Academia-Industry Innovation Linkages in the Case of Saudi Arabia: Developing a University-Industry Triple-Helix Framework to Promote Research and Development Collaboration

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Future innovation platforms in Saudi Arabia cannot be isolated from the changes that are now reshaping the Saudi economy, which has long been known for its chronic heavy dependence on the country's natural resources. This is especially apparent when we consider the proportion of export revenues that is attributable to the oil sector (see Figure 1).

Saudi Arabia in the global research and development scene: Context and economic rationale

Saudi Arabia is not the only nation with natural-resource wealth that affects its economy in many ways, including its research and development (R&D) levels. The continued deep reliance on natural resources for the past several decades has taken its toll on today's Saudi industry. Large corporations dominate the industry landscape; these include Saudi Aramco, which has a monopoly on upstream oil development, and Saudi Basic Industries (SABIC), which is currently the world's seventh-largest petrochemical producer and the largest non-oil company in the Middle East. The Kingdom's development remains largely in the investment stage, although there are potential pockets of innovation.

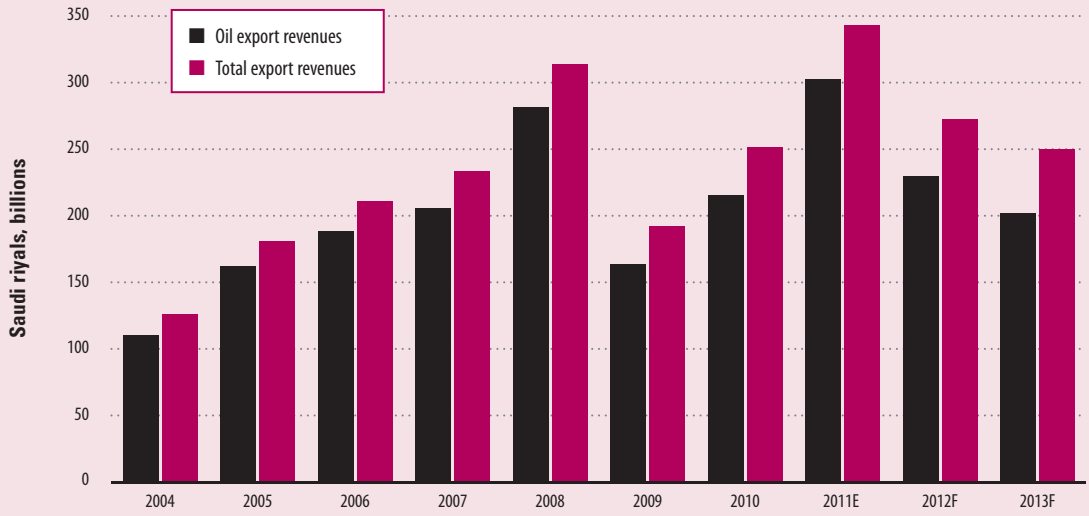
The National Plan for Science, Technology and Innovation (NPSTI 2010–2025) highlighted the major challenges facing the advancement of Saudi Arabia towards industrialization and the diversification of its economy. The Saudi form of Dutch Disease made the manufacturing sector less competitive than it could otherwise have been, and although figures on R&D expenditures by private firms are not being collected, they are assumed to be very low by international standards. R&D programmes remain limited largely to the large industrial companies. Saudi investments have always tended to be risk averse and less favourable towards extending funds to new technology-driven companies that have a high-risk profile.

Moreover, efforts to stimulate innovation and enhance competitiveness at the national level have confronted serious human resources challenges. Although the number of engineers and scientists in Saudi Arabia has increased in the last few years, it remains low when compared with those of other industrialized countries. According to research from the International Development Research Centre,[1] Saudi Arabia has the lowest total early-stage entrepreneurial activity rate of all the factor-driven economies in its study. Only 4.7% of the adult population are actively involved in the start-up of a new business or own a young business that has existed for less than three and half years.

