

INSTITUTIONAL CHANGE AND INNOVATION IN THE BRAZILIAN OIL INDUSTRY

The Brazilian national oil company Petrobras has acquired considerable technological and R&D capabilities particularly in deep-water technology. This company, which competes with global leaders, had been engaged in important R&D efforts since before the reforms of the 1980s and 1990s. Petrobras created several post-graduate oil-related technology programs in Brazilian universities by allocating substantial funds for research conducted by universities and research centres. In addition, since the 1950s, Petrobras had developed a procurement policy to improve supplies industries' technological and productive capabilities. This paper examines the implications of institutional reforms on national R&D programmes, and the lessons for other developing countries.¹

Beginning some 20 years ago developed and developing countries alike reformed their energy sectors through privatisation of public monopolies and the opening of energy markets to competition. The impact of these reforms on R&D expenditures were largely negative, contrary to assumptions that increased competition would improve innovation efforts. There was sharp decline in R&D spending, which was quite significant in countries that engaged more deeply in reforms. Firms and governments neglected investment in long-term research in energy in an attempt to generate more profit.

In the USA and UK, R&D expenditures decreased in the electric power sector after privatisation, while competition intensified. More recent figures show that R&D expenditures were halved in 9 of the 18 countries surveyed by the World Energy Council, and most of them were in developed countries. In the USA that accounts for 40 per cent of world R&D; expenditures fell by 70 per cent between 1995 and 1999, due mostly to the decline in private sector expenditure.

Two prominent sectors, electricity and petroleum, received the greatest policy attention. However, reforms in developing countries were more far-reaching in electricity than in the fossil fuel industry. This might be because oil companies, being important sources of tax revenues for

exporting and importing countries, put on greater resistance to reform. Privatisation would mean the loss of an important source of revenue. While a small group of developing countries privatised their national oil companies in order to attract foreign investment, others did so to increase the management autonomy of national companies to allow them to survive competition.

National oil companies in some developing countries are responsible for a significant portion of total R&D efforts and do have an important influence on the national system of innovation (NSI), i.e. universities, research centres, and national supplies industry. For example, in Mexico, Pemex and the Mexican Petroleum Institute (IMP) were responsible for 77 per cent of public expenditures in energy R&D. Thus we presume deeper impact of institutional change in countries where state companies are central actors of NSI, as the increase in competition will conduce these actors to reduce their own R&D efforts.

■ Institutional Change in Brazil

The Oil Law 9,478 of 1997 provoked important changes in the Brazilian oil and gas sector. The Law ended the monopoly of Petrobras by allowing new private companies, most of them foreign, to compete with Petrobras in the upstream and downstream of the industry. The internal market was opened to imports of crude and refined products and a new institutional actor, the Petroleum National Agency (ANP), was created to regulate competition.

However, anticipating the negative outcomes of increased competition in the research system, particularly within universities, research centres, and national suppliers, the Law created new sources of funds for R&D projects. These included additional royalty payments for oil extraction, part of which was allocated to science and technology. The Ministry of Science and Technology (MCT) created CTPetro, which manages the funds. A Co-ordination Committee, consisting of civil servants both at federal and state level, was created and executive functions are undertaken by the Federal Technology Agency (Finep), which is in charge of the highest share of the CTPetro resources.

The main form of application of the fund is the university-industry partnership. Universities or research centres in co-operation with industry conduct approved technological projects.

This institutional change allowed Petrobras to maintain its R&D and enlarge previous Science and Technology (S&T) efforts in the face of falling R&D expenditure at the global level. However, there were significant changes in the strategy of the main S&T actors.

■ Changes in the Brazilian Oil Industry Innovation System

The oil and gas sectoral innovation system comprises specialised firms, universities, research centres managing training programs, and sectoral funds. In the petroleum industry, the production sector has two main actors: oil companies and the oil supplies firms. The oil companies control different stages of the oil and gas production process, while oil supplies firms are in charge of sets of products and services for the oil companies. At the global level, oil companies control important shares of R&D efforts. In developing countries, like Brazil, these efforts are concentrated in the national oil companies.

The roles and functions of actors are depicted in Table 1. Phase I corresponds to the previous institutional arrangement where Petrobras monopolised oil and gas activities in Brazil, while Phase II shows the new institutional arrangement.

In Phase II, the network became multi-polar and co-ordination was weaker. The rules of competition changed, and Petrobras abandoned some of the missions that guided its actions during the previous phase, such as promoting

domestic universities, research centres, and oil supplies firms. CTPetro could not substitute for the roles played by Petrobras before the reform for reasons beyond the scope of this article. It is sufficient to note that the creation of the important new fund generated tensions in the co-ordination function of the system.

Again, the co-ordination function was weakened with the entrance of the CTPetro as a main actor largely because co-operative projects require a firm's co-founding. There is also a lack of capacity to define the scope of the programmes. Lastly, specification of regional spending rules² reduced programming co-ordination since poor regions had less technological capabilities in universities and research centres.

Overall, CTPetro promoted technological variety involving a larger number of actors by mobilising existing technological capabilities to create new knowledge bases.

