MSM | MAASTRICHT SCHOOL OF MANAGEMENT

Working Paper No. 2013/17

Technological Innovation, Entrepreneurship, and Development

Wim Naudé [1] and Adam Szirmai [2]

Forthcoming September 2013

[1] Maastricht School of Management, UNU-MERIT, University of Maastricht and IZA- Institute for the Study of Labour.
[2] UNU-MERIT and Maastricht Graduate School of Governance, University of Maastricht.

MSM

The Maastricht School of Management is a leading provider of management education with worldwide presence. Our mission is to enhance the management capacity of professionals and organizations in and for emerging economies and developing countries with the objective to substantially contribute to the development of these societies.

www.msm.nl

Technological Innovation, Entrepreneurship, and Development

Wim Naudé[*] *and Adam Szirmai*[**]

Abstract.

What is the relationship between technological innovation, entrepreneurship and development? Is it better for developing countries to coping and adapt existing technologies from richer countries rather than undertake or promote intensive research and development (R&D) of their own? We tackle these perennial issues afresh by considering the relationship between knowledge, innovation and growth in the past and by identifying whether and how the scope for catch-up growth exists. We focus on the interesting case of technological innovation in the comparative economic performance of China; we draw some lessons for development elsewhere.

Key words: innovation, entrepreneurship, development, knowledge, China, BRICS

JEL classification: F23, L52 L53, O25, O40, O33, O34

This paper is forthcoming in The European Business Review, Sept 2013

[*] Maastricht School of Management, UNU-MERIT, University of Maastricht and IZA- Institute for the Study of Labour.

[**] UNU-MERIT and Maastricht Graduate School of Governance, University of Maastricht

1. Introduction: Novelty and New Gadgets

Technologies are 'rules and ideas that direct the way goods and services are produced' (Kemeny, 2010:1544). Technological *inventions* are new rules and ideas about what to produce and how to do it. It results in technological *innovations* when new rules and ideas find practical use through being applied and/or commercialized by entrepreneurs.

Technological innovation contributes to higher levels of economic output and can deliver new goods and services that change human lives and capabilities. According to Lipsey et al. (2005:5):

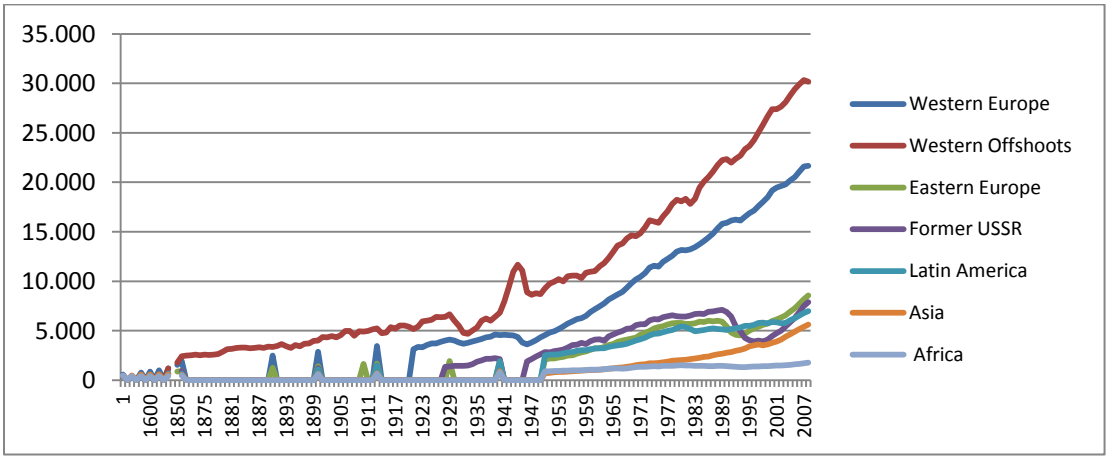
> People living in the first decade of the twentieth century did not know modern dental and medical equipment, penicillin, bypass operations, safe births, control of genetically transmitted diseases, personal computers, compact discs, television sets, automobiles, opportunities for fast and cheap worldwide travel, affordable universities, central heating, air conditioning...technological change has transformed the quality of our lives.

