Special Feature: Globalization of Technology Transfer

The changing role of technology and knowledge transfer and the need for institutional change

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This paper explores the interdependence between technology and knowledge transfer and their connection to innovation, information and communications technology (ICT), and institutional change. The extent to which opportunities offered by new technology can be captured is strongly influenced by knowledge transfer coupled with absorptive capacity. Institutional reforms should be led by the need for fostering demand-led “pull” of technologies in response to real needs. Crucial governance structures, including those that impact on universities and learning processes, need to appreciate diversity and openness. The interface between transfers of technology and knowledge, and the means for engineering local capacity and competence development, need to be reviewed in this light.

Introduction

A massive structural change is happening within nations as well as across borders. Urbanization and the transition from an agrarian to a manufacturing or industrial economy and then to a service-based society, have been the obvious aspects of this change for some time. The explosion of trade associated with globalization, technological progress and information revolution have added to those. Meanwhile, huge shifts have emerged in the economic weight of different parts of the world. Centuries-old economic dominance by Western Europe and the United States has gradually given way to an economic revival of Asia, initially led several small or medium-sized economies – the so-called Asian tigers. More recently, the ancient powers and most populous nations in the world, China and India, have re-emerged as major economic powers. Parts of Latin America and,
Africa, including the dynamic economies of Brazil and South Africa, too have experienced a revival.

In the last few years, the illusion of an almost unchecked march towards a more integrated and booming world economy has ended. The crisis, which started with the collapse of the United States housing bubble, is connected with the financial and macro-economic set-ups of that country. While these did play a pivotal role in the global economic downturn, the critical deficiencies that still afflict national and international governance should not be forgotten. Several institutions and factors have fuelled the present global financial crisis and the deepening recession. The current developments will probably accelerate the ongoing restructuring, leading to the prominence of the developing countries in Asia and around the world. The most important will be the lessons learnt and how they are leveraged to initiate change in the systems of governance.

Accelerating technology transfer across national borders, through international trade flows and/or foreign direct investment (FDI), is central to most discussions on globalization and development. International trade and FDI have provided laggard economies with tools to draw on the progress achieved by countries ahead of them on the development trail. At the same time, many have viewed the overseas operations of multinational enterprises (MNEs) with scepticism. In recent decades, globalization has been associated with increasing income differences, both between and within countries, although the development of countries such as China has provided some check on the overall trend. Similarly, lively debates on the ‘digital divide’ expected information and communications technology (ICT) to increase discrepancies. However, ICT dramatically improved the means of people across the world to access, disseminate and utilize information.

The emphasis on creating opportunities to enable economies to catch up with technology, based broadly on trade at more equal terms and economic development, is not accepted universally. Income differences remain huge, and ICT is often used for the wrong reasons and at excessive cost. There are signs of new kinds of challenges and bottlenecks. To gauge the situation more appropriately, and for policymakers and others to help realize potential benefits, it is important to understand what changes are taking place and what factors are pivotal for capturing opportunities and overcoming obstacles.

This paper argues that the increasing interdependence of technology and knowledge transfers is a major feature of the present economic situation. Innovation and ICT are at the centre of the technology revolution under way. Exploitation of new opportunities depends on strengthening mechanisms for promoting demand-side technologies. In contrast, many institutions in developed and developing countries are focused on supply-side initiatives, in both technologies and knowledge generation. Part of the task is to set up conditions to enable stronger and more constructive circulation of knowledge, and put knowledge to more effective use. Seen in this light, the term “absorptive capacity” takes on new dimensions. The interface between the transfer of technology and knowledge and the means of developing local capacity and competence should be reviewed in this light.

**Technology transfers through MNEs**

For some time, technology transfers have been seen as key to the ability of developing countries to catch up with developed ones. As official development assistance stagnated from the 1980s onwards, the sprawling activities of MNEs appeared to be critical for development. As stated by Hymer (1960), Dunning (1977) and others, the importance of MNEs was not because they provided finance, but because they gave rise to transfers of firm-specific assets, notably in the form of technology transfers. The importance of such asset transfers was underlined by the weight of MNEs in research and development, in international trade, and in transforming existing markets and opening new ones.