It seems the wealth of resources that was once argued to have been an obstacle to Saudi Arabia diversifying its economy in innovative ways will become a benefit. Saudi Arabia is gradually taking part in the globalization of R&D. The country's growing resource incomes are increasingly driving the transformation of the economy towards a knowledge-based system. In 2012 Saudi Arabia was one of three new emerging economies to appear on the world R&D map for first time (Malaysia and Indonesia are the other two) according to Battelle's *2012 Global R&D Funding Forecast*.[2] Although Saudi Arabia is not now one of the global science and technology (S&T) supply countries where multinational enterprises (MNEs) choose to locate their offshore R&D centres, and is not now a natural target for R&D-related foreign direct investment (FDI), a multitude of multibillion-dollar developmental projects—mainly in the petroleum upstream/downstream processing and the construction and engineering fields—have brought multinational R&D centres of international industrial corporations (see Box 1).

International research collaboration is now acknowledged to be an important transmission mechanism through which technology can be diffused between firms and across regions and countries. FDI plays a major role in the process of globalizing R&D, and MNEs are the main actors. MNEs are seen as the primary driver of global R&D, and the world's biggest multinationals are increasingly happy to locate their

Figure 1: Annual export revenues of Saudi Arabia



Source: Compiled by the authors from data presented in Jadwa Investment, 2012.

Box 1: R&D centres of international industrial corporations in Saudi Arabia

Dhahran Techno-Valley (DTV) is a prominent Saudi example of locations where MNEs opted to locate offshore R&D centres. DTV is a specialized technology cluster focused on petroleum processes that was launched at the King Fahd University of Petroleum and Minerals (KFUPM) in 2006 (in close proximity to Saudi Armco's headquarters). It currently hosts R&D centres for key multinationals and other large local industries. Dow Chemical Company recently announced its intention of entering into a strategic relationship with the King Abdullah University of Science and Technology (KAUST) to establish a multi-year, multi-million dollar joint research framework initially aimed at using catalysis to develop new routes for producing chemical derivatives. In addition, Dow announced its intention of exploring developmental efforts at the KAUST Research Park and Innovation Cluster.

In another example, along with Sumitomo, Saudi Aramco has set up PetroRabigh—a joint venture plastics development park—at King Abdullah Economic City mainly in order to develop types of chemical cracker and their derivatives. These development parks are possible because large industrial organizations worldwide continue to decentralize their R&D facilities and build new ones in offshore locations. Growing evidence shows that, within a few years, the research parks of the major Saudi universities will bring together academic research organizations, national industries, and multinational R&D centres in an emerging Saudi triple helix arrangement, where each of these three elements combines with the others to offer a dynamic and robust framework. The Saudi triple helix arrangement includes the Saudi Universities, the Saudi mega industries, and the MNEs.

R&D facilities in emerging markets. More than 95% of the 700 firms with the largest R&D expenditure worldwide are MNEs; they account for close to half of the world's total R&D expenditure and more than two-thirds of the world's business R&D. The top R&D-performing MNEs often spend more on R&D than many nation states do, and their presence is felt not only through activities in their home countries but also increasingly abroad. Companies on the Fortune 500 list have 98 R&D facilities in China and 63 in India. Multinationals expect about 70% of the world's growth over the next few years to come from emerging markets. This estimated growth is associated with the strategies of those industrial organizations that build global marketing and sales support presence at their technology market locations (among many other reasons). The offshoring of R&D in developing countries has involved internationally known MNEs such as Ericsson, GE, IBM,

Intel, Microsoft, Motorola, Nokia, Oracle, Texas Instruments, and SAP. These emerging international R&D trends have started to manifest themselves in national innovation systems, which are becoming more integrated in global innovation networks and more dependent on foreign sources of knowledge.

