TECHNOPOLICY BRIEF 4

WHO NEEDS TECHNOLOGY POLICY?

Ha-Joon Chang

AFRICAN TECHNOLOGY POLICY STUDIES NETWORK

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ABOUT THE AFRICAN TECHNOLOGY POLICY STUDIES NETWORK

The African Technology Policy Studies Network (ATPS) is a multi-disciplinary network of researchers, policy makers, actors in the private sector and other end-users interested in generating, promoting and strengthening innovative science and technology policies in Africa. With a regional secretariat in Nairobi, the network operates through national chapters in 17 African countries, with an expansion plan to cover the entire sub-Saharan Africa.

One of the objectives of the network is to disseminate research results to policy makers, legislators, the organized private sector, civil society, mass media and farmers' groups through publications, dialogue and advocacy. Among its range of publications are the Working Paper Series (WPS), Research Paper Series (RPS), Special Paper Series (SPS) and the Technopolicy Briefs.

Technopolicy Briefs Series are commissioned short papers written by experts from all over the world specifically to address current science and technology policy concerns and questions in Africa. The briefs are also summaries of technical papers published under our WPS, SPS and RPS written to highlight significant policy recommendations. These briefs are writen with the busy policymakers and non-specialists in mind. The materials are designed for general readership and help advance the advocacy and knwoledge brokerage roles of the ATPS.

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Abbreviations and acronyms

ATPS	African Technology Policy Studies Network
FDI	Foreign Direct Investment
IMF	International Monetary Fund
IP	Intellectual Property
IPR	Intellectual Property Rights
NGOs	Non-governmental Organizations
NICs	Newly Industrialized Countries
R&D	Research and Development
TNCs	Transnational Corporations
TRIPS	Trade-related Intellectual Property Rights
UNESCO	United Nations Educational, Scientific and Cultural Organization
WTO	World Trade Organization

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1.0

Why Do We Need Technology Policy?

1.1. What is technology policy?

In this brief, technology policy is defined as a set of government actions that affect the generation, acquisition, adaptation, diffusion and use of technological knowledge in a way that the government deems useful for the society rather than individuals. However, the legitimate domain of technology policy is a matter of debate.

There is, naturally, a large overlap between technology policy thus defined and industrial policy that is interpreted as a set of government actions that influence the development of private industries to promote society-wide objectives. The overlapping areas include policies, such as research and development (R&D) subsidies to industrial firms, regulation of foreign direct investment (FDI) in relation to technology imports or regulation of technology licensing in designated industries. The area that does not overlap between the two policies include support for "basic R&D", that do not relate directly to particular industries or the management of the patent law and other intellectual property rights (IPR) laws. This means that, while most technology policies can be regarded as part of industrial policy, there are some areas that are unique to technology.

1.2. Why do we need technology policy?

Broadly, there are two contending views on technology policy based on two distinct views of technology and its evolution[1]. The first one, termed the "pro-market view" argues that if left alone, profit-maximizing firms, driven by competitive pressure, will

[1] A more theoretical discussion of the two contending views of technology policy can be found in H-J. Chang & A. Cheema, 'Conditions for Effective Technology Policy in Developing Countries – Learning Rents, State Structures, and Institutions', *Journal of Economic Innovation and New Technology*, forthcoming (2002)

choose and develop technologies that are not only more profitable but also beneficial to society. Behind this view lies the belief that price mechanism provides signals that best match the supply and demand for technologies. Supporters of this view, therefore, argue for a market-based technology policy where the government basically allows firms to do whatever they want in developing and adopting technologies and only intervenes because some technologies are easier to "copy" than others. The market, therefore, does not offer adequate incentives for developing such technologies because the returns from them may not fully accrue to the investor. If the technologies have immediate commercial applications, the solution to the problem is the protection of IPRs, especially through patents that basically grant a temporary (but in practice quite long, usually 20 years) monopoly to the inventors. If they are related to "basic" knowledge, a possible solution is to subsidize the "basic R&D" activities that generate such technologies.

The above is a "possible" reason because in its extreme version, the "pro-market" view would not even accept these interventions. In relation to IPR, for example, in the 19th Century many free-market economists believed that patents were also forms of monopoly and should, therefore, be abolished. The Netherlands actually did this in 1869 and did not revive the patent law until 1912. In basic R&D, there are also free-market economists who believe that even this protection can be provided through far-sighted private sector funding, for example, encouraging the sector to fund basic research in universities.

