing vast quantities of data, and by the automation of discovery in certain areas.

The formation of wikicapital is associated with individual capacity to work together in teams and to engage in the give and take of effective collaboration. This is a function of what is sometimes called "emotional intelligence"[21] and is an aspect of personality which is conditioned by culture and can be strengthened by an educational environment and training which attaches due importance to cooperative behavior (Lundvall 2007; Mulgan 2000).

***Making a Creative Society Innovative***

The quality of human capital and the enhancement of its creativity through the formation of wikicapital create the preconditions but catalyzing innovation calls for triggers and mechanisms which reinforce certain types of productive behavior. One of these is a culture which is relatively tolerant of risk taking, specifically risks associated with entrepreneurial activity. It is a culture which also is more tolerant of entrepreneurial failure. Not only is business failure not stigmatized but specific institutions (e.g. bankruptcy and limited liability laws) contain the penalties imposed on individuals when their business ventures fail and allow for fresh initiatives. Thus, the social attitude towards certain kinds of risk taking induces willingness on the parts of individuals to be ambitious and to search for significant and disruptive innovations.

This attitude goes hand in hand with mechanisms for rewarding innovation handsomely if they prove to be commercially successful. Those can take a number of forms. One is the assignment and protection of rights to intellectual property which allow

[19] Fleming and Marx (2006 pp. 12, 10) note that "inventor networks are shrinking becoming more "small world" [with] multiple overlapping ties of cohesion [which] engender trust".
[20] Galison (1997) describes how advances in high energy physics are now dominated by large, often cross national, teams working with extremely expensive equipment for detecting and measuring.
[21] Just as there is IQ there is now an emotional intelligence quotient or EQ which measures the ability to manage ones emotions, and to perceive those of a group ("Emotional Intelligence" 2007; Layard 2005).

individuals or entities to derive benefit from a discovery over a number of years.[22] Societies can support the cause of creativity by making it possible to acquire intellectual property at an affordable cost in terms of money or time and ensure that the rights once obtained can be enforced again affordably, by an effective legal system.[23] The monetizing of intellectual property and knowhow by way of markets for technology is a second (Arora, Fosfuri, and Gambardella 2001; Pisano 2006).

The trading of knowhow and the commercialization of technology is supported by a variety of mechanisms such as venture capital, government funding schemes for SMEs for example the Small Business Innovation Research (SBIR), the floating of IPOs, and through M&As. Income and capital gains taxes which are not steeply progressive can assure that a substantial portion of the rewards from entrepreneurship and innovation accrue to the innovators while tax credits and generous depreciation allowances can encourage investment in innovative activities. Furthermore, a society which is accepting of so-called "good inequality"[24] can accommodate wider income differentials thereby buttressing the incentive mechanism which attaches great value to singular achievements. This acquiescence of large income and wealth differentials can contribute to social mobility and neutralizes the social disapproval of conspicuous consumption by the rich.

For the incentive system to deliver results on a sustained basis calls for competition domestic and foreign. Competitive pressure motivates innovation in pursuit of commercial rewards and also weeds out the weaker offerings and innovations which have outlived their utility. Competition spurs innovative effort because many businesses are finding that it is often a surer means of earning higher returns than competing solely on the basis of price or quality or service although those too remain important. Thus, the

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[22] Jaffe and Lerner (2006) observe that the American patent system is "based in the constitution itself and codified in roughly its modern form in 1836, the patent system was an essential aspect of the legal framework in which inventions from Edison's light bulb and the Wright brothers' airplane to the cell phone and Prozac were developed".

[23] However, the rules for patenting and the process for screening submissions must be designed carefully so as not to award patents to commonplace findings which provide legal leverage to individuals and can stifle innovation. In recent years, many software and design patents are being awarded for trivialities which are only deemed new and non-obvious because a new domain and the technological infrastructure to support it have emerged. An easing of submission rules and standards of examination has also contributed in the U.S. (Jaffe and Lerner 2006). The standards for awarding patents must be upheld so as to avoid flood of litigation which beyond a point, can be inimical to innovation.

[24] Chaudhuri and Ravallion (2007).

framing and enforcement of rules (including trade policy) governing market competition complement rules governing intellectual property. Together they influence the tempo of innovation, in particular, through the entry of firms which are a conduit for new products and services but also by providing enough latitude for firms large and small to benefit adequately from research activities and risk taking, as for instance in the pharmaceutical industry.

