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# Subtle Mechanisms of growth: technology and economic growth[1]

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**SUMMARY**

This article discusses the obstacles faced by developing countries in obtaining economic growth. Passivity in technological learning, a large productivity gap in relation to developed economies, dependence on spurious competitive advantages and the reproduction of technological underdevelopment are presented as challenges to be overcome. The author argues that breaking with the passive strategy is the only way for these countries to build a better future.

**KEYWORDS:** technology; economic development; public policy; developing countries.

The search for the reasons behind economic growth is an ancient challenge. In less scientific versions the tendency was to locate its source in a precious object endowed with magical properties. Some of the more famous ancient accounts conferred such powers to the Golden Fleece, the Holy Grail and even the Elixir of Long Life. Almost always, though, the excitement of these finds dissolved into disillusion. In ancient Greece, to obtain the Fleece, Jason relied on the help of Medea, the woman he had taken as a wife in a somewhat stormy marriage. Jason exchanged Medea for another princess. And in revenge Medea killed not only her rival but her own two boys by Jason.

The future that had appeared shining and radiant with the Fleece transforms into the gloom of disappointment. Sadly the same plot is frequently encountered in economics.

In the post war period, economists from distinct lineages developed theories to explain the reasons for such a high degree of contrast between countries and peoples. As in the fables, these analysts frequently announced miraculous keys that would open the doors to transforming the poor countries into the rich and prosperous nations of the North.

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But why *are* some countries rich and others poor? This simple question never ceased to inflame government meetings and perturb academia. For decades and decades. It suffices to re-read the first writings of Adam Smith or Marx, peruse Schumpeter's books or delve into Keynes's proposals to sense the importance of the theme. The need for social revolution as a means of overcoming underdevelopment and for investment in infrastructure, education, population control, donations and reforms of every kind have all already been identified as solutions to the impasse. But in most cases these have simply functioned as gateways to new and more complex problems, since poor countries have usually had little success in their pursuit of growth. With rare exceptions, the countries of Africa, Latin America and the Middle East have only experienced economic growth as an aspiration. And economic and social development, as the condition for creating and exploiting opportunities, has only became a reality for the few, small islands of prosperity amid widespread poverty.

The reality is that, despite the theoretical and practical advances achieved by economics, statistics and econometrics, the subtle mechanisms behind economic growth continue to be shrouded in mystery.

In its better moments, the capitalist economy can be seen as a machine for producing economic growth. However this economic growth is also manifestly the source of deep structural contrasts and disparities that have ruthlessly marked the lives of peoples and countries since the first Industrial Revolution. Angus Maddison, one of the most important researchers of long-term economic and social processes recorded that 250 years ago the difference in per capita income between the richest and poorest country was roughly 5 to 1. At the end of the 1990s this ratio was 400 to 1.

As in myths, the recent history of nations is not always a happy one. But there is still space for hope. This is because, in terms of income divergence trends, there are innumerable examples of underdeveloped countries that, at distinct moments, have succeeded in reducing their distance from the more advanced countries. Economists are far from unanimous in explaining the reasons that enabled these feats, and indeed the task remains a special challenge for social scientists.

How did they progress? Why have some nations grown more quickly than others? How important were investment and labour? What role did scientific and technological development play in their trajectories?

These kinds of questions come to the fore because, as we all know, poverty and social inequality can increase with economic growth. Ravallion's studies of dozens of countries over the course of the 20$^{th}$ century show that there is no guaranteed trend towards a reduction in the inequalities provoked by economic growth. At the same time, though, obtaining economic and social development and a consequent reduction in inequalities and poverty is extremely difficult without growth. This is why the pursuit of growth remains a challenge to hearts and minds. Poverty is clearly not limited to a mediocre Gross Domestic Product (GDP). It is also expressed in infant

mortality rates, low life expectancy, cultural alienation, racial and gender persecutions, a despotic treatment of differences, and the re-emergence of previously eradicated diseases.

Recent advances in all these areas have been achieved by countries such as Korea, Taiwan and Singapore. Despite its widespread problems and cultural differences, China's explosive growth over the last 25 years has managed to remove around 400 million people from below the poverty line, one of humanity's biggest achievements.