The alternative to the "pro-market" view of technology policy is the "state-promotion" view that identifies a host of market imperfections especially prevalent in developing countries that dampen the pace of technological innovation and learning. In this view, two characteristics of technology are highlighted – the "tacit" and the "specific" nature. "Tacitness" of technology means that it can never be fully codified into formal instructions. If knowledge, including technical information, is tacit, it can be transferred across individuals and organizations only at high costs. The closely related but separate concept of "specificity" of technology means that it is often developed in an attempt to solve particular problems rather than to establish some general principles. For this reason, technology contains elements of knowledge that are "specific" to the context in it was developed. These two key characteristics of technology imply that prices formed through arm's-length dealings in anonymous markets are often incomplete indicators of the true social value of the technology.

Thus, the advocates of the "state-promotion" view argue that policy interventions are required because of various "failures" in the technology market. In this view, the government should not only protect IPR (and also over-riding them if it is socially desirable) and subsidize basic R&D, but it should also enhance the learning opportunities of firms adopting new technologies, for example, through import protection and preferential government procurement policy. It should also direct technological development and transfer in a way that encourages accumulation of local technological capabilities, for example, by regulating technology licensing or controlling the behaviour of transnational corporations (TNCs). These are policies that go well beyond the boundary of technology policy that is accepted by even the more interventionist member of the "pro-market" school.

Except for some extremists, even pro-market economists would accept that there is need for some technology policy. However, the appropriate scope of such policy can vary across commentators. There is a belief, therefore, that it is more useful to adopt the broader definition of technology policy that is grounded in the "state-promotion" view.

1.3. Is technology policy inconsistent with a market-oriented economy?

Critics of technology policy like to present it as an anti-market intervention by the state. They argue that except in very basic R&D, the market mechanism is able to provide "correct" incentive for the generation, adoption and use of technology. On that assumption, it is natural to conclude that any intervention, including technology policy that restricts the freedom of rational choice of agents from the private sector, is inconsistent with the principle of a market-oriented economy.

However, this is a misleading characterization of technology policy. It is true that some, but not all, types of technology policy, for example, policies on imports of foreign technology may restrict the freedom of certain private sector agents in the short run. However, this can be done in a way that enhances the technological capabilities of the economy thus creating more profit-making opportunities for all and subsequently developing the market mechanism.

There is no shortage of examples where state intervention choked off the generation and the adoption of new technologies. But the mere fact that certain elements in a country's technology policy restrict short run business freedom of certain agents does not imply that it will hamper the development of the market mechanism. Experiences of Japan, Korea and Taiwan prove otherwise. All these countries used strong technology policy that sometimes restricted business freedom of certain private-sector agents but they were still extremely successful in the world market. This shows that an interventionist technology policy may ultimately be more pro-market if it encourages the accumulation of technological capabilities and generates industrial growth.

2.0

What Makes a Good Technology Policy in a Developing Country?

Some Lessons From the Experience of the Developed Countries, Including the East Asian Newly Industrialized Countries (NICs)

2.1. Do developing countries need technology policy?

After discussing general issues on the definition of technology policy, we want to discuss the same subject in the context of developing countries. A major distinction between a developing country and a developed country is that the former is not capable of independently generating new technological knowledge. This is a general statement and we cannot deny that there are some scientists in developing countries who have made some path-breaking discoveries or that many technicians in developing country have devised small but significant improvements in imported technologies. However, it is fair to say that the difference between developed and developing countries is the ability of the former to generate new technological knowledge. Once we accept this characterization, a pro-market economist may argue that there is virtually nothing that the government of a developing country can or should do in technology policy. Why is this?

We recall that the only technology policies that a pro-market economist will recommend are the protecting of IPR and subsidizing basic R&D. However, in developing countries where there is little ability to generate new knowledge, there is little basic R&D in the private sector to subsidize. Likewise, governments in these countries may protect patents and other IPRs but this will not be important because domestic firms will not generate much patentable knowledge. Most of the technologies that firms in these countries can profitably import and use may be “old”, therefore, rarely protected by patents. If this is the case, there is very little that governments in developing countries can do in protecting IPR.