A variety of issues arises in this context. MNEs may prevent transfer of technologies that would be most valuable for the receiving country. They may maintain control over valuable technologies and prevent their transmission to local actors who possess the capacity to become future competitors. Receiving countries may have limited qualified local labour capable of assimilating the skills transferred to them, besides insufficient mechanisms for workers to put such skills to use in new activities. It is also seen that MNEs have concentrated their operations in the developing world to just a few countries – and that too generally to those that were already the most developed, had the largest domestic markets and were the most competitive exporters.

MNEs too have undergone gradual but extensive organizational changes, covering their structures as well as those of their affiliates. The delineations between home base and foreign operations have become hazy. Presence in foreign markets, which began as sales offices, evolved into manufacturing plants, obtained local development units capable of absorbing and adjusting R&D results originating in home operations, and have usually been granted greater autonomy and responsibility to host local research units and innovation centres.

Interdependence between different nodes of this kind have developed within organizations. Exports from third-country affiliates have increased, as has the number of MNEs that originate from developing countries. The boundaries between the operations that are organized within, and under the control of, the individual company and those that are outsourced within the country or to off-shore locations have become subtle. An example of this is the rise of innovation in open-source-laboratory kind of environment where large players mix with smaller independent ones. In most countries and industries, MNEs and large companies have ceased their dominance over innovation, whereas small and medium-sized enterprises (SMEs), and the role of individual entrepreneurs, have gained in importance.

Innovations differ in nature. Some are, for instance, incremental while others are radical. The introduction
of radically improved solutions does not come easily but their adoption will mean that old ways of doing things, and the champions of those ways, have to give way. Turf-battles, and not-invented-here syndromes, appear in all organizations. Innovators tend to be relatively young, and sometimes they are from outside – or the periphery of – the community whose ideas they are challenging. The case is similar with ground-breaking scientific discoveries.

Facilitating radical progress within an organization may require putting in place mechanisms that allow for the ousting, or neutralization, of the losers or allow them to regroup and regain a strong position through credentials other than those associated with the past practices. Especially in early stages of commercialization of new technologies, genuine uncertainty over the chances of success requires a set-up conducive to risk-taking and experimentation, which may be hard to find within an organization with its established niche and core business area. Hence, a serious effort to try out a particular option for a radically new product often requires a spin-off; that is, the effort of an entrepreneur to take forward in a separate new company what has been set out by an innovator (Acs et al., 2004).

In many cases, the innovator and the entrepreneur are not the same, meaning that the required competencies are not identical and do not reside in the same person. Progress may then require that a degree of trust and mutual benefit can be realized by these different individuals, as well as with those prepared to back their efforts with financial means or in the marketplace. For radical innovations to take hold, there may well be later need of a mind-set change, more broadly in industry and in the market, to overcome inertia and realize opportunities.

A one-sided emphasis on new solutions is likely to be inefficient as the virtues of existing knowledge will be under-exploited. If, on the other hand, heavy emphasis is placed on existing knowledge, there will be marginal improvements, irrespective of whether they lead in the right direction or not (sub-optimization of activities over time). Lock-in effects then lead to inefficiency and decline, reflecting the inability to seek out and embrace solutions that are more radical. In the case of financial systems and modes of corporate governance, these differences have usually been associated with the contrast between a market-based, outsider-friendly system and a bank-based, insider-friendly system. Each tends to display varying characteristics and specific advantages for different kinds of industrial activity (Maher and Andersson, 2002). Empirical evidence suggests that countries with strong market-based systems tend to have higher growth in industries where upgrading of skills is decisive and intensity of R&D is high (Carlin and Mayer, 2002).

**The rising importance of knowledge transfers**

Underlying all these is the observation that value-added chains and economic activities have become more integrated across organizational and national borders. Learning opportunities intensify with the globalization of educational systems and so does the need to interact with and draw upon the most innovative actors, wherever they reside. The most critical innovations no longer originate from R&D, but from organizational changes and new ways of using technologies, synthesising different and complementary forms of technology and knowledge. Such synthesis often needs openness and ability to adjust at both ends of complementary partnerships. In this context, countries adopt new ways to attract and capitalize on internationally mobile technology and knowledge resources. A prime challenge is for nations and communities to build a constructive interface between internationally mobile assets and competence on the one hand, and evolving domestic researchers, innovators, businesses and other actors vital to local knowledge accumulation and application on the other hand.