While Petrobras maintained its R&D efforts, there was a reduced co-ordination in national R&D efforts due to CTPetro's tendency to disperse resources. The otherwise negative outcome was mitigated by the general improvement in R&D expenditure, including funding of deep-water technology.

Local oil supplies firms remain the weakest component of the Brazilian system. It is a well-established industry, which originated from Petrobras efforts to reduce equipment and services imports. At the end of the 1980s, Brazilian suppliers were responsible for more than 90 per cent of Petrobras' equipment and materials purchases. However, few firms engaged in R&D efforts in the era of monopoly (Phase I in Table 1). These firms tended to be passive, adopting foreign technology chosen by Petrobras.

Table 1: Functions and Roles of the Main Institutional Actors of the Brazilian Innovation System

Functions/Roles	Phase I: Monopoly	Phase II: Competition
R&D Planning and Co-ordination	- Petrobras	- Petrobras - CTPetro
R&D Funding	- Petrobras	- Petrobras (70%) - CTPetro (30%)
R&D Execution	- Petrobras (mainly) - Universities and Research Centres (few)	- Petrobras - Universities and Research Centres (large number)
Human Resources Training Funding	- Petrobras (mainly) - Federal Government	- Petrobras - CTPetro - ANP - Federal Government
Human Resources Formation	- Petrobras (mainly) - Universities and Technical Schools	- Universities and Technical School (mainly) - Petrobras
New Knowledge Users	- Petrobras - Oil Supplies Firms	- Petrobras - Oil Supplies Firms - Other Oil Companies
Clients of the New Knowledge Users	- Petrobras	- Petrobras - Other Oil Companies
Final Consumers	- Society	- Society

■ Policy Lessons for Developing Countries

Brazil proactively introduced institutional reforms in order to mitigate the anticipated drop in R&D expenditure that would have resulted from reforms. One important reform was the creation of a co-funding mechanism intended to induce university-industry partnerships. It, however, seems to have encouraged externalisation of R&D efforts that benefit only large firms such as Petrobras. The co-funding requirement could be one of the reasons why oil supplies firms did not fully engage CTPetro, the main co-ordinator of

the R&D fund. However, there seems to be several other reasons. First, firms lacking in research tradition had no information on the nature of the program. Second, while CTPetro encouraged new entrants, this was outweighed by the lack of interest of well-established suppliers. Third, local supplier's indifference could be a result of limited scope of R&D, which is restricted only to strategic areas, where appropriability matters leave little room for co-operation.

While the liberal reforms – privatisation and the end of national monopolies – initiated important changes in energy innovation systems world-wide, there was a decline in R&D efforts. In the oil sector, reforms in developing countries were limited to the opening of internal markets to competition while keeping national oil companies under state control. However, anticipating the negative impacts of institutional change demanded attenuating laws and programmes.

While the mechanism described could be appropriate for large firms like Petrobras, with its own internal R&D capacity, and the more advanced system as found in Brazil, the general principles contain lessons for developing countries.

In sum, there are a few key lessons. The first is that to support the innovation efforts of local firms there is a need to initiate, concurrently with reforms, institutional changes, such as a special fund and the organisation to manage it. Secondly, R&D is costly, but it is not the only requirement to improve competitiveness. Developing countries which are less advanced than Brazil may well require other forms of innovation support. All actors should carefully arrive at these requirements through consensus in the national system. Lastly, despite severe expenditure reductions, developing countries need continuing explicit investment in innovation and human capital development to remain competitive.

André Tosi Furtado
University of Campinas, Brazil
furtado@ige.unicamp.br

1 A complete version of the arguments presented in this article, including full references, could be obtained from the author.

2 40% of CTPetro funds has to be allocated in the north, north-east and center-west Brazilian macro-regions.

NETWORK AND CONTRIBUTORS

This Technology Policy Brief was compiled by Banji Oyeyinka at the United Nations University, Institute for New Technologies from original contributions, advice and commentary provided by a network of colleagues:

John Adeoti

Nigerian Institute of Social and Economic Research, Nigeria

Abeeku Brew-Hammond

Kwame Nkrumah University of Science and Technology, Ghana

André Tosi Furtado

University of Campinas, Brazil

A. P. Mitra

National Physical Laboratory, India

FUTURE TECHNOLOGY POLICY BRIEFS

Future UNU/INTECH Technology Policy Briefs will address issues in transnational corporations and innovation, and information and communication technologies.

The next TPB will address transnational corporations, learning and innovation. The issue will examine the World Trade Organisation's (WTO) Trade-Related Investment Measures (TRIMs) Agreement and its potential impact on the role of transnational corporations and technological capability building in developing economies.

Comments, criticisms, and suggestions on this Brief are welcome. Please contact Banji Oyeyinka at: oyeyinka@intech.unu.edu



The United Nations
University

INTECH

Institute for New Technologies

UNU/INTECH
Keizer Karelplein 19
6211 TC Maastricht
The Netherlands
Tel.: +31 43 350 6300
Fax: +31 43 350 6399
www.intech.unu.edu