2.2. Technology policy in developing countries

Does the above argument mean that there is no room for technology policy in developing countries? Not necessarily. Once we accept the insights that inform the state-promotion view, acknowledging a much wider set of "market failures" in technology, technology policy becomes important even in the context of the developing country for a number of reasons.

A. Research and development (R&D)

First, the fact that technology has tacit and specific elements means that even firms that are using "old" standardized technologies imported from abroad and, therefore are not patented, may have to adapt those technologies to the local conditions. For example, Japanese textile producers in the late 19th Century were compelled to adapt textile machines imported from Britain to suit the generally lower humidity in the country. Another example is the relatively high price of metals in the early days of industrialization that made producers in Eastern Asia to substitute some parts of imported machines with locally developed wooden spare parts.

The need for technological adaptation is so great that even until the 1960s, when Japan was already an industrialized country, about one-third of Japanese corporate R&D expenditure was devoted to understanding and adapting imported technologies rather than developing original technologies. This means, therefore, that even at the relatively early stage of economic growth, developing countries need to acquire some R&D capabilities that will allow them make rational adaptations. The absence of such capabilities was one reason why early post-colonial technology transfer did not work well in many countries. During that time, some machines imported to developing countries could not work well because the people lacked the capability to adapt them to local conditions.

B. Education

When we talk of developing technological capability, the usual reaction will be about increasing investment in education. There is no dispute that investment in education is important in building technological capability. However, the question is what kind of education?

Except at the elementary level, education can, and needs to be specialized. Industrial strength of Japan that followed the German example owes a lot to the large number of skilled workers produced by technical high schools. The experiences of Japan and other East Asia countries show the importance of controlling student numbers and funding different university departments according to the overall industrial development strategy. For example, there is little point in channelling money into electronics engineering departments of universities when a country does not have an electronics industry, unless it has an explicit plan to develop the industry as was the case of Korea and Taiwan in the 1970s.

C. Training

In addition to education, training is also necessary for building technological capabilities. The industrial strengths of Japan, Korea and Germany are founded on the existence of extensive high-quality training facilities. Training can be offered in-house or externally, and different countries have combined the two options. In Germany, for example, external training and skills certification system have played a more important role than in-house or on-the-job training used in Japan, where in-house training and re-training has been important in developing technological capabilities of the employees. Korea falls somewhere in the middle, although closer to the Japanese end of the spectrum.

D. Infant industry promotion

Technological capabilities created through investments in education and training are embodied in individual workers. However, technological capabilities that are embodied in the firm through the rules and routines of the organization go beyond the capacity of individual workers. The capability of the firm, therefore, is more than a collection of that of the employees. Such capabilities can only be accumulated through production experiences that the firm employs to improve its rules and routines. Therefore, the development of technological capabilities at the firm level is critically dependent on the amount of production experience that the firms can have.

The key problem, however, that firms in developing countries face when they try to build up new technological capabilities through production experience in new areas

is that some firms in the more developed countries are more productive, making the accumulation of any production experience impossible. This means that some kind of infant industry protection is necessary for the firms in developing countries to have breathing space to accumulate experience in new areas.

Infant industries can be protected through tariffs and other trade restrictions, explicit and implicit subsidies, appropriate restrictions on TNC activities, or preferential treatment of domestic firms in government procurement. This, for example, is said to have been important in the early development of Japanese computer industry. From the 18th Century, when Britain was technologically behind Belgium and the Netherlands, through 19th Century in USA where the infant industry argument was first systematically developed, down to the late 20th Century in Korea and Taiwan, virtually all successful developers have done this to develop new industries[2]

E. Intellectual property rights

Until recently, IPR issues have been considered less important by developing than in developed countries. On the one hand, domestic IPR laws were considered unimportant since there were relatively few R&D activities in developing countries that could generate patents or valuable trademarks. On the other hand, developed countries had been relatively relaxed towards the infringement of their patents and trademarks by developing countries until in the1980s.

However, IPR issues have become critical for developing countries from the late 1980s because of the trade-related intellectual property rights (TRIPS) agreement in the World Trade Organization (WTO) that is forcing developing countries to adopt the pro-patentee IPR laws that are widely used in the developed countries. This, however, has not changed the truth that IPR issues are still relatively insignificant for developing countries as generators of new technology. However, in their status as adopters and users of new technology, the picture has dramatically changed.