These new realities have generated a wave of debates. They provide space for new interpretations. And they have stimulated discussions on the medium and long-term strategies of these countries. The more attractive strategies, I believe, relate to the long-term choices. These generally emphasize that the mechanisms underlying growth have little of the spontaneous, automatic or natural about them. They are choices that undermine the idea of the economy functioning independently of society, as if natural laws operated to ensure an overall equilibrium.

Apart from being healthy, this type of debate on strategies allows the revitalization and redefinition of public policies as a noble activity, the place of the common and the relevant, as Hannah Arendt would say.

For an entire generation of researchers (like Richard Nelson), these evolutions were described as catching-up processes. In the 1970s some Asian countries, following Japan's example, developed in very different directions from those identified by some analysts as a supposed natural tendency for nations and peoples to converge in terms of income, productivity and even institutions. We saw everything in those countries – apart from any expectancy that the mere functioning of the economy could enable them to overcome centuries of underdevelopment.

The idea of catching-up was central to these strategies. As a concept it refers to a country's capacity to reduce the distance separating it from the leading nations. Catching-up is the opposite of the idea of 'convergence.' The latter, by contrast, takes the form of a hypothesis, emphasized by the neo-classical mainstream of the economy, which claims that the confluence of nations towards a common level is an almost natural outcome of capitalist development – so long as the economy of underdeveloped countries is organized according to the rules of the advanced nations.

However, the data analyzed by William Baumol, Robert Boyer and Suzane Berger, among others, has shown that even in the best hypotheses a convergence in income and productivity would only ever be a reality for some countries and, even then, for limited periods of time. Moreover, the uninhibited actions of some Asian countries presented a counterpoint to economic orthodoxy, distorting prices, protecting companies and industries, selecting sectors, defining scientific and technological priorities, setting export goals and incentives – all strategies controlled by institutions bearing zero similarity to those of the Northern countries.

Where the general laws theoretically claimed to direct the economy have proven flawed, history, sociology and politics are needed as irreplaceable analytic perspectives and instruments.

Indeed the Asian examples have led to growing recognition within the history of modern capitalism that the extensive processes of learning, innovation and producing scientific and technological knowledge and training were at the root of the widely different performance of some countries. Here my intention is not to pick out the Asian Tigers as a model, but to highlight long-term processes and try to understand how they may be fundamental to overcoming social and economic underdevelopment and enabling countries to 'catch-up.'

In the 1970s, the Asian Tigers, despite their differences, shared a relatively similar view of the place that knowledge should occupy as a baseline enabling the emergence of new economic and social structures. These countries learned – not without difficulties – that differences in people's qualities of life, the success of companies and the development level of nations depend greatly on the form in which they produce and utilize scientific and technological knowledge, as well as processes of innovation.

Despite the air of mystery, the State's fundamental intermediation in stimulating this process and the technological choices made led to long-term economic growth. In 1956 Robert Solow had already highlighted technology as the only source of economic growth over the long-term. But even in his case, technology continued to be viewed as a component outside the economy's normal mechanisms.

The Korean leap forward made it transparent that intensive investment in producing and manipulating knowledge can introduce more explosive economic dynamics, dynamize and raise labour productivity, increase the quantity and quality of goods and services available to populations, and generate new and better products or services capable of extending the range of human needs met by the productive processes. Nothing magical or mysterious. In a sense, the Asians learnt from the countries of the North – not from their recommendations, but from their history.

During most of the 19$^{th}$ century, England, then the world's workshop, presented a growth rate 50% higher than the average of other advanced countries at the time. The responses adopted by the United States and Germany gradually reduced this distance through the development of strong industrial policies designed to enable future growth. Sustained by their respective States, these countries developed consistently innovative processes for organizing production and distribution. In the United States this movement led to mass production with large economies of scale. In Germany this drive was at the root of the emergence of the chemical industry and the country's systematic Research and Development (R&D) activities. As an experience closer in time, Japan's rapid recovery in the post-war period was based on the organizational and technological innovations achieved by its major companies. The quick citation of these examples serves to call our attention to the broader way in which the question of technology has been treated,

encompassing organizational, processual and even border innovations. Hence there was never a single recipe. The key premise was respect for the national background, since those strategies that proved successful were backed by history and enabled experimentation processes driven by institutions. These countries dared to experiment based on their history and accumulated knowledge and discovered their own path forward.