Today we live in a technological 'age' and global economy where competition has become knowledge-based. In modern theories of growth and development technological innovation has taken the centre stage. Our love for novelty and new gadgets is thus based on practical and theoretical foundations. Moreover, there is growing interest in the relationship between technological innovation (and entrepreneurship) and how it can promote global growth and development. In this short overview paper we consider the essence of this relationship. In section 2 we point to the importance of institutions to facilitate innovate, and how this relate to historical patterns of growth. Then in section 3 we asked whether and how developing countries can catch-up in terms of growth and per capita incomes through technology transfer and use, focusing on the case of technological catch-up and development in China. In section 4 we conclude with some policy recommendations.

2. Popes and Patents

Figure 1 provides a comparative overview of long-run development as measured by per capita income the past two thousand years.

Fig 1. Long-run Overview of Economic Development: GDP per capita



Source of data: Angus Maddison at http://www.ggdc.net/MADDISON/oriindex.htm (In International 1990 ***Geary-Khamis Dollars)***

Figure 1 shows the rapid 'take-off' (or "Great Divergence") in development that occurred in the West. Notable 'classic' scholarly works trying to explain this includes Adam Smith's 'The *Wealth of Nations*' (1776) and Joseph Schumpeter's '*The Theory of Economic Development*' (1911); more recent contributions include amongst many others Landes (1999), Diamond (1997), Maddison (2001;2007), Morris (2010) and Acemoglu and Robinson (2013).

There is a consensus amongst these authors on the importance of knowledge, knowledge-spillovers and the incentive structure of societies to encourage and reward innovation and risk-taking by entrepreneurs. Knowledge creation and dissemination was boosted in 12th century Europe when the first universities were founded, roughly contemporaneously with a legal and administrative 'revolution' initiated by Pope Gregory VII. This 'allowed the novelty-seeking and risk-taking capitalists to pursue their enterprise over a larger space' (Lal, 2006:5). The legal and administrative reforms provided stronger protection for property rights and adherence to the rule of law, laying the ground eventually for the idea of intellectual property rights (IPRs), and

the patenting of new ideas. Historians have documented a burst of innovations in Europe following these reforms. For instance Maddison (2001:51) wrote that

> Increased use of water and watermills augmented power available for industrial processes, particularly in new industries such as sugar production and paper making. There was international specialization in the woollen industry...the silk industry was introduced in the twelfth century and had grown impressively in Southern Europe by 1500...There where improvements in mining and metallurgy which helped transform and expand European weapons production.

Today, Europe and its 'western offshoots' remain the most innovative region of the world. Of the roughly 2 million patent applications filed annually, the bulk is from European and USA based firms (WIPO, 2011).

3. Copying and Catching-Up

Figure 1 also shows that other regions of the world have started to catch-up. The rate of catch-up has perhaps been most pronounced in the case of Asia since 1973. Many have argued that poorer countries may profit from the 'advantages' of technological backwardness. Through a process of licensing, copying, reverse engineering and stealing, they can access new technologies without bearing all the costs and risks of investment in new knowledge. Indeed, European countries during the Middle Ages benefited much from copying and reverse engineering of technologies from the Middle and Far East, including from China. As Szirmai (2014, forthcoming) writes,

> In the fourteenth century, China was the most advanced society in the world in terms of technology…. China knew firearms, blast furnaces, gunpowder, hydraulic clocks, magnetic compasses, advanced seagoing ships with moveable sails, navigation techniques, and the arts of printing and paper-making.