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[2]The only exceptions were Switzerland, the Netherlands, and Hong Kong. For further details, see H-J. Chang, *Kicking Away the Ladder – Development Strategy in Historical Perspective* (forthcoming, May, 2002, Anthem Press, London), especially chapters 1 and 2.

A number of issues have come to light as a result of the TRIPS agreement. The first one is the protection that developing countries, as the final consumers of technology, are offering to the owners of intellectual properties (IP), for example, patents. As observed in the debate surrounding the AIDS/HIV drugs, this can have a serious effect on general welfare of these countries. Another issue is the theft of traditional knowledge that has been made easier by TRIPS. Companies in developed countries are actively scouring the developing world for useful traditional knowledge for which there is no proprietary claim and, therefore, can be patented without any legal problem. Finally, with the tightening of patents and other IPR protection, it now more difficult for developing countries to acquire technology through reverse engineering and adapt it to local conditions.

Others

There are a host of other reasons why developing countries need technology policy. These include:

- promoting innovation
- promoting agricultural productivity
- advancing industrialization
- alleviating poverty
- spreading the gains of technological revolution including the information communication revolution
- encouraging environmentally friendly and sustainable development activities
- promoting a clean environment

F. Summary

The scope for technology policy in a developing country is much wider than what is conventionally perceived. The conventional view on technology policy narrowly focuses on basic R&D and patents but they are not important for developing countries. From this view, it is frequently argued that there is little need for technology policy in developing countries. However, once we recognize the tacit and specific nature of technological knowledge that leads us into the state-promotion view of technology policy, we are compelled to widen our definition of technology policy to include those that influence the development of technological capabilities. These include policies that concern technological capabilities of individuals, for example, education and

training (external and in-house) and those that concern the development of capabilities of firms, such as trade protection, subsidies and government procurement policies. Finally, following the TRIPS agreement, more attention needs to be paid to IPR issues.

3.0

Technology Policy for Africa

Below, some lessons for Africa are drawn from the preceding discussions. Africa comprises countries at different levels of technological development, from South Africa that, in several industries, is near if not exactly on the world's technological frontier, some countries that are yet to start serious industrialization. Therefore, the discussion inevitably involves over-generalization and simplification.

3.1. Research and development (R&D)

Most African countries are in the early stages of industrialization and they need to develop basic technological capabilities, first, rather than investing money in R&D activities. However, this does not mean that they should not engage in R&D. As mentioned earlier, developing countries still need some R&D activities to effectively absorb and adapt imported technologies. In some areas, for example, certain crops, tropical diseases, among others, African countries may have to undertake some R&D because firms in the developed countries who have the capabilities may consider the African market too small to justify the R&D outlays. The fact that pharmaceutical companies in the developed country are spending more R&D money in slimming than malaria drugs confirms this.

If developing some R&D capabilities is necessary, organizational and incentive structure that face various R&D institutions in African countries will have to be reviewed. Given that most of these institutions are public or semi-public, there has to be a firm government initiative to maximize returns from investments in these institutions. Although organizational reform may be important, the quality of R&D personnel will have to be enhanced. This factor is tied to improving tertiary level education. Improving R&D capabilities is not likely to be a priority for most African countries and, therefore, other issues like IPR, education, training and promoting infant industries are likely to be the core of their technology policies.

3.2. Education

To improve education, African countries should emphasize specialized technical education especially at secondary, followed by tertiary levels other than raising the general level of education because, by historical standards, general educational achievements in many African countries are not exceptionally unfavourable.

Between 1860 and 1870, for example, Norway, Spain and Italy were at similar levels of economic development (measured by the admittedly imperfect per capita income) with Kenya, Uganda and Côte d'Ivoire of today. However, the former countries had literacy ratios of 35%, 25%, and 20% respectively, while the latter had literacy ratios of 78%, 40%, and 62% in 1995 (all the following African figures are for 1995). There may be African countries that are doing rather poorly on this account by historical standards, for example, Senegal (33%) and Benin (37%) have literacy ratios that are a bit lower than European countries, such as Sweden and France at 55% of the mid-19th Century at similar levels of income. However, there are also countries that are doing exceptionally well by historical standards. Lesotho, a country at a similar level of development to that of Senegal and Benin, with 71% literacy ratio, outdoes France and Sweden by a substantial margin and far outstrips Austria (30%). Zimbabwe (85%) does much better than USA (65%), the Netherlands (70%), and Belgium (50%) who, in mid-19th Century, were at similar levels of development as where Zimbabwe is today.