Culture, institutions and incentive mechanisms serve as the matrix within which creativity can flourish and lead to innovation. There is, however, a geographical locus for innovation which is no less important than those intangible factors. Much of the creativity which leads to new discoveries and spawns innovation occurs in cities and the bulk of this is in urban areas with certain attributes (Florida 2002; Florida 2005; Chapple and others 2004). The hot spots of innovation are more often than not, major urban centers[25] that are closely linked with other cities around the world and open to the circulation of people and ideas facilitated by efficient transport and IT services. In many instances, this openness promotes diversity which is associated with innovative approaches to problem solving (Page 2007). Cities where innovation flourishes are also centers of learning, hosting the leading universities and training and later employing some of the most talented people in the country. Universities and key, city-based research institutes contribute to the process of discovery through several different channels and work with businesses to transform scientific findings into marketable technologies (Lester 2005).[26] In major urban areas, the path from discovery to innovation is greatly expedited by the co-location of universities, research institutes and businesses which perfect and utilize new technologies (Yusuf and Nabeshima 2007). It is aided further by the presence of providers of diverse and critical business services – financial, legal, managerial, technical, and others which serve as handmaidens to the innovation process and have assisted in the formation of dynamic high-tech industrial clusters in the vicinity of world class universities as in Cambridge, U.K. and Silicon Valley (Bresnahan and others 2001;

[25] Bettencourt, Lobo, and Strumsky (2007) show that the larger SMSAs in the U.S. are a more prolific source of patents and that there is evidence of superlinearity effects.

[26] The emergence of research oriented tertiary institutions and their impact on industrial development in the U.S., Europe and East Asia is described by Mazzoleni (2005).

Cooke 2002; O'Mara 2005; Bresnahan and Gambardella 2004). Without these intermediaries, ideas would have great difficulty gaining commercial footholds.

While large corporations usually have the resources and the expertise to assimilate, develop and market innovations and are often actively looking for certain types of technologies,[27] SMEs generally confront far greater difficulty in accessing and adapting technologies. Small firms need all the help they can get and intermediaries (such as business associations or specialized industrial extension agencies or regional development bodies or university based technology transfer offices) located in cities are in a position to connect small firms to researchers and to assist them in launching new products or services[28] (Yusuf and Nabeshima 2007).

Larger and relatively open cities also have a more favorable demographic profile and flexible labor markets. The population of growing cities usually has a lower median age and such an age profile is a source of entrepreneurial dynamism, innovativeness and higher savings. These demographic characteristics have substantially contributed to past growth in East Asia (Bloom and Williamson 1998).

***Developing and Commercializing Innovations***

While human talent is the source of creativity, the activity of innovation requires financing. The provision of quality education is one part of the equation, however, financing R&D which permits human and wikicapital to generate innovations is predicated on the volume of available funding and its distribution across basic and applied research. The various estimates of the returns on R&D spending indicate that the private returns average 28 percent and that social returns are significantly higher (Wieser 2005; Griliches 2000; Yusuf and others 2003). Once the human capital base has been developed and the creative potential deepened, the payoff from outlay on R&D can be very handsome. In fact, economies which are coming to rely on innovation to drive growth must be ready to invest upwards of 2 percent of GDP annually in R&D so as to

[27] The absorptive capacity of firms depends on their own research and preparedness – see Kodama and Suzuki 2007.
[28] See Debackere and Veugelers (2005) on the role of university TTOs.

continuously augment the stock of knowledge and ensure a sufficient flow of innovations (see Table 3).

**Table 3 – R & D Expenditures and Sectoral Distribution in 2004**

| Country | Share of R&D by Sector | | | GERD as percent of GDP |
|---|---|---|---|---|
| | Industry | Higher Education | Government | |
| Finland | 70.1 | 19.8 | 9.5 | 3.51 |
| Japan | 75.2 | 13.4 | 9.5 | 3.13 |
| Korea | 76.7 | 9.9 | 12.1 | 2.85 |
| United States | 70.1 | 13.6 | 12.2 | 2.68 |
| EU-25 | 63.3 | 22.1 | 13.4 | 1.81 |
| China | 66.8 | 10.2 | 23.0 | 1.23 |

Source: OECD Science, Technology and Industry Outlook 2006.

