Guest editorial

Introduction to the special issue: technological innovation systems in Iran

Neoclassical theory of trade predicts that international trade through technology transfer and learning-by-doing enhances the technological capabilities of latecomer countries. However, the experiences of many emerging economies show the latecomers to industrialization face daunting task of technological development even under the best of international trading circumstances. Moreover, the problem of catching-up becomes even more complex when the emerging economies face techno-economic sanctions.

Economic sanctions, which restrict or altogether impede international trade, aimed at depriving the sanctioned country the benefits of international trade to achieve certain foreign policy goals, have been used extensively since Second World War. Specifically, during 1945-1990, 60 economic sanction cases have been observed, of which two-thirds were imposed by the USA (Lopez and Cortright, 2018).

The Islamic Republic of Iran is one of the countries which have been the target of multilateral and bilateral sanctions since its inception in 1979. After the triumph of the revolution in 1979, Iran has faced "crippling" economic sanctions, because of her strategy of technological catch-up. The Western powers have erroneously construed Iran's strategy of technological catch-up as the country's aim to develop military nuclear technology. Nevertheless, despite the four-decade-long economic sanctions, the country had major advances in technological capability building.

The study of the technological development of Iran during the past four decades is the subject of three sets of chapters and articles that have appeared in two books and special issues of the academic journal. The first set of papers appeared in a book edited by Soofi and Ghazinoory (2013), which includes a chapter on the technological development of the Iranian nuclear industry. The second set of articles appeared in a special issue of *Technological Forecasting and Social Change* (Ghazinoory and Soofi, 2017). Additionally, in the same year, an edited book was published that dealt with innovation and technological development of Iran (Soofi and Goodarzi, 2017). This special issue, as the fourth set in the collection, deals with the latest developments in the national system of innovation of the country.

Below we provide a bird's-eyes view of the articles in this special issue as a guidepost for the convenience of the reader.

The first article in this issue "Policy coherence as demand for excellence in Iranian bio-production industry," deals with the innovation in the Iranian bio-production, a high-technology industry. The article states that despite technological achievements, the industry still faces some obstacles to meet the standards to be among the industries listed on the National Plan for Excellence. The author(s) identify the conflicting policies for the national health system and industrial development as the major obstacle in the path of further technological advances in the industry.

The second article, "Evaluation of the effect of R&D subsidies on Iranian Firms' Innovative Behavior: reconceptualizing behavioral additionality," examines the impact of government subsidies on the firm's innovation. Using propensity score matching technique, the article discusses that the firms that receive government subsidies in Iran go through behavioral changes.

The third article, "Iranian Firms in Biopharmaceutical Value Chain: Where to Go Now?" reviews the rapid growth of the Iranian biopharmaceutical firms in the past two decades. Specifically, the author(s) study the positioning of the firms in the biopharmaceutical value

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chain, evaluate their technological capability building and suggest policies for further development of the firms. The authors conclude that many Iranian bio-pharma firms are at the "assimilative" level of technological capability stage, although several of the firms in the industry have reached the "adaptive" stage.

The fourth article in the issue, "How to Balance Your Technology Sourcing Portfolio in a Developing Country: the case study of Iran biopharmaceutical industry," also deals with the technological development of the Iranian pharmaceutical industry. The article discusses the firm's technological outsourcing portfolio and finds that certain important factors that are present in technological outsourcing in the Iranian pharmaceutical industry are insignificant for technological outsourcing of the firms in the same industry of the developed countries.

The fifth article, "Multi-level Drivers of Catching up in Complex Product Systems: an Iranian gas turbine producer," investigates the pattern of technological capability building in gas turbine industry as a complex product system in a case study. The author studied the technological capability building of an Iranian gas turbine producer named Oil Turbo Compressor Company. The author identified several variables at the firm, industry and national levels that profoundly influence technological catching up activities of the company. An important finding at the firm level is observation of technological capability building from assembling to manufacturing, to upgrading and, finally, to re-design of the existing models of the gas turbine.

Finally, the last article in the issue, "Innovation Policymaking in the Upstream Oil and Gas Industry as a Large Technical System under Economic Transition," deals with decision-making under uncertainty in the oil and natural gas industry in Iran. The author(s) using Q-methodology discuss the over-reliance of the decision-makers in the industry on hard evidence while neglecting important social factors. They find that preferences for innovation activities in the industry are dependent on the preference of the key players and stakeholders.

Given the use of paradigm of evolutionary technological development by several authors in the issue, it is useful to briefly discuss the stages of the evolutionary path. According to Kim (1997a, 1997b), the latecomer firms pass through three stages of technological capability building. First, they go through the acquisition stage where the firms acquire mature technologies from advanced countries. Second, they pass through assimilation. In the assimilation stage, the competitive pressure forces the latecomer firms to increase technical efforts for the production of differentiated products. Finally, a combination of assimilation of production technology and the correct macro techno-economic policies (in the East Asian cases, adoption of the industrial policy and export promotion) the firms enter into the design and production stage, engage in R& D and eventually catch-up with the leading firm in the industry.

The papers in this special issue, as well as in the papers and chapters in the previous works on Iranian technological development cited above, are clear indicators that technological learning -by- doing has begun in Iran; however, the country is at an early stage of the learning processes but has entered in the evolutionary path of technological capability building.

The views expressed by the authors are not necessarily shared by the Guest-editors of this Special Issue.

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