We might be tempted to adopt Alexander Gerschenkron's view of Asian economies, agreeing with him that, as well as the emphasis on technologically more progressive industries, the State performed a paramount role in defining the systems of incentives and support for industrial progress. But we can also be guided by the insights of Schumpeter, who published almost 100 years ago one of the most important books on the economic importance and significance of technological innovation. In his *Theory of economic development* (1911), Schumpeter described how some business leaders sought to introduce innovations into their companies as a way to obtain lower costs than those of competitors, or to manufacture new, differentiated products that gave them a market advantage. In a simplified form, this continuous search by innovative companies for a better market position and a better ability to respond to competition is at the root of the profusion of imitative processes that shape the overall motor of economic growth. Schumpeter, however, never concealed his fascination for inventions capable of provoking ruptures and enabling the emergence of large and powerful companies. From this point of view, his approach was imbued with an almost heroic vision, as Nathan Rosenberg and Richard Nelson pointed out more than sixty years later. The best approach is undoubtedly to produce new syntheses.

Conventional economic theory – which dominated the training of most economists and exerted the biggest influence on western economic policy from the end of the 19$^{th}$ century – was, unlike Schumpeter and the tradition he founded, incapable of incorporating and identifying the importance of technology, seen and understood as an element outside the growth process. Some fifty years ago the first attempt to identify the sources of economic growth were undertaken within this theoretical model. But the thermometer of the quantitative models, despite indicating that capital and labour increases could explain only a small proportion of long-term growth, left out any inquiry into the latter's origin, since technology was absent from the list of factors traditionally seen to determine economic performance. With the advent of new growth theory and the contributions of Paul Romer, recognition grew that intangible processes and factors have a strong influence on the economy. Despite these advances, the movements of producing and disseminating new knowledge and stimulating constant innovations – now perceived to be critical to economic growth – were still unable to find an adequate analytic structure for technology.

The sophistication of much of the research has helped shed light on these processes. In a recent World Bank study coordinated by Carl Dhalman (2004), including data on 92 countries spanning the period from 1960 to 2000, it was concluded that knowledge is the most important determining factor of long-term economic growth. The variables associated with the stock of human capital, levels of innovation and technological uptake, as well as those relating to the infrastructure of

information and communication technologies, were considered especially significant in terms of explaining long-term growth. By taking the number of US patents granted to residents of specific countries as one of the indicators of the innovative performance of their companies, Dhalman showed that each 20% increase was associated with an average 3.8% increase in the yearly growth of GDP of the countries in question.

Similar research by the Organisation for Economic Cooperation and Development (OECD 2004) confirmed that the per capita income levels of more than fifty countries did not automatically converge and that technical progress could not be explained if kept separate from the economics of growth. These studies found that those countries that developed products or processes that were innovative by global standards obtained extraordinary competitive advantages. Their innovative products (or those produced through innovative processes) encountered no direct competition on the market. New products almost always enjoy markets willing to purchase rising quantities and to pay relatively high prices for them. This is the basis of the competitiveness of the economies concerned. And it is this advantage that enables them to maintain higher living standards and fund the continual research needed to ensure leadership in innovative processes.

These studies help us comprehend the dynamic of advanced countries and sharpen the reflection on our own reality in Brazil. A reflection that continually imposes and reimposes itself as an invitation for the participation of the social sciences, whose timid production in the area over the last fifty years almost entirely abandoned the topic, much to the delight of economists.

The movement to reinvest in this reflection, though, is under way across the planet and growing in Brazil. This is the effort to place sociology in the vanguard of the social sciences through studies into the factors preventing better economic performance from developing countries and their ability to emerge at global level by generating technological advantages.

We are now aware that the process of technological change characteristic of these counties is basically limited to absorbing and improving innovations generated in other economies. These kinds of approaches deeply condition competitive positions, especially because the markets for their products are usually occupied by competitors already. Products launched later fail to achieve market growth rates similar to those obtained when first launched. And the initial profit margin is eroded by widespread production and the entry of new imitators.

Difficulties are also caused by the form in which technologies are accessed and absorbed by imitating economies, which generally begin production using less efficient technologies. Less efficient basically because whoever generated the innovation usually has no interest in its replication elsewhere or in creating competitors who may help erode profit margins. In these circumstances, even when the imitating countries purchase technologies, these almost always present a degree of obsolescence or have already been modified.