To formulate appropriate strategies for this, it is crucial to take stock of the changing nature of technology transfer (TT). Traditionally, TT places importance on information and efficiency rather than on knowledge and effectiveness. Often, a TT programme is thought of as a search mechanism that uses technical concepts to transfer technical information and data from the results of scientific research. Implemented with efficiency and speed, information- and data-oriented approach helps develop applications that solve practical problems in products and processes of an industry.

It was long known that TT includes intangible know-how and services, apart from equipment and tangible intermediate and final goods. It has, however, become crucial to understand how TT in the traditional sense best combines with knowledge transfer (KT). KT, which has the potential to leverage the capacity of the recipient to put knowledge and other production factors to action, includes communication and the mobility of people. TT and KT are insignificant without effective absorption, through which the recipient is able to build value-enhancing capacity. TT or KT is more than a communication process. Notably, KT goes beyond what information technology tools can accomplish in a technical sense, and should be measured in terms of its effectiveness in shaping the entire knowledge value chain. Constructive KT is an instrument for capturing synergies within deepening, interdependent processes of knowledge specialization, spanning interlinked relevant components of the knowledge chain.

Together, TT and KT can push the economic performance of a country, a region or an industry to a point where they competently guide the innovation process, which relies on a complex web of relationships. The link to innovation applies not only to significant identifiable technological advances, but also to the discovery process and its imaginative exploitation (Kirzner, 1985). A broad range of competencies that identify, capture, industrialize and commercialize free-flowing technologies and knowledge make KT very conducive to economic growth. The
higher the quality of these competencies, the more likely an entire economy would receive benefits from new venture creations that are superior to the successful reorganization of existing firms. Appropriate combination of TT and KT can thus bring about a self-reinforcing circle of better technical capabilities, higher productivity, economic growth, entrepreneurial activity, and capability to adjust and restructure (Andersson et al., 2009).

**Evolving ICT**

Above all, the changing landscape of today has to do with the evolution of ICT and innovation through a series of steps. The initial computer revolution was followed by a shift from mainframes towards PC and the rise of software packages installed on user PCs. Thereafter came the Internet, the networked computer and increasingly sophisticated mobile phones. The individual PC and mobile handset are now destined to be integrated, and serve as nodes of wider networks. Multiple and intelligent digital functions will allow for more efficient access to software services and applications. Whereas data will most likely reside on remote, large, next-generation data centres, control will be decentralized and user-centric. Software and the Internet will evolve into a universe of inter-connected services, to form an electronic grid in the same way as the electricity grid provides electric power today. As the network grid will provide data and services over the Internet, seamless transition to the physical world becomes essential.

The economic and societal payoffs will depend on the successful integration of the new ICT paradigm into other industries, economies and local communities. To the extent that organizational modes are able to respond, ICT opens the door to two-way communication and more tailor-made and customer-driven applications. Connected to this is the opportunity for firms of relating to, and mobilizing, individual users and customers as drivers of applications and content in their specific context. Meanwhile, technology offers the instruments to enable increased transparency and unprecedented opportunities for newcomers to challenge incumbents, for example, by exploiting geographically diverse niche markets. The importance for innovation of networks and interfaces among smaller, more nimble, highly specialized and complementary units is set to increase for other reasons. Without the burden of huge investments in existing competencies, technologies, equipment and market positions, more flexible and agile actors enjoy crucial advantages compared with colossal organizations marked by vested and rigid power structures. Collaboration within networked communities of largely independent actors may also allow them to combine advantages of small scale at unit level with economies of scale and scope at the network level. The lingering dominance of a few very large firms nevertheless is a huge issue in the digital economy. ICT offers not only potential transparency for customers and newcomers but also helps bestowed existing firms with the information and tools to identify and defy challenges to their market dominance.

The ramifications are particularly stark for developing countries. The Digital Divide – still tangibly manifested in bandwidth, computing power and storage capacity – keeps off large parts of the developing world from the utility of computing and communication. Given the knowledge gap and the need for making progress, the nations lagging behind tend to be stuck with training that accounts for even more lock-in with incumbent technologies and vendors. With the information revolution under way, there are massive opportunities to break such lock-in, improve energy efficiency, increase production efficiency and optimize resource use. For the potential to be captured, government policies and regulatory regimes need to open up for competition, entry by newcomers and new ways of learning.