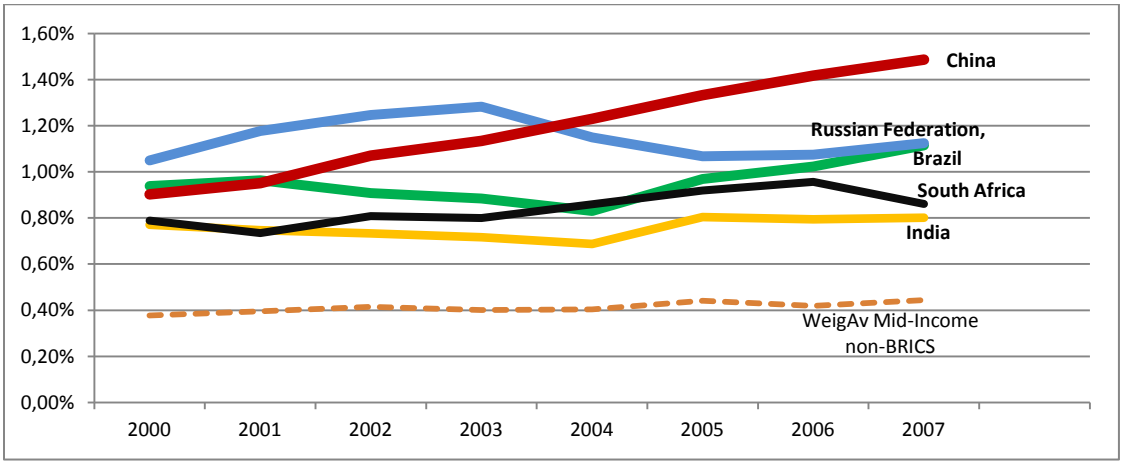
Each of the different 'Industrial Revolutions' in the West have also been driven by adoption – copying - of foreign technologies[1].

The benefits of copying technology in countries at earlier stages of development is that their entrepreneurs can focus on delivering incremental improvements to foreign designs, rather than the risky development of products and technologies that are new to the world. This is a process of innovation that is new to the local market or the domestic firm but new to the world. Once rapid growth is underway, there is a gradual shift - in the most successful countries - to innovation at the frontiers of knowledge. This is largely the story (and present challenge) of technological innovation and development in China in the modern era.

China, together with Brazil, Russia, India, and South Africa are often referred to as the 'BRICS'. China is however quite distinct from the others. Figure 2 shows that in comparison to the others, China has been an outlier in terms of the sharp increase in its research and development (R&D) spending. In China the share of R&D intensive industries such as electronics and aerospace in total exports increased from 2.97 percent in 2000 to 13 percent by 2008 (Fu et al., 2010). Moreover in China the R&D intensity increased from 0.8 per cent in 1999 to around 1.5 per cent in 2007.

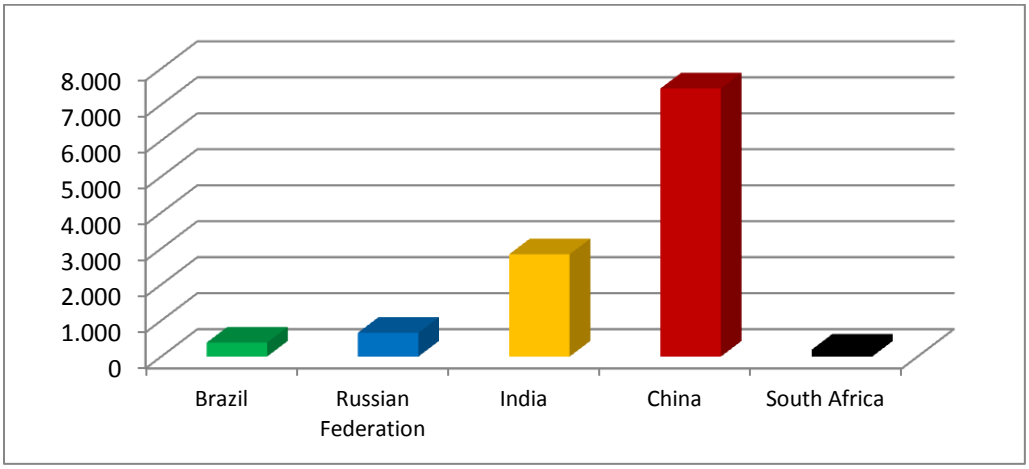
[1] Referring to copying and catching-up Von Tunzelmann (1997:15) writes that "each industrial spurt began by producing products that were already in production elsewhere, with the industrializing countries adopting their more advanced processes to produce relatively established products. The British in the 18th century used machine methods to produce textile yarns and cloths similar in kind to those produced by hand in India…The Americans in the late 19th century took over the principles of steel and chemicals production from Britain and Germany, and through means such as hard driving developed them for mass production. The Japanese a century later imported products like the integrated circuit and rapidly moved towards industrial leadership in products such as DRAMS".

