

# Building an Innovation Economy in Iran

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# 1. Abstract

The report traces Iran's economic development trajectory from the 19th Century to the present. Throughout, the focus is on identifying the development models and institutional arrangements that have served to stimulate, or detract from, economic growth and development. The specific mechanisms through which Iran has attempted to generate economic growth over the years, starting with import-substituting industrialization, entrenching a knowledge-based economy, and, more recently, activating a startup movement that can potentially result in the establishment of an innovation economy, are delineated and examined.

The report acknowledges that the impediments to the transition to an innovation economy are daunting. In spite of the formidable hurdles represented by ineffective governmental institutions and policies, however, the report posits that in light of the country's demographic and educational profiles, laying the foundations for an innovation-driven and entrepreneurial economy constitute the most effective means for generating long term economic growth and development in Iran.

Iran's massive and expanding talent pool, especially the many science and engineering graduates, provides a solid basis for unleashing innovation and entrepreneurship. This innovation can be propelled not only by attempts at finding solutions to the myriad crises, challenges, and problems besetting the country as a whole but also by solving the innumerable mundane issues with which people have to grapple at the local level on a daily basis.

At the same time, while the number of educational institutions and the number of degree holders has expanded, the quality of education requires improvement, with problem-solving and critical thinking skills as well as innovative, entrepreneurial, and independent thinking having to be granted pride of place and explicitly inserted into the curricula.

The study concludes by asserting that factors ranging from international isolation to burdensome regulatory frameworks, inadequate IP and bankruptcy protections, rapacious judicial and bureaucratic structures, and an inefficient education system undermine Iran's capacity to transition to an innovative economy. However, while improving governance and reforming the education system require intervention on the part of policymakers, human capital development through supplemental training, which constitutes the most important factor in the entrenchment of innovation economies, can be undertaken by grassroots organizations. As such, the study ends by proffering four

initiatives on human capital development that can be undertaken in order to alleviate the innovation and entrepreneurship gaps in Iran.

Focusing on developing the creative and innovative potential of the youth, state of the art training in entrepreneurship and innovation for college students, the establishment of community, networking, and training centers for recent graduates, and training in applied artificial intelligence for advanced graduates in technical fields with Masters and Ph.D. degrees, the initiatives steer clear of political and policy domains, focusing instead on bottom-up solutions that can be undertaken by the private sector, NGOs, as well as K-12 schools and higher education institutions.

## 2. Introduction

This study examines the primary determinants of economic growth and development in Iran over the course of the last fifteen decades. From a historical perspective, the study strives to uncover the factors and conditions that have served as engines of growth and development in Iran. Having identified the sources of growth and development in the 20th and early years of the 21st centuries, the study subsequently turns its attention to Iran's present conditions, arguing that, in light of the educational and demographic conditions extant in the country, transitioning to an innovation-driven economy would serve as the most effective mechanism for promoting the twin goals economic growth and development.

Although a work of scholarship, the study presents its findings in prose that is free of jargon, and endeavors to offer an unvarnished depiction of the strengths and weaknesses of the state of innovation and entrepreneurship, and the factors influencing it, in Iran.

The study deploys an empirical methodology and bases its conclusions on valid and reliable data derived from on-the-ground research. Going beyond truisms and simple recitation of often repeated statistics, the study delves deeply into the state of the startup sector as well as its drivers in Iran. As such, it examines not just the quantity but the quality of the nation's talent pool, research universities, and incubation and acceleration programs. The study also assesses levels and ease of commercialization of inventions, the number and quality of technology companies, and the numbers as well as the survival and expansion rates of startups, especially those that can be classified under the technology category.

On the cultural side, attitudes towards failure and levels of social capital extant in society, particularly as they relate to shared norms, values, trust, cooperation, and

reciprocity, which play an indispensable role in setting the requisite milieu for fostering the creative tensions and intellectual exchanges that are paramount for unleashing creativity, are examined and scrutinized.

Recognizing that the government has a key impact not just on how many businesses are created but also and more importantly the ability of firms to grow, the study examines the influence of Iran's legal, regulatory, and administrative structures on the formation, sustenance, and scaling of companies.

Iran has consistently scored poorly on rankings of business climate, levels of economic competitiveness, openness, and transparency put out by such organizations as the World Bank, World Economic Forum, the Heritage Foundation, and Transparency International. It does a poor job in protecting intellectual and private property, has cumbersome labor and bankruptcy laws, and suffers from an inefficient and politicized bureaucracy and judiciary. Moreover, it is generally believed that ideological and political considerations tend to outweigh economic considerations and that companies that grow too large become targets for either full or partial expropriation by one of the grabbing organs of the state. The study carefully assesses and scrutinizes the veracity of such assertions as well as their impact on the entrepreneurship and innovation scene.

On the educational side, evidence suggests that while the number of educational institutions and the number of degree holders has proliferated, the quality of education is low, skills remain deficient, and there is a mismatch between the educational system and the demands of the job market. Prevailing teaching models, meanwhile, are focused on rote memorization, while problem-solving and critical thinking skills, as well as innovative and independent thinking, are deemphasized.

Having diagnosed the impediments to the fostering of entrepreneurship and innovation in Iran, the study concludes by proffering four initiatives that can be undertaken immediately in order to alleviate them. While additional initiatives can subsequently be undertaken, the proposed initiatives make significant, enduring, and practical contributions to the narrowing of Iran's most gnawing deficits (entrepreneurship, innovation, skills, and gender gaps) through supplemental education, training, and retooling. Moreover, the recommended initiatives steer clear of the political and policy domains, focusing instead on bottom-up solutions that can be undertaken by the private sector, NGOs, as well as K-12 schools and higher education institutions.

Specifically, the study recommends innovative thinking and entrepreneurship training for K-12 and college students. The training will be facilitated by curriculum and course material development. Such courses will boost innovation, enhance creativity, provide intra- and entrepreneurship training, and instill a culture of calculated risk-taking. The

courses will also enhance innovation capacity, improve business and management skills, and teach participants how to commercialize ideas, find a niche, and link into the local, regional, and global value chains.

The study also recommends the establishment of Hackers Clubs, which will consist of community networks devoted to skills development and spreading collaboration on the promotion of TED: technology, entrepreneurship, and design. Hackers Clubs will also serve as business networks, providing access to mentors, role models, coaches as well as introductions to a network of investors and prospective acquirers.

### 3. Economic Growth in Iran

After centuries of economic stagnation and underdevelopment, Iran's ignominious defeats in foreign wars in the early years of the 19th Century finally served as the impetus for the initiation of the country's modernization process. The modernizing reforms, however, turned out to be largely sporadic, essentially too little, too late, and largely unsuccessful in their aim of invigorating the country's development trajectory. Thus the era of haphazard reforms in the 19th Century failed to arrest Iran's decay. Instead, the 19th Century became a period of accelerated decline and degradation in Iran in spite of the reform attempts, in part because of a failure of leadership and an inability on the part of the nation's political and social leaders to meet their historical obligations. Bereft of support from the most powerful social force in the country, prospects for reform also suffered an additional blow from the lukewarm, wavering, and occasionally hostile demeanor from the nation's paramount civilian leaders.

What made matters worse was the fact that Iran's decline coincided with the rise of European powers. In the course of the 19th century, while levels of development in all of its dimensions, including social, economic, technological, and political, were improving in Europe, they remained stagnant and vanishingly small in Iran. Illiteracy continued to be nearly universal and public health measures remained essentially non-existent. Instead, superstition, economic decline, and despair became the order of the day.

In the meantime, with the country unprepared to compete economically, technologically, or militarily with the rising European industrial powers, Iran's integration into the global economy, which was itself forced on the Qajar monarchy by European powers, destroyed Iran's domestic textile industry, further undermining the country's economic prospects. Economic decline was followed by social turmoil, leading to various messianic movements, which were brutally suppressed.

With the passage of time, the central government became increasingly weak and decadent in the 19th Century, hardly able to impose its authority outside of the capital. With the central government in disarray, centrifugal forces were strengthened, while the organs of the state, notably the military and administration, remained rudimentary, enfeebled, and corrupt. The Qajar period (1789 - 1925), therefore, was among the most disastrous in terms of loss of both territory and resources as well as economic and social degradation in Iran's history, resulting in what can appropriately be described as a lost century.

The Constitutional Revolution sought to arrest and reverse this decline by putting political development ahead of socio-economic development but largely failed to accomplish its objective. It was thus left to authoritarian modernization carried from above to stem the decline, but authoritarianism ultimately created its own political ramifications.

Seen in this light, Iran's rise in the 20th century was both a miraculous "rise of from the ashes" as well as the response of a nation brought to its knees and determined to surge again. The desire for national resurgence through emulating the West was devised and inculcated by the intellectual elite, who were painfully aware of their nation's decline in the face of the rise of the West, and sought to rekindle Iran's ancient glories in the modern context. It was thus Iran's intellectuals, themselves largely the product of Iran's fitful attempts at modernization, who were the architects of the constitutional movement and the ensuing accelerated modernization process.

In anticipation of this study's aim of identifying a dynamic growth engine for contemporary Iran, this chapter will trace the evolution of Iran's modernization trajectory, focusing on the factors that have contributed to or undermined economic growth and job creation in Iran in the course of the last one hundred years.

The process of modernization in Iran started when the Russo-Persian wars were brought to an end in 1828 by the Turkmenchay Treaty. After their successive losses to Russia, some of the more reflective members of Iran's ruling elite came to the conclusion that their military defeats, underscoring their country's decline and degradation, were due in large measure to Iran's inability to keep up with modern science and technology. By that time, Russia, owing to the superior technology it had developed as a result of its own earlier modernization drive, had completed the conquest of all of Iran's Caucasian territories, having previously formalized its dominion over Georgia, Dagestan, and most of the Iranian province of Azerbaijan through the treaty of Gulistan in 1813. Having awakened from their slumber and reactively seeking to catch up with the modern era, Iranian officials dispatched the nation's first group of



students to Europe to be trained in modern sciences and bring back the skills and knowledge necessary for promoting scientific, industrial, and economic development.