All of these observations are not separate from the changes that the global R&D typology has seen during the last decade. Among the changes observed in the *UNESCO Science Report 2010* is an increase in the number of researchers in developed countries:[3] in 2002, developed countries had 29.7% of the world's researchers; this increased to 37% in 2007. Many indicators show a levelling of the R&D global playing field. Most of the growth in global R&D funding is being driven by Asian economies, which is expected to increase by nearly 9% in 2012, while European R&D will grow by about 3.5% and North American R&D by 2.8%. A country-by-country technical strength analysis perceived China as having the world's greatest technical strength in 2015, while the United States of America was perceived to retain the same position in 2010.[4]

Saudi Arabia seems to be dynamically responding to the global transformation of the R&D environment, and its spending on R&D has witnessed substantial growth. From 0.25% of GDP in 2000, the Saudi appropriation for R&D and innovation will increase to 1% between 2010 and 2015 with the aim of reaching 2% between 2017 and 2015. The Saudi economy is part of the world's changing portrayal of R&D, and is considered to be one of the emerging economies that are slowly (and steadily) increasing their annual investment in R&D infrastructure, education, and intellectual properties.

Box 2: Development Plans for Saudi Arabia

The 8th Development Plan (2005–09) focused on fundamental developments that laid the basis for heading towards a knowledge-based economy. These included starting to implement the first five-year plan of the Science and Technology National Policy; adopting the National ICT Plan, the National Industrial Strategy, and the Strategy and Plan for Giftedness, Creativity and Innovation. The 9th Development Plan adopted the drive towards a knowledge-based economy by focusing on education, which disseminates knowledge, thus paving the way for knowledge transfer and accumulation and thereafter knowledge generation, as well as the utilization of knowledge in various economic and social sectors, particularly production and service activities. Through these endeavours, the 9th Plan sought to enhance the comparative advantages of the economy and add new ones, diversify it, and increase its productivity and competitiveness as well as create appropriate employment opportunities for citizens.

The 9th Plan (2010–14) recognized higher education as one of the most important stages of the build-up towards a knowledge-based economy. Saudi higher education institutions now receive the lion's share of the country's appropriation for R&D. The National Science and Technology Plan (NSTP) implemented programmes and projects worth SR7.9 billion in 2008, which constituted a significant development in financing knowledge-production activities. Moreover, in 2006–07, the number of research centres at Saudi universities increased, with the establishment of seven research centres of excellence for environmental studies, medical genome sciences, oil refining and petrochemicals, renewable energy, materials engineering, biotechnology, and research on dates and palm trees. In addition, 32 training programmes were implemented within the framework of a project for innovation and excellence. Furthermore, several private-sector companies have realized the importance of R&D centres or units and started to establish such centres, which are expected to lead to increasing the knowledge content of their products and services.

The Saudi push for a diversified economy: Key roles for higher education institutions and major industries

Under the country's 8th Development Plan, several major public and private projects in various regions of the Kingdom have been implemented. These include investment projects aimed at diversifying the economic base and achieving balanced development among the country's sectors, such as mining, ICT and petrochemical projects. During the last decade, the picture has gradually changed. The 8th and 9th Development Plans included clear directions for the transfer and indigenization of knowledge and thereafter its generation—either internally through several channels or by including partnerships with leading foreign companies (see Box 2). However, with all these advancements, it should be noted the picture is still not totally rosy. For example, the low number of Master and PhD students was recognized in the Development Plans. These were small numbers by international standards, a failing that reflects negatively on R&D.

The major roles open to Saudi industry in building the future knowledge-based economy were highlighted by the 9th Development Plan. Saudi Aramco and SABIC

and the companies of the Offset Program, particularly in the field of electronics, are now carrying out important technology-transfer and indigenization activities. Saudi Aramco has worked on transfer and indigenization of technology in the oil industry, establishing two R&D centres for that purpose. SABIC also made similar efforts in the petrochemical technology transfer, expanding its Industrial Complex for R&D in Riyadh and locating two upstream R&D centres at the science parks of two major Saudi universities. The company is building a plastics application development centre at the Riyadh Techno Valley research complex inside the King Saud University (KSU) campus. Saudi International Petrochemical Company (Sipchem), which was established in 1999, is building now a corporate Product & Application Development Centre (PADC) at DTV of KFUPM, which will be operational in mid 2012. The Saudi Arabian Amiantit Company, which was established in 1968 and developed into a major diversified industrial group with operations spanning the globe, is now establishing a research centre at DTV.