Literacy and other basic skills are worthy in itself, but only in its value for economic growth. It is fair to conclude from the above statistics that many African countries do not need to radically increase their spending on general education. What African and other developing countries need more are "skilled workers" trained by technical high schools and on-the-job and well-designed in-house training programs. Such workers are considered to have been crucial in helping the industrialization of Japan, Germany and Korea. Unfortunately, there is virtually no mention of the need to train more skilled workers in the numerous discussions on human capital that litter development literature. In the annual *World Development Report*, the institution publishes the number of scientists and engineers in R&D but provides no statistics on categories, such as technicians and skilled workers.

African countries need to strengthen technical education in systems based on British or French curricula that put little emphasis on the subject. Given the technological requirements that face most of these countries, except South Africa, the focus needs to be on the secondary level. Introducing compulsory technical education in all secondary schools, like Korea did in the 1970s and the 1980s, or establishing German-style technical high schools (later used by the Japanese and the Koreans) can also be examined.

Emphasizing the importance of technical education at the secondary level is not an argument for ignoring problems facing universities and other tertiary educational institutions in Africa. Raising the quality of tertiary education that is incomplete in Africa is important even simply for producing good teachers. According to the United Nations Scientific, Educational, and Cultural Organization (UNESCO), while the enrolment ratio (percentage of age groups) at the primary level for sub-Saharan African countries was below average for developing countries (78% vs. 91%) in 1995, at the tertiary level, it was only about one-quarter of the average for the same countries (2.9% vs. 11%). Moreover, the content of university education is also highly biased against technical subjects. For example, by mid-1990s, South Africa produced 5 to 6 times more university graduates in humanities and social sciences than in natural sciences and engineering, whereas the ratio for Korea was around 1:1.5. This means that African countries not only need to invest more in tertiary education but they also need to re-direct efforts towards technical subjects.

3.3. Training

African countries also need to invest more in industrial training. Research show that industrial training in Africa is highly deficient even in the more industrialized countries like Zimbabwe and South Africa. Policies that need to be contemplated and have been used by more successful countries include:

- introducing compulsory training for workers in large firms
- subsidizing industrial training
- establishing public training institutions
- introducing German-style public skill certification system

The public certification system will increase the incentive for workers to invest in training by making it easier for potential employers to recognize their skills.

3.4. Infant Industry Promotion

In addition to enhancing technological capabilities at the individual level through better education and training, African countries need to find ways of enhancing capabilities at firm level by allowing the promotion of infant industries. Tariff protection is the most obvious tool for infant industry promotion, but it is not the only or even the most important means that can be used. There are many other tools that have been used successfully. They include:

- export subsidies
- tariff rebates on inputs used for exports
- conferring of monopoly rights
- cartel arrangements
- directed credits
- investment planning
- control on the activities of foreign companies (e.g., ownership restrictions, local contents requirement, export requirements)
- preferential treatment of national firms in government procurement policy

Two caveats need to be made. First, as experiences show, infant industry promotion policies do not guarantee successful development of firm-level technological capabilities. In many developing countries, it degenerated into the cushioning of inefficient industries. The success of Japan and other East Asian countries in application of these policies have indicated that they are not realistic. They need to comply with overall national technological capabilities and, above all, be based on the ability and the willingness of governments to discipline the recipients of their support in case they do not deliver the results. Policy failures need to be quickly admitted and problems rectified.

Many people argue that the African countries should not use active infant industry promotion policies because they do not have an effective state of the kind described above, but this is an overly negative attitude. State reforms may be necessary in many African countries and it is possible to achieve them, for example, until the 1940s and

the 1950s, respectively, many contemporary observers regarded Taiwan and Korea governments as basket cases of corruption and incompetence. It is only through continuous political and administrative reforms that these countries built effective states. While it is necessary, in the short run, for African governments to calibrate their intervention strategy according to their political and administrative capabilities, it should be emphasized that such capabilities and other social actions can be changed through deliberate actions by governments.