Governments have tended to shoulder more of the financing burden for basic research in universities and research institutes which adds to the pool of scientific knowledge[29] although they do support downstream and applied research by corporations as well. In the majority of cases, resources from the public sector (including for university based research) account for between 20 and 40 percent of spending on R&D (Table 3). The balance comes from the private sector, which typically invests more in applied research and in the development of scientific findings.

This division of responsibilities for R&D points towards the vital role which the business sector and especially, large companies play in the activity of commercialization and marketing. The economic benefit which is derived from innovation by a creative workforce is only fully realized when an innovation acquires a commercial form and value. As I noted earlier, the chain extending from the garnering of knowledge by creative people to the actual marketing of an innovative product or service, which embodies that knowledge, is a lengthy one. It can also entail a significant expenditure of time and resources.

[29] Some of the key research underlying innovation by Pharmaceutical industry in the U.S. was done in public labs or with government fundings.

Researchers of various stripes, individually and in teams, do much of the upstream work which takes an idea and transmutes it into an innovative technology. Developing this to the point where it becomes a marketable product or service is the work of professionals who understand the minutiae of commercializing and marketing an innovation backed by the organizational resources of the firms. This is not only an expensive but also a risky process as shown by the numbers of innovations which fail even when they are developed and launched by companies with vast reserves of expertise and a proven track record. The cost and complexity of commercialization makes the large business firm into a key player in the innovation process. By combining international marketing experience, human resources and financial management and risk assessment skills, brand names and intangible organizational capabilities, these entities are far better positioned than smaller firms and public agencies to convert an innovation into a commercial asset. Large firms are not necessarily the most creative in terms of new ideas nor are their R&D expenditures necessarily more productive than the outlay of smaller companies in terms of innovations. But the bigger companies stand a much better chance of developing and marketing an innovative product or service on a global scale and reaping large returns with the help of well developed research systems and channels of distribution. Even when an innovation is first launched by a small firm, its eventual success on the global market place can depend on an alliance with or take over by a bigger corporation (as in the case with many biotech firms) with the necessary marketing muscle, brand name and manufacturing experience. Cisco is one example of a company which has made innovation through takeover into an art form. The latter is not a minor consideration in a world where the management of manufacturing costs, of product mix, and of product customization for different market segments can involve dispersing production across a number of units located in several countries and frequently, the outsourcing of production to contract manufacturers such as Flextronics and Hon Hai Precision. Thus, production for global markets is itself a considerable innovative feat of organization, management, product integration, quality control and logistics which can be beyond the reach of the small firm. Even the biggest firms, struggle to cope with the costs of sustained innovation, development and marketing on a worldwide scale and are

coming to rely increasingly on alliances or collaborative arrangements with other firms and on specialized intermediaries such as Li and Fung.

***A Summing Up***

This brief overview of the creative society highlights the many pieces which need to be knit together to bring into existence a system which will be a fertile source of new knowledge, which will be able to decant a steady stream of innovations from the accumulating stock of knowledge, and which has the business capabilities to take the innovations to the marketplace and achieve the success rate that is the key to economic growth.

As I have indicated, human talent is a precondition and this is a function of how culture and tradition are mobilized by public and private agencies acting, ideally, in concert, to build a stable society, furnish it with institutions to augment human capital, and enhance its quality and instill values favoring achievement and initiative. This human capital (in the formation of which public policy has a large hand) can be made more creative through the emergence of what I have called wikicapital – the capital arising from networks. The creativity feeding knowledge needs in turn to be translated into innovation which is linked to incentives and the attributes of urban environments (e.g. amenities, services and labor markets). Sustaining innovation at a high level calls for heavy investment in R&D. But the new ideas and findings and technological leads which emerge are only the first step. A prolonged and expensive process of development and eventual commercialization is required before products and services, which pass the market test, can emerge on a routinized basis.

Development and commercialization calls for expertise, ingenuity and entrepreneurial creativity to achieve success. Often breakthroughs are made by small firms but it is the large companies which are responsible for the bulk of commercialization. It is their developmental efforts, organizational capabilities and, resources which ultimately ensure that the innovations generated by a creative society lead to economic growth. Paul Romer (2007) predicts that the country which will lead in the 21st century will be one which implements innovations – meta ideas – supporting the production of new ideas in the private sector (Romer 2007).

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