As with Japan and the Ottoman Empire, Iran's modernization drive, therefore, was reactive and top-down. The most important top-down approach to modernization in Iran in the 19th Century was performed by Amir Kabir, the reformist prime minister of the mid 19<sup>th</sup> century, who established the Dar ul-Funun in 1851 as the first modern higher education institute in Iran. Emphasis was placed on medicine, science, and military training, with the institute subsequently playing a key role in training Iran's small cadre of personnel exposed to modern science and technology.

The next bottom-up approach was made in 1887 by Mirza Hassan Roshdiyeh who founded the first modern elementary school in Tabriz in the northwest of Iran. Later in 1897, he established the first modern elementary school in the capital Tehran, but there was still no formal institutional arrangement for the provision of an inclusive modern educational system. In Iran, the establishment of a modern higher education institution preceded the creation of primary and secondary schools.



Mirza Hassan Roshdieh

In 1906, the constitutional revolution caused additional new approaches to be introduced with the aim of reforming the traditional education system. In 1909, the second parliament passed a bill to establish the Ministry of Ma'arif (culture and science) and to officially establish educational systems including elementary and high schools and also higher education. As a result, a number of elementary and high schools were founded nationwide. Teaching and learning new sciences were the core value of the new system. To train the additional required teachers, the Teachers College was

established in 1920. All these efforts opened pathways towards the modern era and social and economic development.



Dar ul-Funun



Teachers College

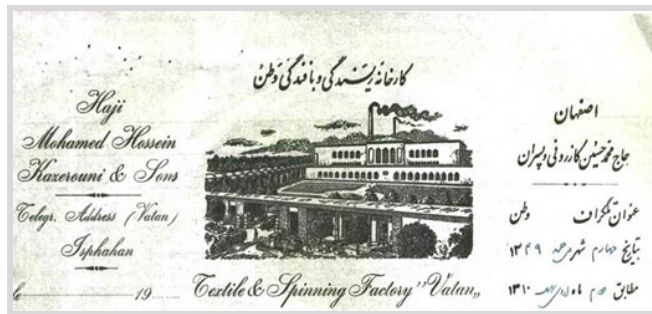
## Interwar Period

After World War I, in the 1920s and 1930s, overall infrastructure improved, and modern industries were introduced. More than 800 new plants were established with the intention of reducing the country's dependence on imports. The state encouraged industrialization by raising tariffs, financing modern industries, and imposing government monopolies. Changes in the legal system, tax structure, and trade policies, the imposition of order, suppression of centrifugal forces, and the unification of the country under a strong and for the most part effective (albeit authoritarian) government went a long way towards encouraging holders of domestic capital to invest in the Iranian economy.

Governmental policies also led to the emergence of a group of new, young entrepreneurs, who benefited from state-building measures, particularly a modern bureaucracy and military, which were instrumental in the promotion of domestic unity and stability. As a result, increased investment in mining, construction, and the manufacturing sector occurred both by the government and the emerging private sector.

In the meantime, infrastructure investment by the government grew significantly. Indeed, while a new class of entrepreneurs and industrialists became increasingly active, the limited size and scope of the private sector prompted the government itself to become the primary agent and promoter of economic development. Statism, or state-inspired economic development, became the order of the day and the primary contributor to economic growth and job creation, especially in the cities, which became the focus of

development. The cities were also the location in which the emerging professional middle class of lawyers, doctors, teachers, and engineers congregated.



Textile industries developed in Esfahan

In the interwar period, the Trans-Iranian Railway became one of the most important initiatives for the promotion of economic development in Iran. The Trans-Iranian Railway was a major north-south connection project started in 1927 and completed in 1938 and went a long way towards improving infrastructure, transportation, and promoting the economic integration of Iran.



The Trans-Iranian Railway

Financed entirely with indigenous capital, the project linked the capital Tehran to the Persian Gulf and the Caspian Sea. The railway connected Bandar Shah (now: Bandar Torkaman) in the north and Bandar Shahpur (now: Bandar-e Emam Khomeyni) in the south via Ahvaz, Ghom, and Tehran.

The trans-Iranian Railway supported economic growth by enabling the rapid transportation of local and imported products nationwide. The railway industry also facilitated technical training and the expansion of the industrial sector by allowing it to more rapidly receive its requisite inputs and access the four corners of the country.

Meanwhile, efforts toward developing human resources also were included in the nation's development agenda. In 1921, the parliament passed a bill to dispatch 100 students annually to Europe for five years to be trained in modern science and technology.

In 1934, Tehran University was established as the first modern higher education institute in Iran. Some smaller independent colleges also joined the new university, including the Teachers College. With the passage of time, Tehran University trained a vast array of professionals in science, engineering, medicine, and other fields.

In the interwar period, industrial and cultural movements started, but industrial growth was not balanced. Integration among sectors and industries was absent, and the new industries met only part of the growing domestic demand. Agriculture, from which 90 percent of the labor force made its living, benefited marginally from economic reform, but the development of infrastructure became the platform for future economic development.

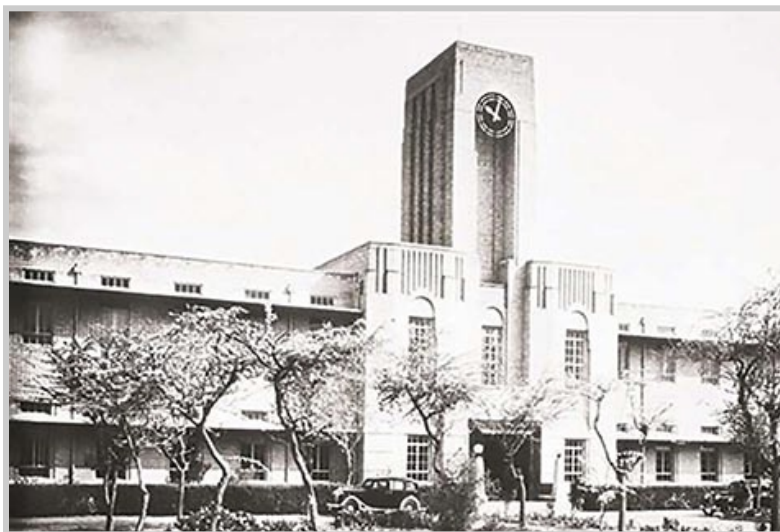
In the meantime, the government managed the expansion of international trade by techniques such as foreign exchange controls, which were imposed in 1936. Many new items were among the imported goods required by industry, the military, railroads, and other areas of infrastructure investment. Traditional agricultural and industrial export products were replaced by oil exports. Despite many advances in domestic and foreign economic policy, however, Iran remained an exporter of raw materials and traditional goods and an importer of both consumer and capital goods in the pre-World War II period.

Nevertheless, in the 1920s and 30s, the pace of Iran's social and economic development accelerated sharply. State building measures improved administration and cohesion. Levels of education and literacy increased, and both the quantity and quality of human resources and healthcare improved. The country became integrated, legally, politically, and infrastructurally, and a new cadre of trained personnel and modern professional middle class concentrated in the cities began to emerge. In aggregate, these changes, especially relative political stability and unity, combined with improved human capital and increased infrastructure spending and industrial development, served as the engines of economic growth in Iran during the interwar period.

## The Oil Industry

The discovery of oil on May 26, 1908, led to oil production, catapulting Iran to the position of the first nation in the Middle East region to develop its oil industry. To support oil production, the Abadan refinery was built and completed in 1912, and quickly emerged as one of the largest refineries in the world. In 1914, the first shipment of oil products was exported from Abadan to Western Europe. Thereafter, the Abadan refinery emerged as one of the most important centers of fuel production and distribution in the world. Indeed, the refinery played such a vital role in the first and especially the second World Wars that without it the outcome of the Second World War may have been different. With the passage of time, the Anglo-Iranian Oil Company, which had been granted the concession to explore and develop Iranian oil, also became Britain's most profitable overseas asset.

To train the personnel for the oil industry, the Abadan Institute of Technology (AIT) was established in 1939 and charged with the task of producing skilled technical staff for the Iranian oil industry in Abadan. The Institute's educational programs were developed and updated according to the demands and requirements of the industry.



Abadan Institute of Technology

In the eventual aftermath of a highly tumultuous oil nationalization movement, the oil, and gas industry became an increasingly important contributor to the government's coffers, progressively covering a larger proportion of the government's budget, financing public development projects, and accounting for the bulk of the country's foreign exchange earnings. With the government becoming the chief agent of economic

development as well as the lender of last resort, oil revenues have played an instrumental role in the generation of economic growth in Iran.

Yet, for more than a century, both before and after nationalization, after which Iran gradually took full control over its hydrocarbons industry, Iran's oil industry has remained essentially disconnected from the nation's other industries, particularly manufacturing, and this separation has promoted inefficiencies in the country's overall industrial economy. Moreover, while oil revenues have served as the basis for economic growth and development, the Iranian petroleum industry itself, which is highly capital intensive, has essentially not contributed to either employment generation or innovation.

## Post-WWII

Between 1941-1945 and the years immediately following the Second World War, when Iran was occupied by Soviet and British troops, no fundamental change occurred in the Iranian economy.

In the early 1960s, Iran initiated its third economic development plan (1962–68) with an emphasis on industrialization. During this period, new economic policies significantly altered the role of the private sector. The expansion of private and public banks and the establishment of two specialized banks provided reliable credit markets for medium- and large-scale private manufacturing enterprises.



Oil Industries in Abadan

Not limited to cheap credit, government programs also included a wide range of incentives to encourage investment in new industries by both Iranian and foreign businesses.