Figure 2: China Rising: R&D Spending as % of GDP amongst BRICS



In contrast, India and Russia only spend as much on R&D now as a decade ago, whilst only Brazil saw a moderate increase. Figure 3 confirms China's primacy in terms of innovation, showing the dominance in patents from Chinese firms registered at the US Patent Office over the 2004 to 2008 period.

Figure 3: China's Dominance: Patents Registered in the USPTO, 2004-2008



Other indicators of technological innovation are consistent with this picture. China is now one of the major producers of wind energy turbines in the world. China Railway Construction spends around a US$ 1-billion on industrial R&D, and by 2009 China's share of world industrial R&D had climbed to 12 percent, second only to that of the USA (WIPO, 2011). At present China

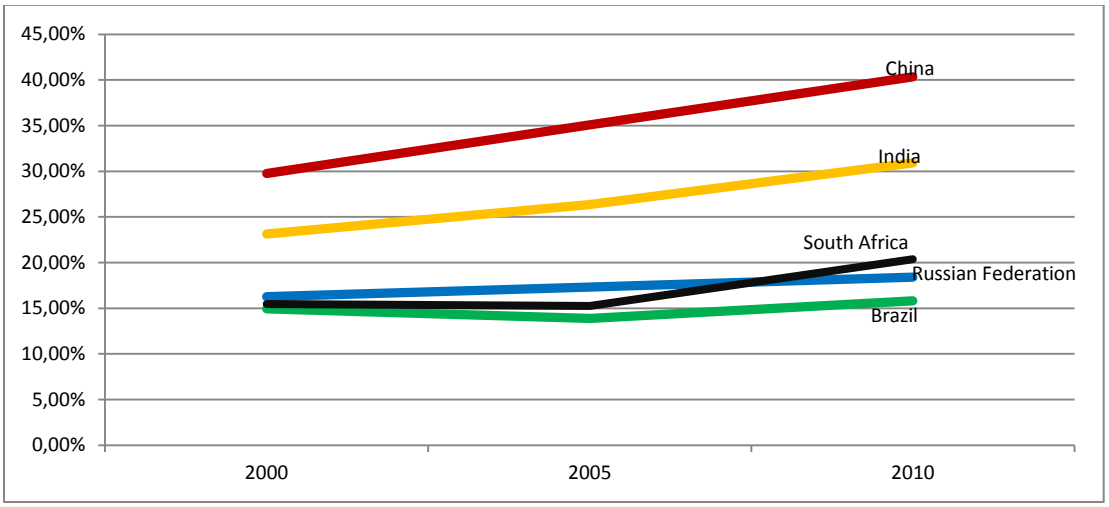
is designing a next generation internet that is “far ahead of anything any other country has at the moment” (Mirani, 2013).

Why has China been much more innovative than the other emerging economies? China’s success lies in its effort to obtain technological innovations from abroad, in combination with its willingness to invest in domestic R&D. It got multinationals to transfer their technologies to the local Chinese context (i) through directly transferring technology to their affiliate or joint ventures (JV); (ii) through promotion of their spillover-effects and (iii) by encouraging multinational firms to specifically develop and implementing technologies through shifting their R&D to the country – setting in motion the internationalization of R&D.