A complicating factor is that digital communication remains plagued by a set of largely unresolved critical issues. These are mostly associated with cyber-crime and problems with security, authentication, privacy and integrity. As in the real world, user trust in digital communication requires control over information (that is, the means to validate and track data, and to control access to and use of one’s own identity) and, hence, accountability. Across financial services, trade, the health sector, e-learning, etc., the use of ICT is either distorted or held up because of lack of satisfactory functionality in this regard. Technological solutions are available, but organizational models have so far failed to respond. Existing corporate interests suffer to some extent, but also benefit from endless efforts (and excessive costs charged to customers) to try and fix what cannot be fixed. Multi-lateral collaborations, such as the International Telecommunication Union, or regional collaboration, such as the European Union, were not given sufficiently strong mandates from national authorities to craft common positions and objectives, or to allow for brokering of effective solutions. The failures reflect the same complications that have hindered progress in achieving common or consistent frameworks for the protection of intellectual property rights. Under such conditions, accelerating decentralization of budgetary responsibilities and decision making have contributed to the issues we now associate with the greatest financial bubble ever seen.

**Governance and university reform**

Many see universities – rather than MNEs – as representing the greatest hope for achieving platforms capable of harnessing TT and KT in a local context. These mainstays of academic excellence are increasingly called upon to show an orderly way forward towards the knowledge-based society. Such hopes are connected to multiple pressures that emanate from:

- Rapidly changing needs in society and in industry, with both big businesses and SMEs calling for attention to their needs;
- Changes in the student population, with increasing number of mature, more aware and more demanding students;
- The increasing demands for lifelong learning and learning in the workplace;
Opportunities for online education;
Internationalization of market for higher education and of faculties;
Dwindling access to public funding, under the pressure of health or financial sector reform;
The non-given role of universities as incumbent amid the challenge posed by alternative players and newcomers;
The growth of the information society and changing mechanisms for generating widely accepted, trustworthy knowledge that undermine the traditional monopoly of the university (Beck, 2003); and
The changing and growing importance of quality assessment and research evaluation systems.

Calls by policymakers for universities to “deliver” are in conflict with the interest of researchers to obtain greater resources with fewer strings attached. There is the argument that society requires independent universities devoted to “basic research” or “free science” as a platform for free thinking and experimentation, as other actors tend to be profit-minded and short-sighted. This will pay dividends notably in the long term. However, there is as much diversity among universities, as there is between universities and research institutes. To fulfil their role in TT and KT processes, universities must embrace and pursue a degree of “specialization”, with focus on “core business” rather than applying a one-size-fits-all approach. Even the “research university” is hardly based on a single model. The relationship between research, invention and innovation is not linear or homogeneous (David and Metcalfe, 2007).

Among the potential contributions of universities, the much-vaunted university channel of knowledge communication is at the intersection between disciplines – and between theory and practice – and is capable of blending rich combinations between complementary competencies. Funding interdisciplinary chairs that focus on both technical and business topics represents an often controversial, yet important, step towards evocative and informative knowledge communication. Linking complementary abilities in science, risk-taking, seed- and venture funding, and entrepreneurship could provide a unique cradle and incubator for fast-growing start-ups. Some of these may be spin-offs from the university (realized by faculty or by students); others would grow out of existing companies operating in the vicinity of the knowledge space, and is nurtured in the university environment. Each local context is characterized by its specific peculiarities, and working out constructive interfaces between different stakeholders requires experimentation and learning. Each university will encounter a particular combination of hindering, or enabling, regulation, tradition and founding principles. By way of illustration, Jönköping University, a young independent foundation university, is one of only three in Sweden not subject to the restrictive conditions of a public authority. In this capacity, it enjoys the atypical advantages of:

- Being able to hold board meetings in English (and thus not being limited to Swedish-speaking board members);
- Starting its own holding companies overnight (rather than waiting for years for the uncertain outcome of government scrutiny);
- Controlling its own premises locally;
- Running its own endowment;
- Employing and determining compensation for senior management independently of the government;
- Arranging with entrepreneurship training in collaboration with its Science Park, generating, by far, the highest numbers in Sweden of new enterprises started by students; and
- Organizing 850 medium and small size companies as mentors for all its business and engineering students (this last advantage emanating not from legal reasons but from a sense of identity).