The Esfahan Steel Company opened in the late 1960s and became the major initiative for Iran's industrial development. Thereafter, Iran's automobile industry developed on the heels of the steel industry and was followed by other industries, such as home appliances, food processing, cement, etc. Meanwhile, Investment in construction, roads, highways, dams, bridges, and seaports also increased. In the aftermath of the 1963 land reform program, part of the agricultural sector also attracted significant investment, particularly from public sources.

Many large-scale agricultural operations in meat, dairy products, and fruit production were established. Small-scale farmers, however, did not benefit from the new investment opportunities.

Higher education also developed rapidly and extensively. In 1948, more universities in major cities such as Mashhad, Tabriz, Esfahan, and Ahvaz were established. In the 1960s Aryamehr (Sharif) University of Technology and Pahlavi (Shiraz) University were founded to reform the educational system and serve as impetuses as well as support structures to the promotion of industrial development.



Esfahan Steel Company

Between fiscal years 1964 and 1978, Iran's gross national product grew at an annual rate of 13.2 percent at constant prices. Economic growth, however, became increasingly dependent on oil revenues in the 1970s, particularly in the aftermath of the fourfold increase in the price of oil in 1973. By 1977, Iran's oil revenues had reached US\$20 billion per year (accounting for 79 percent of total government revenues). Other sectors of the economy and regions of the country did not experience a uniform pattern of growth during this period. Economic and social polarization minimized competition among businesses and limited development to the part of the economy concerned with the interests of dominant groups.

From the early 1960s until 1976, the private sector, particularly enterprises engaged in manufacturing, non-oil mining, commerce, construction, and agriculture grew exponentially.

As with the pre-World War II period, to bring about the rapid industrialization of the country, the state itself became heavily involved in infrastructural development and the construction of heavy industries. However, by drawing upon oil revenues to provide numerous incentives to the private sector, which included the sale of state-owned factories, a prosperous industrial private sector and bourgeoisie was also fostered. In addition, to promote domestic production, the government initiated a policy of import substitution, levying hefty duties on non-essential imports.

Largely due to the state's policy of encouraging industrialization and private enterprise, in the course of 1963 to 1976, Iran experienced a semi-industrial revolution. The number of entrepreneurs increased sharply, as did the share of manufacturing in the GDP from 11 to 17 percent and annual industrial growth from 5 to 20 percent.

Concomitantly, the number of industrial entities expanded from fewer than 1,000 in 1957 to 6,200 in 1974, accounting for 75 percent of the industrial products in the same year. During the same time period, the modern middle class, composed of technocrats, educated government functionaries, and professionals such as lawyers, engineers, teachers, and doctors also swelled substantially.



Sepah Bank



Melli Bank

Iran's brisk and steady rate of economic growth in the 1960s and especially in the 1970s was in large measure due to the surge in oil revenues. During these years, particularly in the 1970s, Iran became a rentier state, a nation whose government derives the bulk of its revenues from the sale of a natural resource. Oil revenues, in



turn, enabled the state to invest in the capital goods, infrastructure, education, and human capital, as well as construction and industrialization policies that, combined with Iran's youthful and more productive population and technology transfers from abroad, served as the engines of economic growth.

Ironically, Iran's rate of economic expansion in the 1960s and early 1970s, though slower than the post-1973 four-fold surge in oil prices, was much more steady, stable, and sustainable than after the rise in petroleum prices. The quadrupling of oil prices and the subsequent decision on the part of the state to arbitrarily double the pace of economic development, with the country unprepared to absorb the doubling of spending, resulted in runaway inflation followed by a deep recession and destabilization.

## Post-1979 Period

Since 1979, Iran has managed to register a respectable record in the promotion of indicators of social development. But its record on economic development has been lackluster at best, with the country saddled with a dysfunctional economy that has left its significant potential unrealized.

On the social development front, since 1979 Iran has substantially boosted its rates of education, literacy, immunization, physicians, and nurses per capita, and life expectancy. It has also reduced its infant mortality rate and increased its citizen's access to healthcare and clean water. At the same time, through its social development programs, particularly in rural areas, the country had, until its recent economic decline due to draconian sanctions and internal mismanagement, succeeded in diminishing the overall rate of poverty (from 40 to below 20 percent), though not that of income inequality. Since 1979, Iran has also introduced modern amenities (such as paved roads, electricity, piped water, television, educational institutions, even the internet) to rural areas.

The greatest strides in literacy and education have been made by youth and women, with females outnumbering males as graduates from the nation's expanding institutions of higher education.

Infrastructure has also improved, especially in the aftermath of the end of hostilities with Iraq in 1988, when the government sought and largely succeeded in developing the country's communication, transportation, education, and energy infrastructures (including its nuclear power facilities). Iran has also succeeded in integrating its communication and transportation infrastructure with that of the countries surrounding it.

On the economic front, however, the structural flaws of the pre-revolutionary period have been perpetuated and exacerbated. The resulting institutionalization of a state-dominated, oil-dependent, inefficient, and uncompetitive economy (beset by mismanagement, venality, high levels of inflation, un- and under-employment, anemic growth, subpar productivity levels, insignificant rates of foreign direct investment, production of low-value-added goods and services, and insignificant levels of non-hydrocarbon exports) has proved inimical to the ability of Iranians, especially the youth who constitute the majority of the population (65% of the nation's population is under the age of 35) to attain gainful employment and housing, get married, and engage in family formation.

Moreover, although unlike the hitherto prevailing pattern in Iran's neighbors to the south, Iranian women have become a relatively active force in the Iranian economy, at 16 percent their participation levels are still quite low and not commensurate with their educational attainments.

Largely swayed by developmental models that emphasized the non-market path to economic development, the framers of Iran's post-revolutionary constitution enshrined the principle of state domination and control of the economy in the nation's new constitution in 1979. In spite of several subsequent attempts at privatization, state and quasi-state organizations have consistently exerted control over what is estimated to be 70-80 percent of the Iranian economy. In recent years, the Iranian Revolutionary Guard Corps has increased its hold over the service, manufacturing, and commercial sectors of the economy, with its enterprises estimated to account for roughly 30 percent of the Iranian economy.



Tehran, Iran

While the average rate of economic growth per year in Iran between 1960-1975 stood at 10 percent, it fell to -2 percent between 1979 and 1989 (when the country experienced

a baby boom and war with Iraq and increased its population by 20 million) and has barely risen above an annual average of 4 percent since. Indeed, Iran's GDP per capita reached its pre-revolutionary level only in 2007, and since 1979, both the inflation and unemployment rates have almost never fallen to single digits. Meanwhile, over-employment in the bloated public sector has proved stubbornly resilient and detracted from the nation's capacity to increase economic growth or job creation in the private sector, the primary engine for economic development. Iran's per capita GDP in 2014 was lower than that of Algeria and even Iraq.

While the Iranian economy has registered a lackluster performance in the course of the last 40 years, as with the 1970s, periods of growth have coincided with spikes in the price of oil, with the injection of petro-dollars into the economy serving as the primary engine of growth in Iran. Economic growth rates have been highest when high oil prices have been combined with a confluence of other factors, namely improved relations with the outside world, lifting or lessening of economic sanctions, improvements in governance, and greater openness to the outside world.



Tehran University



Sharif University of Tech



Esfahan University of Tech

The most important source of growth, however, has been surging in oil prices, which have provided greater access to hard currency, allowing the country to reduce its foreign debt obligations to manageable levels, and prompting the Central Bank to ease restrictions on imports. This easing, in turn, has allowed domestic manufacturers to purchase the requisite capital goods and raw material to which they had hitherto been denied, thereby boosting productivity.

In the meantime, the nation has consistently scored poorly in rankings of business climate, levels of economic competitiveness, openness, and transparency put out by such organizations as the World Bank, World Economic Forum, the Heritage Foundation, and Transparency International. In 2019, Iran ranked 127/190 countries in the World Bank's Ease of Doing Business Report, which measures regulatory quality

and efficiency, and 91/141 in the World Economic Forum's Global Competitiveness Report. In 2019, the most recent year for which scores are available, it ranked 146/180 in Transparency International's Corruption Perceptions Index.

An even more formidable barrier to the nation's ability to generate an upturn in its economic performance and create sustainable growth and job creation is the negative perception of its brand and reputation. The practice of measuring global perceptions of countries was initiated by Simon Anholt in 2005. The Anholt – GfK Roper Nation Brands Index ranks countries on such dimensions as governance, exports, tourism, culture, people, and investment/immigration. Iran has consistently scored at the bottom 10 percent of the 50 developed and developing nations the index ranks. Iran's negative image and tarnished reputation, combined with the difficulties of doing business in the country, have inhibited a significant proportion of investors and firms, especially foreign ones with deep pockets and state-of-the-art technology, from committing to Iran.

Moreover, according to a study by the International Monetary Fund in the early 2000s, which does not appear to have become outdated with the passage of time, at roughly 150,000 highly educated immigrants per annum, Iran has one of the highest rates of brain-drain in the world. On the other hand, levels of foreign direct investment that the country has managed to attract, especially outside the oil and gas sector, have remained vanishingly small.



Iran Khodro is the largest car manufacturer in the Middle-East



Locomotive production line of Wagon Pars Company

In short, Iran's persistent inability to create the requisite conditions for its youthful population to achieve gainful employment and enhance its economic welfare has stood in sharp contrast to its ability to increase the nation's literacy rates and educational levels. Moreover, according to statistics put out by the regime itself, unemployment

among youth with college and university degrees, especially women, tends to be higher than among those with lower levels of education, with youth unemployment hovering around 30 percent (some independent economists put the figure at above 50 percent) and more than 700,000 individuals with Master's and Ph.D. degrees currently unemployed. Since 2006, the country has only managed to generate 500,000 net new jobs, the equivalent of graduating college and university students in 2013 alone. Chronic underemployment, meanwhile, has become entrenched and seemingly immune to amelioration.