China attracted most of this technology-transferring FDI into its manufacturing sector. Manufacturing is in many ways intricately linked with technological innovation. Manufacturing is by its nature important for knowledge accumulation, and generates positive externalities, including spillovers of information and new management practices, and generates variety. There are currently an estimated 9 billion different variety of goods in production, more than the number of people on the planet (Marsh, 2012).

At least before joining the WTO, foreign investors to China were expected to form joint ventures with local firms, through which technology transfers were facilitated. Huge amounts of FDI for manufacturing never replaced indigenous efforts: the country invested heavily in domestic fixed capital formation (see Figure 4 below).

Figure 4: Investing to Crowd-In Technological Innovations: Domestic Investment as Share of GDP in China and other emerging economies (5-year averages)



Many challenges still remain for China. The country is not yet as innovative as the USA or Europe. Although the numbers of its patents are increasing, the economic value of its patents is not yet comparable (*The Economist*, 2013); its companies are rather known for incremental innovations and imitation. In spite of rapid productivity increases since 1991, there is still a large gap in manufacturing value per person of more than 70 per cent compared to the USA (Szirmai 2014, fig. 4.1, forthcoming).The indigenous innovation system in China is not yet as effective as the MNE-based system (Tang and Hussler, 2011).

4. Concluding Remarks: Absorption and Angels

What are the lessons we can draw from the above for developing countries? The first is that even if advanced economies profit more from innovation than less advanced economies, it does not mean that innovation is less important for the latter. Nor does it imply that imitative or incremental innovation is not worthwhile or somehow inferior. On the contrary, as the example of China had shown, also innovation by copying and borrowing is very important for catch-up growth.

The second lesson is that absorptive capabilities matter. It is "the ability of an organisation to identify, assimilate, and exploit knowledge from its surrounding environment" (Fu et al.,

2010:1210) and is a function of "trust and social capital, sound governmental and non-governmental institutions, human capital development, and managerial and technical competence" (Kemeny, 2010: 1545). Both the speed and the intensity of adoption of foreign technologies are important. Comin and Mestieri (2013) estimate that although the speed at which developing countries adopt new foreign technologies have increased, the degree of penetration of such new technologies have been must faster in more advanced economies. Moreover they estimate that this difference in technology penetration-rates can explain around two-thirds of the differences in the divergence in per capita incomes across the world since 1800.

A third lesson is that the nature of innovation in its relation to growth and productivity changes over time. At some stage as 'the latecomer approaches the technological frontier, its strategies have to shift from imitation to innovation' (Tang and Hussler, 2011:25). This is the fundamental challenge about to face a handful of emerging and middle-income countries, most notably China.

A final lesson is that entrepreneurship matters, and even more so when a country reaches the knowledge frontier (Thurik, 2011; Ács and Naudé, 2013). As a result, policy makers across the world are keen to promote entrepreneurship: especially the small sub-set of entrepreneurs that are really innovative, or potentially innovative. Not all entrepreneurs or firms are innovative. Innovative entrepreneurs require venture capital or "angel' investors. Shane (2009) finds that for the USA angel or venture capital supported created around 10 per cent of all jobs in the private sector in 2003. In developing and emerging economies, angel or venture capital finance is sorely lacking.

In this regard China's experience remains illuminating. Despite the dominant role of state finance a substantial shift has taken place towards entrepreneurial finance. Although still far from adequate China now has more than 1,000 venture capital funds and *ChiNext*, a stock-exchange where new start-ups can raise risk capital (Blank, 2013). After ensuring the absorption capacity of its firms, the Chinese government is now providing them with the 'angels' to support their increasingly risky innovation efforts.

In conclusion, technological innovation is a core driver of development. How nations can harness their knowledge-economies and entrepreneurs to invent and innovate will continue to shape the dynamics of global business and international development in the decades to come, just as it did in the past.