There is more, though. The less efficient use of technologies also arises from the very process of technology transfer. Part of this knowledge is tacit – that is, it is not easily transferred by projects, manuals or codified instructions. For this very reason, transfer requires considerable investment of time and resources to be absorbed effectively. Consequently, even though the imitating country may obtain access to the same technology used by its more efficient competitors, it tends to produce less efficiently until the technology is fully absorbed.

To lessen this gap between the imitating country and the sector leaders, the imitator needs to develop knowledge of the technology at an intense rate to the point of becoming as (or even more) efficient. While the imitators are producing significantly less efficiently than their competitors, they will tend to compensate for this lag by paying relatively lower salaries, providing subsidies, imposing state protection, making predatory use of natural resources, and so on. This is the perverse form of compensation well-known to developing countries.

The problem is that these countries (including Brazil) run the risk of becoming indefinitely dependent on spurious mechanisms for maintaining competitiveness. In other words, pursuing the path of less technological progress becomes a norm. These kinds of strategies end up neglecting investment in technology. And this passivity is unlikely to enable them to generate a true alternative for development.

Although the majority of developing countries remain imprisoned within the confines of passive learning, there are cases of imitators who were or are currently proving capable of achieving successful processes for rapidly, continuously and efficiently absorbing and improving technologies. Active technological learning strategies have allowed some economies to achieve continuously rising productivity and accelerated modernization of their product list. As a result, they have steadily moved towards real competitiveness.

Imitators are frequently banished from the universe of rewards that drive product innovations. Their profit margins are squeezed by relatively high costs. Their exports are often dominated by mature and less dynamic products, meaning that their prospects for growth are always limited.

Moreover, market integration and the advance of competitors means that a stagnant economy cannot remain on the same level and ends up being pushed backwards by the loss of competitiveness. As Alice said to the Red Queen in *Through the Looking-Glass*, in today's world it takes all the running you can do, to keep in the same place.

The structural problems relating to the process of generating and absorbing technologies, as well as their consequences in terms of competitiveness, are some of the more important reasons why imitators find it difficult to obtain high levels of income and equity. As an example, it is worth recalling that wage rises – a key requirement for any effective development process – may remove one of the few competitive advantages of these economies. However it cannot be stressed enough that dependency on low labour costs as a key factor of competitiveness is a long-term

trap. As time passes, new competitors with lower wage costs appear on the international market. One eloquent example is China and its voracious devouring of the markets of emerging countries, including Brazil. Labour-saving technological improvements are also continually introduced, thereby eroding competitive advantages based on cheap labour and pushing wage costs further downwards.

Consequently, a competitive strategy based on low labour costs and ignoring technical progress is, over the long-term, a self-defeating approach to competition, hindering the construction of any real national development strategy.

In this sense, one of the main objectives of industrial policies for emerging countries must be to break the vicious circle formed by a passive technological learning process, a large productivity gap in relation to leading economies, dependence on spurious competitive advantages and the reproduction of technological underdevelopment. Breaking with this passive strategy is the only way for these countries to build a better future.

The fact that advances in scientific and technological knowledge and innovations are currently developing at an unprecedented pace further heightens the threats posed to developing economies by the scientific and technological race. It is worth recalling that more than half of the exceptional growth that took place in the US economy in the 1990s came from industries that had not existed in the previous decade, almost all created and developed as a result of innovations in the areas of electronics, information technology and telecommunications.

Taken as a whole, these changes may also open windows of opportunity for countries like Brazil, so long as we manage to develop systems of technological learning through the definition of incentives, funding policies, political coordination and adequate institutions. Most developing economies lack the minimal support needed to confront these challenges and exploit the opportunities with some chance of success. This is not the case of Brazil, though, which despite its limitations today has the foundations for the construction of a national system of innovation and learning, an infrastructure capable of functioning as a key element in its economic and social development strategy.

We have the differentiating factor of a diversified and integrated production structure. We possess a domestic market of considerable size. A far from negligible network of research and development institutions. A postgraduate system that issues around ten thousand PhDs per year. A scientific production that has grown six times more than the world average over the last twenty years. A competitive aeronautic industry. Competitiveness and market dominance in ethanol production, which, supported by an efficient R&D system, presents an immense possibility for active international inclusion in the biomass market.

In conclusion – and at the risk of offering an ingenuous optimism – I believe that Brazil's future increasingly depends on intensifying its own technological investment to accelerate its growth,

improve its inclusion in knowledge-intensive markets, reduce its inequalities and raise the quality of life of its population.

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