This disparity between relative improvements in literacy and education on the one hand and economic stagnation, centralization, mismanagement, and widespread un- and under-employment on the other has been accompanied by, and in part given rise to, a plethora of social and environmental ills--ranging from pollution and water scarcity to high levels of addiction, prostitution, and depression to rising fatalities from collisions and increasing divorce rates and disparities in income distribution.

Yet, Iran's demographic profile can be transformed from a liability to an asset through the promotion of entrepreneurship, innovation, and business and management skills in the ranks of Iran's capable and educated workforce, especially the younger generation under the age of 35. Entrepreneurship and innovation can also go a long way towards bridging the gap between social and economic development. They can also make a significant contribution to the resolution to the problems of economic mismanagement, stagnation, as well as un- and under-employment.

## 4. Knowledge Economy in Iran

In the late 1990s and 2000s, information technology spread in Iran as a socio-economic platform for growth and development. The Internet started in Iran through academic entities and the private sector, but soon came under the control and was monopolized by government officials.

At the same time, mobile phones also spread throughout Iran. Thereafter, information technology, the Internet, and mobile phones caused a lot of changes in the means of communication and thereby business, science, technology, arts, and culture.

To gain a true understanding of information and communication technology and knowledge economy in the last two decades in Iran, the following issues have to be examined:

- Infrastructure
- Business and Services

- Human Resources
- Obstacles to Proliferation
- Unfulfilled Potentials

## Infrastructure

In the last two decades major steps have been taken to maintain steady growth in the information and communication sector in Iran. However, there continue to be lingering obstacles to the entrenchment and flowering of the sector, which should be addressed.

Investment in ICT infrastructure since 2000 shows that the number of Internet users and cell phone subscribers has grown exponentially. Iran is among the top five countries that have had a growth rate of over 20 percent and the highest level of development in telecommunication and have been awarded the UNESCO special certificate for providing telecommunication services to rural areas. A number of important facts and figures about the ICT infrastructure in Iran are provided below[1].

- **Telephone - Fixed Lines**

Number of subscribers: More than 30,000,000

Subscribers per 100 inhabitants: 38

Rank in the world: 9

Provider: Telecommunication Company of Iran (semi-private)

- **Telephone - Cellular Phone**

Number of subscribers: More than 87,000,000

Subscribers per 100 inhabitants: 108

Number of smartphones: 50,000,000 (Est.)

Rank in the world: 18

Providers: MCI Hamrahe Aval, MTN Irancell (semi-private)

- **Internet**

Access to Internet: 13.5 million households

Percent: 55.5% of all Iranian

Rank in the world: 20

International Connection: Infrastructure Company of Iran (semi-private)

Channels: Submarine fiber-optic cable to UAE with access to Fiber-Optic Link Around the Globe (FLAG); Trans Asia Europe (TAE) fiber-optic line runs from Azerbaijan through the northern portion of Iran to Turkmenistan.

Apart from the Iran-Kuwait submarine communications cable network, Iran is launching an optical fiber channel and a submarine communications cable in the Persian Gulf.

- **Access to Computer**

Urban: 64.8% households

Rural: 36.1% households

- **Electronic Banking**

SHETAB System: Electronic transactions between all banks

eBanking and Mobile Banking: e-Payment and e-Services available in all banks

POS: Over 6,500,000 point of sales

Bank Card: More than 400 million active bank cards

- **Supporting tools**

Top Level Domain (TLD): .ir, more than 1,200,000 registered domains

Farsi Unicode: ISIRI 6219, Persian Information Interchange and Display Mechanism, using Unicode

Open Source Support: Localization of Linux and Android

## Business and Services


Business and services in the era of the knowledge economy encompass a wide range of products and services, from telecom and Internet to software, applications, and e-services, and are developed by high tech and startup companies.

We review the startup ecosystem in Iran, and will also look at a sample of established and startup companies, technology parks.




We have also a look at the investment entities, accelerator, and incubator programs. Finally, we will examine the regulations that support startups.

- **The Startup Ecosystem**

The Iranian startup ecosystem includes accelerators, incubators, investors, events, and media. We will briefly scrutinize the important elements of the ecosystem.

Organization		Description
DMOND		<ul style="list-style-type: none"> <li>- Est. 2014</li> <li>- Accelerator and Startup camp</li> <li>- Consultancy services, seed funding</li> </ul>
Technovation (AVATECH)		<ul style="list-style-type: none"> <li>- Est. 2014</li> <li>- Accelerator program</li> <li>- Seed investment</li> </ul>
TAC		<ul style="list-style-type: none"> <li>- Est. 2015</li> <li>- Accelerator program</li> <li>- Seed venture</li> </ul>
FINNOVA		<ul style="list-style-type: none"> <li>- Est. 2015</li> <li>- Accelerator program, Training program</li> <li>- Seed venture</li> </ul>
TIVAN		<ul style="list-style-type: none"> <li>- Est. 2016</li> <li>- Network of entrepreneurs</li> <li>- Training program</li> </ul>
PersisGen		<ul style="list-style-type: none"> <li>- Est. 2016</li> <li>- Accelerator program in biotech</li> <li>- Seed investment in biotech</li> </ul>
SARAVA		<ul style="list-style-type: none"> <li>- Est. 2015</li> <li>- Funding and investment</li> <li>- Support for business development</li> </ul>
SHENASA		<ul style="list-style-type: none"> <li>- Est. 2016</li> <li>- Funding and investment</li> <li>- Support accelerator program and training</li> </ul>
Khoshfekri		<ul style="list-style-type: none"> <li>- Est. 2010</li> <li>- Coaching startups</li> <li>- Entrepreneurship educational resources</li> </ul>
















Esfahan Plus	 اصفهان پلاس رسانه جامعه کارآفرینی اصفهان	- Est. 2015 - Social entrepreneurship - Networking platform
TechRasa	 TECHRASA	- Est. 2015 - Startup and tech media - Startup events
Shanbe Magazine	 شنبه Startup Magazine	- Est. 2016 - Startup media - Startup events

There are also several governmental funds to support high-tech projects and startup companies.

- **Companies**

While high Tech and software companies have grown up in the Iranian market in the last three decades, the flowering of the startup movement has developed in the last decade. Below we will provide a brief sketch of some of the more established startup companies in Iran.



Company		Description
System Group	 همکاران سیستم SYSTEM GROUP	- Est. 1990, Business software solutions - More than 50,000 customers, 1,500 associates - First public software company 2011
Neda Rayaneh		- Est. 1993 - Internet service reseller - Cloud services
Informatics Services Corporation		- Est. 1993 by the Iran Central Bank - Providing national banking system
Fanap		- Est. 1995 by the Pasargad Private Bank - Providing core banking solution
Digikala		- Est. 2006, Largest e-commerce startup in Iran - Value reported \$500 million in 2015

Takhfifan		- Est. 2010 - Group Buying, Daily Deals
Aparat		- Est. 2010 - Iranian video sharing services - Broadband service 40 Gbit/s
Cafe Bazar		- Est. 2011 - Iranian Android marketplace - Surpassed 40 million users
ESTD		- Est. 2012 - Providing oil reservoir simulation software - Local and global customers
Divar		- Est. 2013 - Classified ad platform - More than 15 million subscribers
MamanPaz		- Est. 2014 - Food provided by chefs in houses
TAP30		- Est. 2016 - Peer-to-peer ride-sharing
Keshmoon		- Est. 2016 - Saffron marketplace by farmers to customers

- **Science and Technology Parks**

There are a total of 42 Science and Technology Parks and 186 Incubators across the country. Concentrated primarily at universities, they have for the most part been

established by the government. They continue to be supported by and are beholden to the government. Below we provide a brief synopsis of the key components of two of the major tech parks in Iran.

Tech Park		Description
Esfahan Science and Technology Town		<ul style="list-style-type: none"> <li>- Est. 2000</li> <li>- Synergy between R&amp;D and industry</li> <li>- Science Park, Pre-Incubator and Incubator</li> </ul>
Pardis Technology Park		<ul style="list-style-type: none"> <li>- Est. 2001</li> <li>- Promotes ties between universities and industry</li> <li>- Incubator, Tech Park</li> </ul>

- **Regulatory Structure**

In order to support the knowledge economy, the Iranian government has set up a regulatory body to support high technology knowledge-based startups. Companies may apply for the support, and will be evaluated according to the following criteria:

- Suitable high technology
- R&D based design
- Minimum viable product

Eligible startups will receive some support which the most important are as follows:

- Financial support
- Tax exemption
- Insurance support

## Human Resources

Iran's population is more than 80 million, more than 60% of whom are under the age of 30. Almost 4 million are college students, which provides the requisite human capital for developing a knowledge economy.

Table 1 below depicts the most recently available statistics for the academic year 2018-19 on the distribution of levels of education and degree attainment for the country's total college and university population of 3,616,114 students [2].

Table 1 - Higher education students 2018-2019

<b>Degree</b>	<b>No. of Students</b>	<b>Percentages</b>
PhD	141,077	3.9%
MSc	744,235	20.5%
BSc	2,076,361	57.5%
Associate	654,441	18.1%

Table 2 depicts the percentage of students enrolled in varying majors [2].

Table 2 - Higher education students' major

<b>Branches</b>	<b>Percentages</b>
Humanities	46.9%
Engineering	28.5%
Arts	8.2%
Basic Science	6.6%
Food and Agriculture	6.6%
Medical Sciences	6%

Table 3 depicts the numbers and percentages of graduates and their levels of degree attainment in the academic year 2017-18.

Table 3 - Higher education graduates 2017-18

<b>Degree</b>	<b>No. of Graduates</b>	<b>Percentages</b>
Ph.D.	10,107	1.3%
MSc	166,060	21.3%
BSc	429,752	55.1%
Associate	173,727	22.3%

Even according to official statistics, levels of unemployment among college graduates are highly elevated. Table 4 depicts the percentage of unemployed college graduates by gender, [1].