References

Acemoglu, D. and Robinson, J.A. (2013). *Why Nations Fail: The Origins of Power, Prosperity and Poverty*. London: Profile Books.

Ács, Z. and Naudé, W.A. (2013). 'Entrepreneurship, Stages of Development, and Industrialization', (In Szirmai, A., Naudé, W.A., and Alcorta, L. eds. *Pathways to Industrialization in the 21st Century*. Oxford: Oxford University Press.)

Blank, S. (2013). 'The Rise of Chinese Venture Capital', at http://steveblank.com/2013/04/12/the-rise-of-chinese-venture-capital/ (accessed 03-7-2013)

Comin, D. and Mestieri, M. (2013). 'If Technology Has Arrived Everywhere, Why Has Income Diverged?' *NBER Working Paper No. 19010*.

Diamond, J. (1997). *Guns, Germs and Steel: The Fates of Human Society*. New York: Norton & Co.

Economist, The (2013). 'How Innovative is China?', *The Economist*, 5 January 2013, online at http://www.economist.com/news/business/21569062-valuing-patents

Fu, X., Pietrobelli, C. and Soete, L. (2010). 'The Role of Foreign Technology and Indigenous Innovation in the Emerging Economies: Technological Change and Catching-up', *World Development*, 39 (7): 1204-1212.

Kemeny, T. (2010). 'Does Foreign Direct Investment Drive Technological Upgrading?' *World Development*, 38 (11): 1543-1554.

Landes, D.S. (1999). *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor*. New York: Norton & Co.

Lal, D. (2006). *Reviving the Invisible Hand*. Princeton: Princeton University Press.

Lipsey, R.G., Carlaw, K.I. and Bekar, C.T. (2005). *Economic Transformations: General Purpose Technologies and Long-Term Economic Growth.* Oxford: Oxford University Press

Lundvall, B.A., K.J. Joseph, C. Chaminade and J. Vang (eds) (2009). *Handbook of Innovation Systems in Developing Countries: Building Domestic Capabilities in a Global Setting*. Cheltenham: Edward Elgar.

Maddison, A. (2007). *Contours of the World Economy, 1-2030 AD*, Oxford: Oxford University Press.

Maddison, A. (2001). *The World Economy*: *A Millennial Perspective*. Paris: OECD.

Marsh, P. (2012).*The New Industrial Revolution: Consumers, Globalization and the End of Mass Production*. New Haven : Yale University Press.

Mirani, L. (2013). 'China's internet is better than yours', *Quartz,* 29 March, at http://qz.com/68972/chinas-internet-is-better-than-yours/

Morris, I. (2010). *Why the West Rules – For Now*. London: Profile Books.

Shane, S. (2009). 'Why Encouraging More People to Become Entrepreneurs is Bad Public Policy', *Small Business Economics*, 33: 141–49.

Szirmai, A. (2012). *Proximate, Intermediate and Ultimate Causality: Theories and Experiences of Growth and Development,* UNU-MERIT Working Paper Series, 2012-32, May 2012, 76 pp.

Szirmai, A. (2014). *The Dynamics of Socio-Economic Development*.2nd revised edition. Cambridge: Cambridge University Press (first edition 2005).

Szirmai, A., W. Naudé and M. Goedhuys (2011). (eds). *Entrepreneurship, Innovation and Development.* Oxford: Oxford University Press.

Tang, M. and Hussler, C. (2011). 'Betting on Indigenous Innovation or Relying on FDI: The Chinese Strategy for Catching Up', *Technology in Society*, 33: 23-35.

Thurik, R. (2011). 'From the Managed to the Entrepreneurial Economy: Considerations for Developing and Emerging Economies', (In Naudé, W.A. ed. 2011. *Entrepreneurship and Economic Development*. Basingstoke: Palgrave Macmillan.)

Von Tunzelmann, G.N. (1997). 'Innovation and Industrialization: A Long-Term Comparison', *Technological Forecasting and Social Change*, 56: 1-23.