

Off shore deep-water oil exploitation and sugar cane ethanol: a lever for future growth or declining technologies?

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The cycle of social and economic development currently underway in Brazil suggests that the period of structural stagnation that started in 1981 and continued at least to 2003, is definitely over. Economic growth is being underpinned, *inter alia*, by a robust expansion of the internal market, associated with a decrease in both absolute poverty and social inequality, and favourable international markets for agricultural and mineral commodities have boosted exports. Also, Brazil is seen as an international leader in key energy technologies, in the design and integration of complex systems, and in agribusiness. Although the local industry is under extreme pressure posed by cheap imported goods, Brazil is perceived as an important player in the aircraft, automotive, creative, software, mechanical and natural resources processing industries and is displaying robust export performance, even in the conditions of deteriorated terms of trade in these sectors. The combination of a strong internal market and a sound technological base has led to a fairly continuous influx of foreign direct investment in several industries, including manufacturing and low-end services and also noble activities such as research and experimental development. Evidence of internationalization can be seen in the number of local firms that have become multinational enterprises, investing first in South America and Latin America, and then elsewhere.

This positive context has been complemented by a relatively successful transition to a democratic system, and by the establishment of a pool of sophisticated related social and political institutions such as a free press and legislation to protect basic labour rights. Other relevant infra-structures and regulatory frameworks that are attracting admiration from external observers include a well structured

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post-graduate system, and a legislative system that is trying to guarantee and protect the country's ethnic minorities and natural resources (the Amazon and other ecosystems). For these reasons, compared to Russia, India and China (the countries that with Brazil are referred to as BRIC), Brazil is seen as the leader in terms of governance and political institutions. These factors also reinforce perceptions of the country as a potential destination for investments. The space that exists to reduce interest rates and spread in the banking system, indicates that Brazil may become even more attractive for investment in the "real" economy.

Against the backdrop of rather positive picture, it is the job of academics to try to identify potential future bottlenecks that could impede the process of development. We identify some of these bottlenecks in relation to energy, indicating lines of research whose exploration could be rewarding for post-graduate students and early-career scholars. In so doing, we recognize that difficulties may arise in other areas (for instance in the financial system, in public security, or in the natural environment), but, in the context of this article, a focus on energy related issues serves to confine the discussion. The argument being proposed is that some of the factors underpinning economic growth and the related catching-up process in energy, are the result of economic activities in sectors envisaged as strategic by previous generations. As they mature, these economic activities may lose their potential to drive growth. If and when this happens, it is vital that there are alternative avenues for national development.

In energy, there are two key sectors providing economic dynamism: the development and exploitation of sugar cane ethanol as an alternative to gasoline, and off shore deep-water oil exploitation. The use of sugar cane ethanol as a biofuel was encouraged some 40 years ago, during the military regime. Biofuel was seen by many as a 'Brazilian idiosyncrasy', and lost relevance in the 1990s, to re-emerge most recently as a key technology in the context of alternative fuel and advances made by the automotive sector in relation to engines. The position of leadership in this area held by the Brazilian automotive industry (composed mainly by subsidiaries of multinational corporations) could be in danger of being challenged in the near future by a combination of three inter-related factors. These factors are first, outward technology transfer in relation to engines. The development of improved, flexible and technologically advanced engines that

can run on ethanol or gasoline, has been achieved in the main by multinational corporations. This means that the knowledge accumulated may be transferred to and benefit parent companies and other subsidiaries, as happened in the past in the case of Brazilian subsidiaries of multinational corporations, which benefited from “technology transfer”. The second factor is the development of second generation ethanol. Several countries are investing in this technology and, although it is unlikely in the near future that an economic alternative to sugar cane will emerge, there is no shortage of examples of how new and more efficient fuels have displaced existing market leaders. The third factor is the influx of foreign direct investment in the production of ethanol. This is perhaps the most worrying trend, because the knowledge in this area is being absorbed by companies that are global energy players, which means that it can be transferred to subsidiaries elsewhere, which in turn would erode the leadership enjoyed by Brazilian producers.