The Saudi national ecosystem and academia-industry links

While implementing the 8th Plan focused on the knowledge production and dissemination challenges, the 9th Plan recognized different difficulties with regard to indigenization of knowledge and transforming knowledge into products in Saudi Arabia. These included two intertwined dimensions: (1) directing the country's investment in R&D and innovation towards areas important to the national economy and (2) the needs for developing effective academia-enterprise innovation linkages.

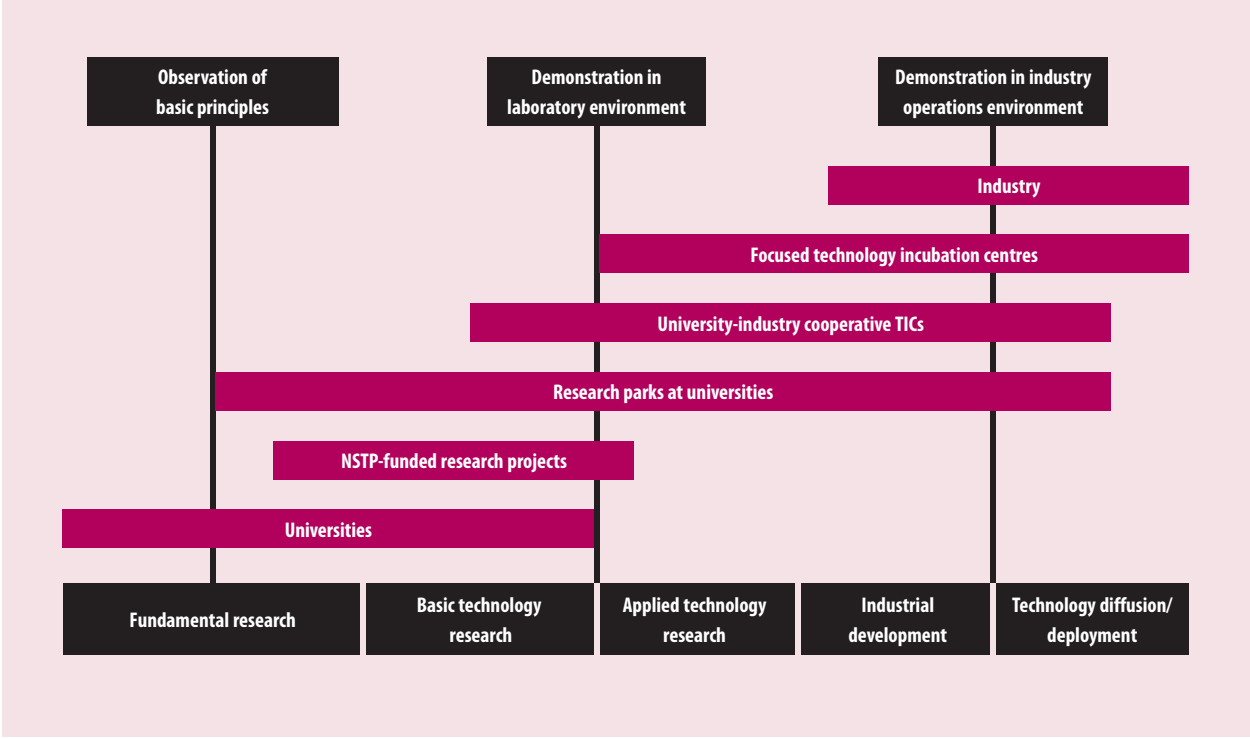
To address the relative imbalance among basic and applied research, development, and innovation, NSTP funding for research in universities came under contract with the production and service sectors, thus avoiding being geared merely towards academic publication and career promotion. The academia-enterprise innovation linkages dimension encompasses several important enablers, including intermediary institutions that interface education and R&D with production and services sectors. These intermediary institutions also play an important role in transferring R&D results to production lines and services and transforming knowledge into wealth. In addition to research parks at the campuses of major Saudi universities, both quantitative and qualitative expansion of intermediary institutions has occurred in the last few years. An NSTP programme was launched in 2009 with the aim of creating a chain of cooperative technology innovation centres (TICs) between universities and the private industrial sector (both local and global) at leading universities in the Kingdom.