Of these, the last two points may not be a direct outcome of greater manoeuvring room, but an indirect result of the “mental” boost generated by independence on the other points. Differences among Swedish universities are marginal with regard to the degrees of “freedom” in determining the programme or course content, which professors to hire and on what contracts and what conditions, how many students to engage, how to fund courses or research programmes, what priorities to make in determining research profiles, etc. In many countries, however, the prospects of universities to shape strategies with any “teeth” to them are bleak.

Generally, university governance must be based on strategic capabilities to adapt, specialize and embrace diversity in a knowledge environment (Andersson, 2008). At the same time, autonomy and decision-making capabilities will mean different things to different people. There is no silver bullet, but each university should be able to foster its specific governance model that applies across the range of university functions, including education, research, and innovative and path-breaking relations with wider society that includes big business, SMEs, hospitals, schools, and so on. If universities are to remain prime knowledge producers, and serve as a cradle for innovations with the potential to deliver what is truly novel and useful, they must be able to interpret, activate and respond to the needs of multiple actors. This ultimately includes inspiring openness and readiness to try and adopt new products and technologies, without lacking critical reflection and judgement to help counter herd behaviour and collective failure, including those leading to asset bubbles.

The optimal combination of continuity on the one hand, and that of preempting and adjusting to a changing world, on the other, is bound to vary. Reforms on regulation and funding, promoting student mobility and inspiring more in-depth provision of information should aim to widen the scope for entrepreneurial universities to promote greater diversity, ensuring that increased autonomy accompanies increased accountability. It is thus that an economy can enable universities...
to form a rich set of diverse nodes capable of driving networks in support of demand-led TT and KT.

Concluding remarks

The extent to which countries and societies are able to exploit and benefit from advancing technical opportunities will crucially depend on their ability to attract accompanying KT while raising their absorptive capacity. Of key importance will be the ability to foster institutions conducive to innovation in the new landscape marked by the evolving role of ICT and the empowerment of the user side.

The collapse of the main economic and policy regime of the past decades has brought parts of the world economy close to a stand-still. Current conventional wisdom points to many causes for the financial sector meltdown. Besides the greed, exorbitant remunerations, dysfunctional financial market supervision and the lack of transparency, the financial turmoil was fed by a macro-economic environment marked by high liquidity, mild interest rates and low volatility. Moreover, many stakeholders were ready to accept unwieldy debt-led expansion, not only of the financial sector, but of the economy in general.

The source and the scope of the crisis are such that lasting impacts need to be awaited. These will most certainly lead to fewer sources of risk-willing capital to support experimentation and entry by newcomers into the economy. The potential for usage of new technologies remains unbridled, however, and will be closely related to the nature of KT and how it can be activated to attract new applications.

In general, scope for better performance is hampered by rigidities and lack of openness of various kinds. Basically, progress is held back by failures in governance and learning. At the international (and multi-lateral) level, the mechanisms that broker solutions for international community have proved too weak in areas such as trade, investment, global environment (which forms the very basis for our most precious assets, such as the air we breathe and the water we drink), and such mainstays of the knowledge society as intellectual property rights. In the areas of education and learning, universities tend to look to the past rather than to the future, and to standardize and imitate rather than to experiment and innovate.

At the centre of the financial disarray stands the United States, whose core position in most cross-border TT and KT has been undisputed for decades. The United States is home to the largest MNEs, and its strengths include high investment in R&D and dynamism in the science-industry interface. Relative to other parts of the world, however, its most striking attributes have probably been greater appreciation for entrepreneurship, openness to new and varied kinds of competencies (including those of immigrants), and acceptance of failure as well as success.

It will take time before the macro-economic problems are resolved. We must be prepared for prolonged challenges and review how the micro-institutions and incentives – which are key for TT and KT, science-industry interface, innovation, risk-taking and entrepreneurship – can be designed for the economic landscape that is now taking shape. It is in the midst of crisis that chances for overcoming rigidities are the best. Policymakers should shift from a defensive stance towards searching for the tools required to underpin opportunities for win-win in various forms of cross-border exchange, not least through support of renewal, diversification and better ways of promoting learning, including in governance.

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References