In relation to these trends, we need to research the following topics: i) what is the role of the Brazilian subsidiaries in the automotive sector in transferring knowledge and technology and the related engineering on biofuels, to their parent companies and other subsidiaries? Is the transfer of knowledge and technology unilateral, with Brazilian subsidiaries simply teaching parent companies and subsidiaries elsewhere about this technology (the most worrying hypothesis), or (from a more positive viewpoint) will Brazilian subsidiaries assume the role of global technology leaders, transferring knowledge to other subsidiaries and parent companies, and in the process learning a great deal about what they do in respect of alternative fuels, and reinforcing their position as global centres of excellence. A combination of case studies, surveys and patent analyses might perhaps be appropriate to throw light on aspects; ii) What can we learn from the economic history of technologies, about the transition between different types of fuels? Elements such as public subsidies to new technologies, training of human resources in areas relevant to new types of biofuels, existing infra-structure and accumulated experience could be analysed. Historical patterns might clarify which types of factors could create the conditions for sugar cane ethanol to be challenged by new types of biofuels in the near, medium or long terms; iii) A very promising line of investigation is to clarify what are the effects of the influx of foreign direct investment in the production of sugar cane ethanol over the whole related “sectoral system of innovation”. Will the new players, i.e. multinational

corporations with an interest in energy, continue to use native knowledge in this area? Will the knowledge accumulated over many centuries about sugar cane plantations, and knowledge related to ethanol processing simply be sucked out of the country? Is this possible even? What will be the technological role, if any, of these new subsidiaries in the broader structure of their corporations? Again, a combination of case study and survey methodologies might be suitable for these analyses.

The exploitation of off shore deep-water oil was a long-term venture, boosted during the military regime. Although off shore oil exploitation goes back several decades, the discovery of huge reserves in more recent years has prompted a new cycle of investment in Brazil covering many different, but related areas, such as maritime defence (with the development of assembly and design capabilities in relation to conventional and nuclear submarines for instance), infra-structure (oil platforms, air transport, terrestrial transport and so on) and related demand for knowledge (many multinational corporations, local firms, Brazilian and foreign public research institutions are investing in research and experimental development to be undertaken in Brazil). This is a very positive situation, which is creating local jobs, income and technological development.

However, stocks of fossil fuel are declining. New types of apparently cleaner technologies, such as fuel cells or automotive engines run on electricity, are emerging and may displace them. In other words, Brazilian industry may be investing and creating substantial fixed capital in a sector which, in a few decades, may show sharp decline. Two areas of analysis are of interest here: i) whether this influx of investment can create a flexible knowledge base for the Brazilian industry, such that all fixed capital can be directed to alternative activities once substitution of fossil fuels by cleaner alternatives accelerates globally; ii) to clarify and indicate how more flexible use of the whole fixed capital created around an industry that may decline at some point in the future, can be achieved.

We suggest some relevant questions for research. What are the capabilities that must be created among the local skilled labour force (e.g. technicians, managers, engineers, industrial researchers) so that all investment related to the exploitation of off shore deep-water oil generates positive externalities for other industries and sectors? Can these capabilities be observed in the local industry

in terms of its strategy, operational routines and research and experimental development efforts? Will it be possible to divert all the knowledge on this industry that is being/will be accumulated in universities and other research organizations, to other industry sectors? Of course, some of these trends will become clear only as contemporary investments mature. For this reason, it is difficult to identify the methodologies best suited to their investigation. The convention is that, because the nature of these questions is exploratory, the best methodology is case study.

Perhaps most important in all this, is that research in economics should help to identify future strategic sectors. Off shore deep-water oil exploitation, and sugar cane ethanol as a biofuel were established as priorities for Brazil several decades ago, and the country is currently reaping the benefits of the efforts made by previous generations. The technological developments, accumulation of indigenous capabilities, and research efforts extend over many years. It is crucial to identify what are the industries that may have the potential to trigger the development of whole new sectors based in Brazil. The energy technologies analysed above should support the growth of the Brazilian economy for some time, but we must envisage alternative technologies to take over as soon as they start to decline.