Table 4 - Gender of college graduates

<b>Gender</b>	<b>Unemployed</b>
Female	31.1%
Male	14.1%

Table 5 depicts the percentage of unemployment among recent college and university graduates on the basis of their fields of study.

Table 5 - Unemployment

<b>Field of Study</b>	<b>Unemployed</b>
Computer Science and Engineering	41.4%
Environmental Science	37.6%
Arts	28%
Natural Sciences	27.8%
Architecture	27.7%
Law	25.7%
Industrial Services	25.6%
Life Science	25.3%
Health Care	24.8%
Agriculture	21.1%
Engineering	21%
Business Administration	20.6%
Social Sciences	20.3%
Math and Statistics	17.8%
Journalism and Media	17.5%
Transportation	15.3%

Education	9.3%
Vet Medicine	8.7%

- **Upshot,**

As can be seen, Iran's human capital and the number of its post-secondary degree holders are quite impressive, making it a prime candidate for leapfrogging to an innovative economy. At the same time, however, the unemployment rate among college graduates is quite high. At a more granular level, more than 40% of computer science graduates are unemployed. Moreover, there are more than 100,000 Ph.D. holders in Iran, yet more than 30,000 of them are unemployed. We will discuss this issue in greater detail below and will examine how to create a more sustainable human resource development as well as job creation.

## Obstacles and Proliferation

Below, we will review the startup ecosystem in Iran, including the prevailing infrastructure and human resources, subsequently turning our attention to some of the obstacles that inhibit the entrenchment of an innovation economy.

## Ecosystem

The startup movement has started and has attracted many young and talented individuals. Private acceleration and incubation programs and investment entities are numerous and expanding.

In the meantime, governmental supported incubators and tech parks tend to be bureaucratic and less likely to fulfill their objectives but there is some governmental support for knowledge-based high tech startups.

- **Infrastructure**

As we saw, the communication infrastructure, including fixed telephone lines and cellular phones, has proliferated and produced a strong communication backbone. The Internet has high penetration and is very popular. Electronic banking has dominated financial systems.

- **Human resources**

Almost 5% of the population are college students, more than 60% of whom are females, but there are extremely high rates of unemployment among college

graduates, especially females, whose rates of labor force participation is among the lowest in the world. Unemployment among college graduates in the fields of science and engineering is embarrassingly high.

The Unemployment rate among PhDs and master's degree holders is also very high, as many in this category are unable to find jobs suitable for their education, becoming compelled to either become a part of the brain-drain, become downgraded in the job market, or remain unemployed.

- **Obstacles**

- Dearth of creative teaching and innovative learning in the K-12 education
- Absence of innovative thinking training in college education
- Lack of R&D directed towards result-oriented approaches
- Lack of commercialization of scientific output
- Absence of a developed private sector
- Marginalized presence in the global market
- Sanctions
- Brain drain
- Weakness of entrepreneurial culture
  - Inclination to develop an idea or product
  - Reluctance to regard failures as learning opportunities
  - Copycat
  - Lack of investment model
  - Lack of exit strategy
- Ineffective institutions, absence of the rule of law, capricious and weak enforcement mechanisms
- IP protection
- Bankruptcy and failure protection
- Regulatory framework
- Bloated and burdensome bureaucracy

## Unfulfilled Potentials

With slightly more than 1 percent of the world's population, Iran possesses the largest known natural gas reserves (16 percent of the global total) and the fourth largest petroleum deposits (approximately 10 percent of global reserves). The combination of its natural gas and petroleum deposits makes Iran the world's largest reserve holder of hydrocarbons. Nor is this all. Based on current estimates, Iran possesses at least 7 percent of the world's mineral wealth, with 68 varieties of non-oil minerals, and roughly 60 billion metric tons of mineral reserves, making it the 15<sup>th</sup> largest mineral reserve holder in the world. According to the New York Times, mining, which currently contributes less than 5 percent of Iran's GDP, has the potential of becoming a \$65 billion a year industry –easily rivaling the nation's oil sector.



Startups in Iran

In addition to its enormous wealth of natural resources, Iran also occupies a particularly important strategic location. Apart from being the only country that connects the Caspian Basin to the Persian Gulf region, Iran's status as a neighbor to 15 countries across land and sea and its position as a bridge between Europe, South Asia, the Caucasus, and Central Asia makes it an ideal north/south and east/west transit route.

Iran's natural resources, geographic position, and relatively advanced infrastructure make it ideally situated to accelerate its economic take-off and enhance substantially the socio-economic welfare of its population. However, humans, not natural, resources, or coveted geostrategic location, are Iran's most formidable endowment. Indeed, proper policies on human capital development and capacity building can enable the country to experience an economic renaissance led primarily not by hydrocarbons, minerals, and transit fees, but entrepreneurship, innovation, production of high value-added products, and technology.



According to the World Bank, roughly 98 percent of Iranians between the ages of 15 and 24 are literate. According to the Central Bank of Iran, the number of individuals with postsecondary degrees, which currently stands close to 16 million (out of a population of some 84 million), is increasing rapidly, with 4.5 million students enrolled in post-secondary institutions of higher learning. Roughly 40 percent of those graduating from tertiary institutions are engineering majors, 60 percent of whom are females.

## 5. Innovation Economy in Iran

During the previous century (1300 - 1400 AH, 1920 - 2020 AC), while Iran experienced tremendous economic growth, development, and industrialization, it did not experience cutting edge industrial development, nor did it catch on to the informatics revolution. During the interwar period, improved infrastructure, exemplified by the trans-Iranian railway, along with improved governance, integration, and state-led economic development served as the primary growth engines in the country.

In the aftermath of the Second World War, particularly in the 1960s and 70s, import-substituting industrialization financed in large part by petro-dollars and massive infrastructural spending constituted the core engines of economic growth.

During the last three decades, meanwhile, much progress has been made in laying the educational foundations for the entrenchment of information technologies and the knowledge economy, which have also made marginal contributions to job creation and the growth of the Iranian economy. The enormous potential of information technologies, however, has remained unfulfilled.

Yet if the Iranian economy is to realize its true potential, it has to catch on to the fourth industrial revolution and transfer itself into an innovation-driven economy. Introduced in the mid-twentieth century by Joseph Schumpeter, Innovation economics is an increasingly relevant economic theory that emphasizes the role of entrepreneurship and innovation in the promotion of economic growth. Innovation economics is based on the basic principle that the main goal of economic policy should be to stimulate greater productivity through greater innovation.

Contrary to neoclassical economists, innovation economics is predicated on the notion that what stimulates economic growth in contemporary economies is not the accumulation of capital, but innovative capacity supported by scientific knowledge leading to technological progress.

Indeed, given the country's tremendous wealth of human capital, the flowering and entrenchment of an innovative economy constitutes the most promising and logical next growth engine for the Iranian economy.

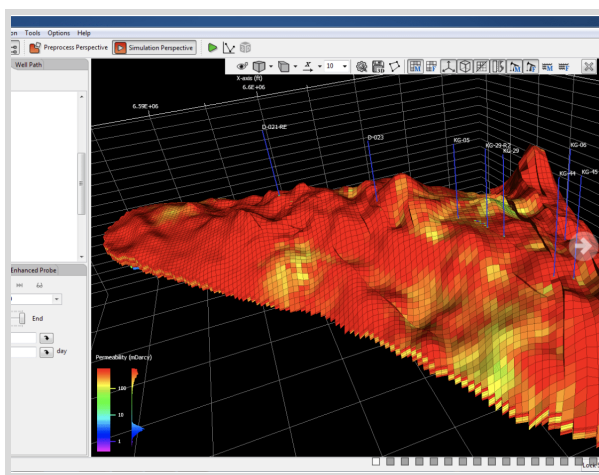
## Capitalizing on Strengths

It is possible for Iran, the Middle East region's first rentier state (a country that derives a substantial portion of its revenues from the sale of a natural resource rather than relying on a dynamic economy and taxing its citizens) to successfully diversify and build a knowledge-based and innovation-led economy while cutting its dependence on extractive resources.

If it were to come about, such a development would help to once again catapult Iran into the position of a regional trailblazer. Iran, after all, was the first country in the Middle East to discover and subsequently nationalize its oil reserves. It was also the first to experience genuine constitutional and social revolutions.

Iran possesses many of the key ingredients that have enabled such nations as Taiwan, China, Japan, and India to enhance the prosperity and well-being of their populations through augmenting productivity and innovation levels and adding to the number of small and medium-sized businesses in their countries.

Iran's talent and skills base are impressive indeed, as are the technical and financial endowments of the diaspora, numbering some 4-5 million. The 1 million Iranian experts in the US alone are estimated to be worth more than one trillion dollars and are keen to build bridges and lend a helping hand when the legal and political barriers are removed.



Oil Reservoir Simulation  
ESTD Company (Tehran, Iran)



AI-Enabled Personal Assistant, Cafe  
Bazar (Tehran, Iran)

Iran also boasts one of the highest levels of global tertiary education participation. Indeed, its tertiary participation rate is higher than those in Germany, France, and the United Kingdom. Moreover, in the course of the last 19 years, the number of individuals enrolled in Iran's post-secondary institutions has increased by a factor of three, causing the country to achieve the world's fastest-growing scientific output, as measured by the number of articles published in peer-reviewed journals, although the quality of many of these articles is suspect. In many cases, the quality of education is also not up to par and the number of patents registered has failed to keep up with the number of scientific publications.