The second caveat that applies to the proposal for infant industry promotion policies to enhance firm-level technological capabilities is that many of the recommended policies are frowned upon today, if not actively banned, by donors and international organizations like the WTO, the World Bank and the International Monetary Fund (IMF). The best examples include:

- tariff protection for infant industries
- local contents requirement for foreign companies through the TRIPS agreement of the WTO
- preferential treatment of national firms in government procurement
- export subsidies (through the WTO subsidies rule)

In the short run there is little that individual African countries can do to change these policies. However, all the exemptions and loopholes that exist need to be exploited, for example, agricultural subsidies and others available to depressed regions are acceptable to the WTO and like many developed nations, African countries should use them to the maximum. Regional subsidies, especially, can be linked to the newly developing practice of industrial "clustering". Those who qualify as the least developed countries in the WTO provision should also exploit their exemption from the ban on export subsidies to the maximum to enhance the production experiences of their firms.

More importantly in the long run, African countries should work together with other developing countries and civil society campaign groups to change WTO rules and other elements in the current global governance regime. The success of the African group in the recent WTO ministerial talk in Doha on drug patents and agricultural market access is a positive example that even the weakest countries can influence international policy agenda if they work together on the basis of an intelligent campaign strategy.

3.5. Intellectual Property Rights

For the African countries, the most important task is to convince the world that patents and other IPRs are socially-conferred monopoly rights and, therefore, can and should be over-ridden when they harm the greater social good, for example, the case of AIDS/HIV drugs. The TRIPS agreement acknowledges this matter because it allows compulsory licensing. In practice, however, there are many procedural difficulties and political pressure on countries not to engage in compulsory licensing except the powerful countries, for example, the 50% discount that the US government extracts from Bayer for the patent of the anti-anthrax drugs by threatening to use compulsory licensing. If this undesirable situation is to change, African countries, as the main victims of the AIDS/HIV epidemic, should lead the campaign to support the view that legally-endowed monopoly that accompanies patents and other IPRs can be justified only when the benefits they generate by creating new knowledge is more important than the costs they impose by exercising monopoly.

African countries also need to campaign for an international regulation on the theft of traditional knowledge. As some of the major sources of untapped traditional knowledge, they have a great stake in establishing rules on the ownership and the use of these resources. It is possible to think of a solution where developed countries are compelled to make TRIPS more advantageous to African countries as a compensation for the benefits that they had derived from free use of the traditional knowledge.

Finally, African countries and other developing countries need to push for revision in TRIPS so that they can easily adapt imported technologies. All developed countries progressed on the basis of often illegally importing advanced technologies and adapting them to local conditions. The governments of virtually all these countries openly sponsored industrial espionage, while many of them offered very weak or no protection to foreign IPRs. Developing countries should emphasize that preventing them from following a similar path is depriving them of a key instrument for economic development.

4.0

Conclusion

There is little that developing countries, especially poorer ones like most African countries, can do about technology policy if it is narrowly defined in basic R&D and intellectual property rights. However, once we accept a broad and more realistic definition of technology policy, there are many things that the poorer African countries can and should do, such as:

- developing some R&D capacities and improving the governance of R&D institutions
- improving the quality of the workforce by investing more in training and technical education at the secondary levels
- enhancing technological capabilities of firms by enabling them to have greater production experience through various broadly defined infant industry promotion policies

With the TRIPS agreement, these countries now need to be more proactive in dealing with IPRs issues, although most of them will involve collective action among developing countries on the international scale. All these policies need greater resources, better organization or even political and administrative reforms to succeed. Some of them will require changes in the international rules of the game. However, none of these difficulties are insurmountable and there is a wealth of experience from Europe, North America, and East Asia that African countries can draw from to devise an effective technology policy that is adequately calibrated to meet their material, technological and political conditions. There are also new actors, especially non-governmental organizations (NGOs), such as the African Technology Policy Studies Network (ATPS) whose help the African countries can enlist in developing new technology policy. It will not be an easy task, but failure to do so will hamper industrial recovery and development in the continent for even longer. Time for more aggressive and lateral thinking has arrived.

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Professor Ha-Joon Chang works at the Faculty of Economics and Politics, University of Cambridge

For more information this series and ATPS Contact:

The Executive Director
The African Technology Policy Studies Network
3rd Floor, The Chancery, Valley Road
P.O. Box 10081 00100 General Post Office
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Tel: +254-2-2714168/092/498
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