With a similar approach, the World Bank's *Innovation Policy Guide for Developing Countries* emphasizes the development of an innovation scheme to provide public-private partnerships and industry-university collaboration by focusing on funding the seed stage of potential niche research projects as a possible innovation path for Saudi Arabia.[5] In 2011, TICs were established at three major Saudi universities: KFUPM, KSU, and King Abdulaziz University (KAU). The centres are geared towards developing advanced technologies that secure demanded advanced products and give new resources to generate wealth and work opportunities for citizens. They are also driven by industrially relevant problems. Types of university-industry cooperation include joint funding, sharing of resources, and in-kind support. The activities of these centres involve education and training programmes including, but not limited to, a PhD programme that complements the research programmes and builds engagement, innovation, and R&D capacity with industrial members. These centres are also strongly encouraged to extend their activities in order to involve undergraduates in their research. This is part of the efforts for developing Saudi human resources training programmes attuned to modern knowledge and technology.

Further important dimensions of the NSTP are motivating Saudi research universities and enterprise sectors to expand partnerships in increasing knowledge production nationally and to provide more incentives for joint ventures and R&D-related FDI investment in knowledge transfer and indigenization.

Encouraging the commercialization of research and promoting technology transfer from universities and research institutes are two of the main objectives of the National Policy for Technology Business Incubation (NPTBI). The King Abdulaziz City for Science and Technology created the BADIR programme to advance that policy to meet some of the NSTP objectives. The BADIR—which means 'initiate'—programme is mandated to support a network of five national technology-focused incubators that assist emerging-technology companies with specialist accommodations. BADIR incubators will focus mainly on the priority

Figure 2: Intermediary university-industry programmes/institutions: Positions in Saudi Arabia's technology development



technologies of ICT, biotechnology, advanced materials, manufacturing, and energy technologies and work closely with affiliate incubators in national universities. The work is near completion and is expected to be implemented under the auspices of the NSTP.

Enhancing academia-industry innovation links in Saudi Arabia

The industrially oriented NSTP-funded R&D projects, the research parks at major universities, the cooperative TICs, and the focused technology incubation centres constitute jointly a large-scale national effort for aligning universities' research with the future strategic needs of the Kingdom and transitioning public R&D results to production and service sectors. These programmes and intermediary organizations have been positioned in the technology development structure according to their levels of technology readiness (Figure 2). The university-industry innovation linking system was designed to operate mission-driven environments—the elements of the system will receive ongoing support from the government and leverage significant funds from industry (both national and multinational). It is assumed they will have transformative effects on the industrial base of Saudi Arabia during coming decades.

Consolidating these initiatives requires a special type of engagement—known as 'triple-helix engagement'—that fosters dynamic exchanges among Saudi universities, national funding (and policy-making) organizations, and local/global firms. Coordinating among the intermediary organizations and numerous Saudi national knowledge-based economy initiatives and knowledge nodes requires effective and well-designed regulatory regimes and policies. Special arrangements are needed to coordinate activities of the university-industry cooperative TICs and the R&D centres of the MNEs at the research parks at universities. Also, there are no clear links between the developmental initiatives that take place at the newly established economic cities and the research clusters that have started to emerge at the campuses of the Saudi universities.

Regulatory regimes and policies needed for Saudi Arabia to enhance current academia-industry linkages

The R&D centre environments of the large industries—represented by both national and multinational enterprises—require advanced engineering and manufacturing support services. Petroleum R&D processes are typically known for their

heavy demands for high-precision mechanic work, which Saudi Arabia currently lacks. The deficit in engineering design skills and the inability of the labour force to execute small devices or provide specialized shops that can build systems and components to specifications as required by the scope of research projects are among the most challenging difficulties facing the advanced research centres in the Kingdom. Encouraging small- and medium-sized enterprises in Saudi Arabia to invest in these types of engineering design and manufacturing services will require a specially designed favourable investment environment and new types of investment policies. In the same way, encouraging industrial ventures in building innovative prototypes that could become successful in international markets was among the possible innovation paths recommended for Saudi Arabia by the World Bank's innovation policy guide.[6] Saudi institutions of higher education need also to be encouraged to align their curricula with these developmental demands and to develop special training programmes to bridge the skills gap in these particular sectors.