With more than 1 million graduates in IT-related fields, Iran also has one of the highest shares of engineering graduates in the world. Forty percent of college students study engineering, and though the country's population is one-quarter of the US, it has roughly the same number of engineering students as America (234,000), 60 percent of whom are women. Competition to get into engineering programs is fierce, and roughly 20-25 percent of graduates (especially of prestigious public universities) are world-class, many of whom receive full scholarships from the likes of MIT, Cal Tech, Berkeley, and Stanford upon graduation. It should be recalled that in 2008, Professor Bruce Wooley, former Chairman of Stanford University's Electrical Engineering Department, characterized the Iran's Sharif University of Technology as having one of the best undergraduate electrical engineering programs in the world.

Infrastructure and connectivity are also improving, with 50/80 million population having access to the internet, 45 million smartphones in operation, and roughly 100 incubators/accelerators scattered throughout the country. The country launched the 3G service in 2014, and the percentage of internet users has consistently been on the rise. At 130 percent, the level of mobile phone penetration is higher than in Germany.

Other factors that can act as catalysts in spawning an entrepreneurial and innovative economy in Iran are the predominantly urban nature of Iranian society, the relatively high esteem in which entrepreneurs are held by the general public, as well as the strong work ethic and industriousness that prevails among the public.

According to the *Global Entrepreneurship Monitor*, entrepreneurs are held in higher regard in Iran than in France, with the image and status of entrepreneurs in Iran being on par with how entrepreneurs are perceived in the US. Concurrently, according to the World Bank, 73 percent of Iran's inhabitants now reside in the nation's urban centers, eight of which have a population of more than one million. Iran's current urbanization rate is roughly equal to urbanization levels in Germany, Switzerland, and Turkey.

Experiences of economically successful countries have shown that dynamic cities are necessary (though obviously not sufficient) for the establishment of innovation clusters that are indispensable for increasing creative output and inventiveness. Moreover, the

types of collaboration/clash across disciplines and ideas that tend to occur in diverse and cosmopolitan megalopolises play a crucial role in fostering innovative business ideas and solutions to socio-economic conundrums.

At the same time, although Iran has been blessed with hydrocarbons, its large population and periodic sanctions, especially the most recent debilitating unilateral secondary American sanctions, have prevented its government from establishing a cradle to the grave economy. The country, therefore, has been spared one of the most baleful consequences of the oil curse. Iran has avoided the steady erosion of the work ethic of its population, which is so rampant among the inhabitants of the Gulf Cooperation Council states due to their much smaller populations and the even more central role that oil plays in their economies. On the other hand, because of its large and increasingly educated population, Iran has also avoided the GCC pattern of becoming dependent on both skilled and menial expatriate workers for the functioning of its economy.

If harnessed properly, then, Iran's skills and talent base, relatively positive attitudes towards entrepreneurship and free markets, strong work ethic, as well as familiarity with the culture of entrepreneurship developed over the course of millennia (not to mention potential access to the knowledge, experience, and funds of its overachieving expatriate community) can enable the country to increase productivity, fuel innovation, and add to the number of small and medium-sized businesses.

Indeed, the experiences of the so-called East Asian Tigers, as well as China and India, have amply demonstrated that an educated and technically savvy population has the capacity to generate economic growth, employment, and high-value-added goods and services in relatively short order. In India, for instance, ICT services currently account for roughly 67 percent of the nation's service exports.

Moreover, the experiences of both emerging and developed countries demonstrate the overwhelmingly important role that small and medium-sized companies can play in employment generation and innovation promotion. In the US, for instance, companies with less than 500 employees are responsible for creating two-thirds of all the net new jobs. Employees in small and medium-sized companies also tend to generate 13 times more patents than workers in large companies. This is of acute importance for Iran, where the public sector is not, nor should be, in a position to generate employment, and the established companies in the private sector tend to be bereft of the wherewithal to create the requisite jobs.

However, far from emulating the example of developing countries that have succeeded in building robust and high-value-added economies, Iran has thus far failed to take advantage of the intellectual and creative capacities of its citizens. Some 5.7/12 million college graduates, 25 percent of engineers, and 21.8 percent of scientists are

unemployed. While unemployment in the ranks of educated men stands at 20 percent, at least 50 percent of educated females are estimated to be without jobs. According to the World Bank, Iranian women, who constitute the most educated social force in the country, are also the most underutilized talent pool not just in Iran but in the world, since they are either unable or discouraged from obtaining employment outside their homes. Under such circumstances, it is not surprising that a significant proportion of the “best and brightest” become a part of the brain drain each year.

The inability on the part of Iran's educated population to obtain employment is due both to the lack of sufficient jobs being created, especially in the STEM fields, and the dearth of practical, management, business, commercial, and entrepreneurial skills on the part of the educated population. There is a mismatch between the skills-building opportunities are minimal, the number of graduating and existing MBA's is low, and graduates in non-business related fields are exposed to virtually no business and management training.

According to the World Economic Forum's Global Competitive Index, Iran ranks 115/144 countries in terms of providing on-the-job training. What is more, with the exception of elite institutions, basic standards of learning tend to be low to mediocre and the level of skills mismatch tends to be high. Furthermore, the didactic and hierarchical nature of the curriculum, as well as the mode of instruction, tend to be inimical to creative and critical thinking.

## Innovation Economy Ecosystem

The innovation economy is one that experiences sustained growth through the creation and implementation of new technologies, products, or processes in an ecosystem of inventors, entrepreneurs, and investors. Innovation is the conception, design, and implementation of new products and processes or changes to existing products and processes that create value for society.

Indeed, the ability of the innovation economy to solve problems and create value while improving the functioning of all sectors of the Iranian economy, combined with Iran's large, demanding, and sophisticated local market and the nation's capacity to access markets in the Middle East and Central Asia, can do wonders for the Iranian economy.

But the emergence of a successful innovation economy is dependent on a multitude of factors, generally falling into the following categories: *economic incentives*, *availability of financial capital*, *supply of human capital*, and *access to information*. In this sense, the most important factor is human capital, which Iran is very rich in. Iran is also endowed with motivated, talented, and educated human resources. However, the quality of the educational system in Iran is frequently not up to par, and the system tends to

deemphasize critical, innovative, and out-of-the-box thinking. In the meantime, the quality of high-level research in science and engineering also tends to fall short of global standards. Regulatory, legal, bureaucratic, and cultural challenges also abound. Initiating regulatory reform is challenging, complicated, and frequently out of the grasp of civil society organizations, especially in the short to medium term. The country, however, can benefit greatly from quality supplemental training and education directed towards the development of technical skills as well as innovation and entrepreneurship. Supplemental education, moreover, has the advantage of being able to be initiated and sustained by public and private sectors and NGOs as well.

Supplemental training can also help to ignite and lay the foundations for the flowering of technology entrepreneurship and an innovation-based economy, which could serve as the most potent subsequent growth engines for the Iranian economy.

The relatively new theory of the innovation economy is based upon the idea that diverse collective knowledge, responsible entrepreneurship, technology, art, innovation, leadership, and collaboration fuel economic growth. Key concepts in the innovation economy include emotional intelligence, cross-collaborative culture, and scalable processes.

The development and entrenchment of an innovation economy ecosystem in Iran require the assessment of its current situation, highlighting the obstacles to its advancement, and consideration of solutions for alleviating the obstacles. Although a Startup movement has started in earnest in Iran, resulting in the relatively steady generation of companies that are inherently innovative to varying degrees, a large number of obstacles inhibit the transition from a knowledge-based to an innovation-based economy. We analyze these obstacles in the table below, proffering solutions to how to address them, and offering suggestions on how the solutions should be prioritized.

<b>Obstacles</b>	<b>Causes/Consequences</b>	<b>Suggestions</b>
Lack of creativity in the development of K-12 curricula	<ul style="list-style-type: none"> <li>- Inflexible K-12 educational system</li> <li>- Test-oriented approach in training</li> </ul>	<ul style="list-style-type: none"> <li>- Extracurricular project-based learning</li> <li>- Incorporation of subjects imparting 21st-century skills, such as computational thinking, system and design thinking</li> </ul>

Absence of innovative thinking training in college education.	<ul style="list-style-type: none"> <li>- More than 20% of engineering graduates are unemployed</li> <li>- More than 40% of computer graduates are unemployed</li> </ul>	<ul style="list-style-type: none"> <li>- Addition of Entrepreneurial training to college curricula</li> <li>- Skills training for college graduates</li> </ul>
Lack of R&D directed towards result oriented approaches	<ul style="list-style-type: none"> <li>- More than 30,000 unemployed PhDs--and rising</li> <li>- Lack of commercialization of scientific output</li> </ul>	<ul style="list-style-type: none"> <li>- Advanced project based training and special purpose acceleration and incubation programs</li> </ul>
Weak Entrepreneurial culture	<ul style="list-style-type: none"> <li>- Disinclination to develop an idea or product</li> <li>- Negative attitudes towards failure and disinclination to learn from mistakes and try again</li> <li>- Embrace of the copycat approach</li> <li>- Lack of investment model</li> <li>- Lack of exit strategy</li> </ul>	<ul style="list-style-type: none"> <li>- Entrepreneurship training</li> <li>- Improvement of rules and regulations</li> </ul>
Ineffective institutions, absence of the rule of law, capricious and weak enforcement mechanisms	<ul style="list-style-type: none"> <li>- Insufficient IP protection</li> <li>- Stringent Bankruptcy laws and absence of failure protection</li> <li>- Burdensome regulatory framework</li> <li>- Bloated and burdensome bureaucracy</li> </ul>	<ul style="list-style-type: none"> <li>- Improving rules, institutions regulations</li> <li>- Developing improved contract models under current rules and regulations</li> </ul>
Absence of a developed private sector	<ul style="list-style-type: none"> <li>- Lack of startup support by corporations</li> <li>-Lack of merger or acquisition</li> </ul>	<ul style="list-style-type: none"> <li>- Development and strengthening of the foundations of the innovative economy</li> </ul>
Marginalized presence in the global market	<ul style="list-style-type: none"> <li>- Sanctions</li> </ul>	<ul style="list-style-type: none"> <li>- Looking at the regional markets and improvement of relations with the outside world</li> </ul>

The above table highlights a spectrum of requirements for transitioning to an innovative economy in Iran. In addition to the above, it is also essential to improve connectivity and

infrastructure. However, bringing about improvements in infrastructure as well the quality of governance and the rule of law are among the responsibilities of the government and, while some of these reforms are on the agenda, others continue to receive short shrift.

There is no doubt that factors ranging from international isolation to burdensome regulatory frameworks, inadequate IP and bankruptcy protections, rapacious judicial and bureaucratic structures, and an inefficient education system undermine Iran's capacity to transition to an innovation economy. However, while improving governance and reforming the education system require intervention on the part of policymakers, human capital development through supplemental training, which constitutes the most important factor in the entrenchment of innovation economies, can be undertaken by grassroots organizations. As such, the proposals offered by this report concentrate on human capital development initiatives that can be undertaken by public and private sectors and NGOs as well, and are designed to alleviate the innovation and entrepreneurship gaps in Iran. Our proposals, which are designed to enhance, develop, and propagate the requisite skills, knowledge, and culture among the youth, will be presented below.

Focusing on developing the creative and innovative potential of the youth, state of the art training in entrepreneurship and innovation for college students, the establishment of community, networking, and training centers for recent graduates, and training in applied artificial intelligence for advanced graduates in technical fields with Masters and Ph.D. degrees, the initiatives steer clear of political and policy domains, focusing instead on bottom-up solutions that can be undertaken by public and private sectors and NGOs as well.

We believe that the creation, implementation, and proliferation of the programs below can go a long way towards reducing the deficiencies of Iran's educational system and empowering college students and recent graduates to become entrepreneurial change agents and problem solvers. The programs will enhance entrepreneurship and innovation skills and result in the development of platforms for creating synergy, peer-to-peer learning, and collaboration.

- Innovative Thinking Lab
- Hackers Club
- Startup Garage Course

Meanwhile, to enhance technology advancement and what refers to as "deep" innovation we suggest the promotion of the following program:



- AI Centric Innovation Hub

The contents of the four aforementioned programs will be explained below.

## **Innovative Thinking Lab (آزمایشگاه نوآوری)**

### **Highlights**

To improve creativity in the development of K-12 curricula, the Innovative Thinking Labs will be offered as after-school programs in high schools that prepare students to not only survive but thrive in the innovation-driven global economy.

The Lab's objective will be to empower students to become creative problem solvers by improving their cognitive and critical problem-solving skills.

Innovative Thinking Labs will enable students to practice team-based problem solving by participating in extracurricular activities that emphasize hands-on, project-based learning in a collaborative environment.

The lab will enable students to design and build things and solve real problems, thereby bringing the learning culture into line with real-world issues and providing students a clear sense of how learning can develop creative and innovative mindsets.

### **The Lab**

The Lab will be equipped with both basic and advanced tools, such as 3D printing, laser cutters, micro engines, sensors as well as IoT and AI tools.

The Lab will support students to practice problem-solving skills through a "Learn, Design, Make" approach while simultaneously acquiring soft skills.

Curricula, contents, workbook, as well as a teacher's guide, will be developed for the following topics:

- Design and System Thinking
- Computational and Algorithmic Thinking
- IoT, AI and Robotics

### **Clarification**

Project-based learning and hands-on training are basic principles in the Innovation Lab to improve skills and creativity.

Students will be organized in teams to work on projects. Each team will be trained to define problems and design solutions, create prototypes, and test and adjust their prototypes as necessary under the support of mentors.

## **Hackers Club (باشگاه هکرها)**

### **Highlights**

The Hackers Club will be a community center for recent college and university graduates, where they could avail themselves of the opportunity to develop soft and technical skills, team up, and network with compatriots to jointly learn and collaborate on the promotion of innovation and entrepreneurship. The goal is to provide a platform for supplemental skills to address the mismatch between what is taught in schools versus the demands of the job market on the one hand and the capacity to succeed as an entrepreneur on the other.

The Hackers Club will endeavor to be a platform for encouraging teamwork and collaboration with the aim of fostering innovation and entrepreneurship.

### **The Club**

College graduates are in need of opportunities to be trained in:

- Problem-solving and collaboration skills
- Entrepreneurial and innovative thinking skills
- Technical skills

The Hackers Clubs aim to address these needs by imbuing computer science, engineering, and other graduates with the skills to flourish in the job market.

Such an organization is likely to attract many members and recruits since:

- A startup movement has started in Iran
- The youth, in particular, are eager to work, create and innovate
- The infrastructure for supporting technology-based endeavors has been established and is continuing to expand
- The appetite for investing in startups, ranging from the fledgling to more mature, is beginning to grow.
- The youth are keen to both learn about and transform themselves into success stories, which serve as guiding principles as well as sources of inspiration and emulation.

Hackers Clubs will serve as community centers to cultivate innovative thinking and entrepreneurship through a bottom-up and market-oriented approach, and will help to:

- Unleash innovation
- Promote job creation
- Enhance prosperity

The Hackers Clubs will be established as NGOs under the support of local industries entities interested in advancing social impact. Hacher's clubs will be established around the country and, as they grow in numbers, recruits, and influence, a union of Hatcher's Clubs will coordinate collaboration and cooperation among them.

### **Clarification**

The Hackers Clubs will primarily attract college graduates and empower them by providing them with soft skills, such as design thinking and entrepreneurship. The clubs bring college graduates together, helping them to team up, discover problems, and ideate solutions. They will be encouraged to learn about and focus on local and neighborhood problems, come up with market-oriented solutions, and establish startup companies to address those problems. While the local markets will serve as venues from which problems will be derived, some of the solutions proposed for resolving the problems result in the creation of products or services that may have broader regional or even global attraction.

## **Startup Garage Course (درس کارگاه نوآفرینی)**

### **Highlights**

Startup Garage will be an undergraduate course recommended for all college students to learn about innovative thinking and entrepreneurship. It will be a hands-on and project-based course designed to develop innovative thinking mindsets and entrepreneurial skills. It will prepare college graduates to be motivated to be entrepreneurs.

### **The Course**

Startup Garage will be an intensive, hands-on, project-based course in which students collaborate in teams to design and test new business concepts that address real-world needs. The Startup Garage course will equip students with 21st-century skills in entrepreneurship and innovative thinking and will promote the pursuit of careers toward innovation and entrepreneurship.

In Startup Garage, students will learn to apply the concepts of design thinking, engineering, finance, and business organization. Teams should identify unmet customer needs, design new products or services that meet those needs and develop business

models to support the creation and launch of those products or services. Accomplished graduates will learn about what it takes to be successful entrepreneurs and determine whether starting a business or working for a startup, is the right path for them.

### **Clarification**

The Startup Garage course will be composed of a package that includes a textbook, project manual, instructor's guide, online mentorship support, and digital repository. College students will enroll in the course to learn about innovative thinking and entrepreneurship in a hands-on and project-based approach. The expectation is that the desire to engage in innovation and entrepreneurship will spark in young college graduates the motivation to address local neighborhood needs. Annual nationwide gatherings can bring together students to learn about selected projects, collaborate, and achieve synergy.

## **AI Centric Innovation Hub (ہابِ نوآوری با رویکرد ہوش مصنوعی)**

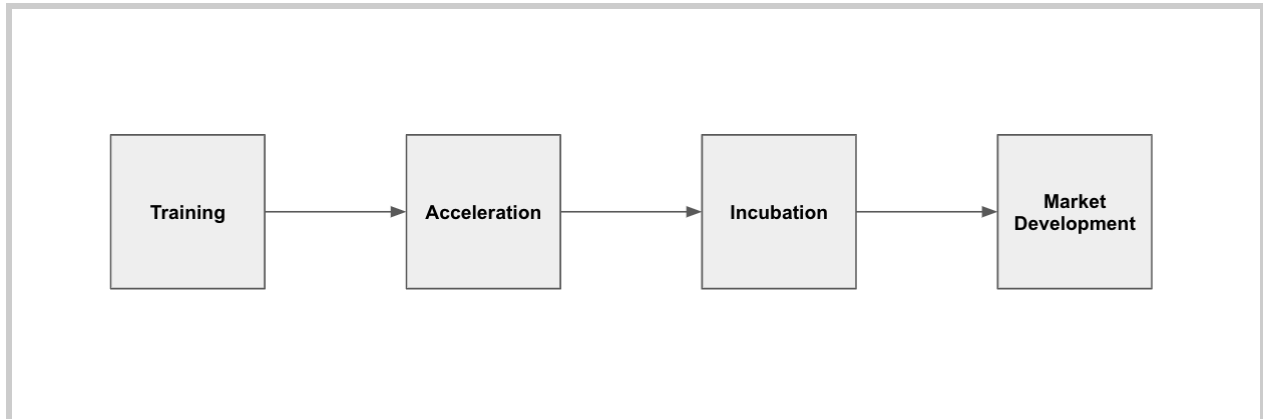
### **Highlights**

The Innovation hub will consist of an ecosystem that harnesses the power of artificial intelligence and associated fourth industrial revolution technologies to spur cutting-edge intra- and entrepreneurship in such sectors of the economy as energy (both hydrocarbons and renewables), healthcare and biotechnology as well as other service-oriented industries.

The main goal at the hub is to repurpose recent graduates with Masters and Ph.D. degrees through supplemental training in entrepreneurship, innovative thinking, data science, and artificial intelligence so they could address the needs of industries through AI-based innovation.

### **The Hub**

Since innovation is the product of ecosystems, innovation hubs will create ecosystems that empower and facilitate the generation of creative ideas by intra- and entrepreneurs, and the adoption of those ideas into new products, processes, services, and organizational models focused on AI applications. Project-based training, support for the development of the projects in the acceleration and incubation programs, along market development constitute the core components of the innovation hub.