In regard to the protection of intellectual property (IP) rights—a protection that is important for attracting the R&D activities of foreign companies—Saudi Arabia has achieved significant progress, which was a requirement of membership in the World Trade Organization. However, further work is needed in this area to develop more transparent and enforceable regimes for IP rights. From an MNE headquarters perspective, among the main drawbacks of R&D offshoring is the potential loss of control over the results. In order to stimulate the patenting activity of firms, an instrument used by several countries is offering fiscal incentives to cover patenting costs. This support may be of interest to foreign investors in R&D. Ensuring the presence of adequate skills in IP is necessary as well; this can be done, for example, by sponsoring IP education and identifying specialized law firms and consultants that can be contacted by potential foreign investors.

An abundance of natural resources has been always one of the most important determinants of FDI in Saudi Arabia, but indications of a gradual shift—from resource-seeking to other types of FDI—are growing. This diversification of the type of FDI should be encouraged. Increasing the attractiveness of Saudi Arabia as a location for offshored R&D centres and R&D-related FDI requires policy makers to foster scientific excellence through the creation of both scientific and technological networks of public and private research not only within boundaries of the country but also with distant partners. In the end, Saudi Arabia is a developed country entering the era of globalized innovation; this reality needs to be reflected in its national policy for science and technology. For this reason, Saudi national policies for science and technology should be related to the integration and concentration of resources to reach an internationally competitive critical mass. The small number of graduate students remains an impediment for knowledge generation in the Kingdom. To ameliorate this situation, policies are needed that stimulate Saudi institutions of higher education to continue engaging with enterprises and to adopt a method of systematic and formal consultation with industry in the development of structured Master and PhD programmes that address industry's requirements.

Creating more favourable conditions for bringing a larger portion of the world's R&D-related FDI is also needed. The World Bank's Doing Business 2012 data for Saudi Arabia indicates that the country occupies an advanced position (12 out of 183) in terms of the ease of doing business. However, this environment remains mainly limited to investments in economic development projects. There are special needs for handling important issues hindering technology development by international companies and the R&D offshore centres of MNEs in Saudi Arabia. New legislation is essential to facilitate the importation of special materials or ordering equipment. Plans for attracting FDI should also include differentiated packages for R&D-related FDIs.

To obtain greater gains from foreign technology transfer to local Saudi firms and industries, several conditions must be met through indigenous R&D. Foreign technology can generate technological change and upgrading for local firms only insofar as sufficient indigenous R&D activities and human capital are present. The level of local absorptive capacity is a crucial determinant and depends on the human capital and the country's appropriation for R&D. Experiences from emerging economies suggest that maximizing the benefits of innovation and accelerating catch up requires parallel encouragement for indigenous innovation and the acquisition of foreign knowledge. China's model—and also the Indian and Brazilian models—of 'walking on two legs' reflects prudent strategy for maximizing benefits of developing countries. It is true that the offshored R&D centres in Saudi Arabia are, so far, mainly for Western-headquartered corporations, but selecting and shaping

the best combinations of foreign technology transfer to Saudi Arabia is a strategic challenge. There are numerous and multi-tier choices of technology engagement rather than the simple bi-dimensional North-South divide. The Saudi emerging economy is of the resource-rich type and technologies developed in Saudi Arabia could be more appropriate for other resource-abundant countries.

The efforts undertaken by Saudi Arabia during last decade to diversify its economy and enhance its knowledge/technology content are a step in the right direction for preparing for a post-oil era. The approach of the rich-resource country of using the resource itself as an anchor for attracting the R&D centres of major industrial international corporations may provide useful observations and lessons learned for other resource-abundant countries. Directing a major portion of its resource-dependent financial revenues towards spending on R&D is another important investment that has been made by the Saudi government. The Saudi university-industry innovation linkages, which includes several intermediary organizations/programs, is still at an early stage of implementation and must be closely watched to properly determine its lessons for success and failure.

Notes

1 IRDC, 2010.

2 Batelle, 2011.

3 UNESCO, 2010.

4 Batelle, 2010.

5 World Bank, 2010.

6 World Bank, 2010.

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