Well-educated human resources in Iran with Ph.D. and Master's degrees and backgrounds in science and engineering will constitute suitable candidates to join the hub and receive state-of-the-art training in artificial intelligence.

The aim would be to repurpose and retool recent graduates with a demonstrated aptitude and potential by imbuing them with advanced training in the fields of artificial intelligence and data science

Training in AI as well as the acceleration and incubation programs will constitute the core of the innovation hub, and together will constitute the innovation hub's ecosystem. The above flow diagram below depicts the key components of the innovation hub's ecosystem.

Well educated individuals can be admitted to the training program and will receive 3 to 6 months of training in the following disciplines:

- Design and Systems Thinking, Entrepreneurship
- AI, Machine Learning, Deep Learning

The training will be hands-on, project-based, and team-based, with the teams working on market-oriented projects.

Upon termination of the training and evaluation of projects by a panel of judges, eligible teams will be given the opportunity to join the acceleration and incubation program to establish a startup company.

Subsequently, those whose companies demonstrate high potential will be invited to participate in the next phase and will be supported to engage in market development.

## **Clarification**

AI and data science is changing the world and powering the 4th industrial revolution (4IR). As we head towards the 5th industrial revolution (Industry 5.0), which will bring about the interdependence of man and machine using cognitive computing and human intelligence, mass customization, and personalization for humans will increasingly become the norm. However, while there is tremendous demand for AI products and services as well as those who can create them, particularly in Iran, the demand in the job market, both in industry and academia, for young PhDs and Masters degree holders in the fields of science and engineering is quite limited. As we have already seen, there is a glut of unemployed and under-employed university graduates. While lamentable, current conditions also present a unique opportunity for talents with expertise in science and engineering to receive supplemental training in AI and data science and be repurposed to fill market needs. In addition to bridging the gap between the requirements of the job market and the skills of the graduates, the hub will produce world-class intra- and entrepreneurs that will enable Iran to maintain a strong presence in the AI market with valuable products and services.

## **Opportunities**

Prospects for engaging in creativity and innovation are enhanced through the encouragement of diversity, multiplicity, and variety and the constructive clashes that occur at the intersection of different disciplines, attitudes, and mindsets. It would therefore be important that the participants in the training programs are derived from diverse backgrounds. Teams composed of varying disciplines and mindsets will be cobbled together to address real-life challenges and problems. The AI-centric innovation hubs will especially be keen to support ideas derived from the local context with broader regional and global applications. In Iran, such opportunities are likely to cohere in the energy and biotech sectors

- **Oil and Gas**

For more than a century, Iran's oil industry has remained disconnected from other industries, particularly the manufacturing sector. Oil startups, however, are the key to the integration of the petroleum industry into the broader economy. AI, Data Science, and IoT have the capacity of bringing lucrative opportunities to the oil and gas industry as well as the renewable energy sector. Participants in the training sessions of the innovation hub should be provided with the opportunity to receive internships in the oil and gas industry to discover the needs and opportunities that they may address and

resolve through innovation. Such innovations may lead to business development and the establishment of startup companies.

Indeed, the oil & gas industry constitutes a field in which AI technologies have the potential to have a transformative impact, and where there are many opportunities for Iranian entrepreneurs. AI can be applied to the oil and gas sector including but not limited to the following areas:

- AI algorithms detecting risks in oil pipelines.
- AI algorithms detecting asset behavior anomalies
- Rig diagnostic AI bots
- AI-enhanced process engineering
- AI-enhanced oil recovery
- AI-enhanced maintenance
- AI-enhanced HSE

- **Genomic, Biotech, and Life Science**

Genomics and biotechnology are also sectors that contain many opportunities in AI-based R&D. Artificial intelligence technologies will fundamentally change how genomics, biotechnology, and life sciences startups and companies turn data into actionable insights.

In Iran, there are also abundant opportunities to gather national population genomic data and work on native rare diseases. Areas ripe for exploration:

- Heart disease diagnosis
- Cancer detection
- Medical imaging
- Disrupting the pharma industry by offering solutions to long-tail diseases (10,000 diseases are untreated)

Participants in the hub should be granted the opportunity for internship in this sector to discover problems, work on them as projects, and find innovative AI-based solutions to them.

- **Sustainability**

As the field of AI develops, so will the potential to protect the environment. From the land and air to both drinking and ocean water, renewable energy, and climate change AI is shaping up to be the key that governments, organizations, and individuals can tap to work toward a cleaner planet.

## 6. Postscript

Based on the above analysis, we believe that in light of Iran's demographic and educational profiles, laying the foundations for an innovation-driven and entrepreneurial economy constitutes the most effective means for generating long-term economic growth and development in Iran. The imposition of draconian sanctions combined with the decline in the price of oil has abruptly ended the dependence of the Iranian economy on petroleum. Even if the sanctions are lifted and oil prices recover, however, Iran would do well by investing the proceeds from the sale of its hydrocarbons in a fund used for facilitating the country's transition to an innovation economy rather than financing current spending.

Historically, crises have frequently provided the occasions for initiating and sustaining bold yet essential reforms and initiatives. Today, Iran's youthful population, almost universally literate and more educated than at any time in the country's history, constitutes the most formidable asset to the Iranian economy. We have discussed several initiatives for human resource development. Looking towards the future, we should also examine the role that the petroleum industry can play as the primary source of financing for the development of Iran's economy. While sanctions and international isolation present obstacles to the entrenchment of an innovation economy in Iran, they have also had a number of unintended beneficial effects. Below we will discuss, on the one hand, the role that the petroleum industry and sanctions have played and can play in the development of an innovative and knowledge-based economy in Iran and, on the other hand, the role that the strengthening of the innovation economy can have on the petroleum industry and sanctions. We will conclude by exploring the prospects for the promotion of the innovation economy in Iran in the post-2020 period.

### Oil and Gas and Petrochemical Industries

For many years, Oil and gas were the primary sources of income for the Iranian government and provided the resources for public development projects, the government's annual budget, and the bulk of foreign exchange earnings. Nevertheless, throughout this period, Iran's oil industry remained essentially disconnected from the nation's other industries. As with other economic sectors, the entrenchment of a knowledge-based and innovation-driven economy can provide the opportunity for startup companies to serve the oil and gas sector by developing innovative products that can appeal to both local and international markets. Greater details on the opportunities provided by the oil and gas industry during the innovation economy era are provided below.



## Overview

With slightly more than 1 percent of the global population, Iran possesses at least 7 percent of the world's mineral wealth, 10 percent of its petroleum reserves, and 16 percent of the planet's natural gas deposits. Iran possesses the second-largest known natural gas reserves and the third-largest petroleum deposits in the world. The combination of its natural gas and petroleum deposits makes Iran the world's largest reserve holder of hydrocarbons. [19].

In light of its enormous wealth of human and natural resources, entrepreneurial and youthful population, strategic location (apart from being the only country that connects the Caspian Basin to the Persian Gulf, Iran's status as a neighbor to 15 land and sea countries and its position as a bridge between Europe, South Asia, the Caucasus, and Central Asia makes it an ideal north/south and east/west transit route), and relatively advanced infrastructure, Iran is—and has been—ideally positioned to serve as a magnet for investments that could accelerate its economic take-off, transform the country into a locomotive for regional growth, and enhance substantially the socioeconomic welfare of its population.

Since its discovery and large-scale production more than a century ago, however, more so than Iran's other multifaceted endowments, petroleum has frequently been the driver of the nation's development trajectory. In analyzing the role of oil in Iran's economic development, however, a number of important points have to be borne in mind. First, From the 1920s to the 1960s, the price of oil was low, as was Iran's production capacity, and the contribution of petroleum as a source of earnings and revenue for the Iranian government was not significant. Iran became a rentier state only in the aftermath of the downward trend in oil production in the US starting in 1971 and, more importantly, the quadrupling of oil prices in 1973, although the nation's level of economic diversification remained higher and its dependence on oil lower than that of its neighbors across the Persian Gulf region.

The second point is that oil is not a labor-intensive industry. Presently Iran's oil exports have become virtually halted because of sanctions, but even when the country was exporting at full capacity both before and after the revolution, the contribution of petroleum to the Iranian economy was indirect by serving as the government's primary source of revenue, which was subsequently used to either cover current spending or invest in development projects. However, while in the 15 years preceding the revolution and after the termination of the Iran-Iraq war until the imposition of debilitating sanctions on Iran (2012-2015) and (2018 - ) oil revenues served as the basis for economic growth

and development, the Iranian petroleum industry itself, which is highly capital intensive, essentially did not contribute to either employment generation or innovation.

Moreover, with the exception of a brief period during Khatami's second term, Iranian governments from the 1970s onwards have made the mistake of injecting all of the nation's oil earnings into the economy during periods when petroleum prices have been high, increasing the economy's dependence on oil, assuming the continuation of high oil prices, and thereby setting the stage for intense periods of bust that have inevitably followed short periods of boom.

### **Oil and Gas in the Innovation Economy Era**

In post-revolutionary Iran, where the nation's hydrocarbon revenues are not simply subject to global prices but can also be affected by sanctions, the creation of an oil reserve fund as an instrument for saving and investing oil revenues when prices are high, keeping the flow of oil revenues into the economy steady at all times, and utilizing the funds as necessary when the bottom falls out of prices is essential. Just as important would be the ability to draw upon the reserve fund to pay for the requisite investments in education and training for paving the way for Iran's transition to an innovation-driven economy.

Iran's status as the world's largest reserve holder of hydrocarbons, especially the second reserve holder of gas, which is both relatively cheap and clean, ensuring its demand into the foreseeable future, as well as Iran's important capacity and potential in petrochemicals, make the country's eventual return to the hydrocarbons market highly likely. Moreover, Iran's re-emergence as a major exporter can be expedited by alterations in American policy towards Iran and the Middle East, along with modifications to Iran's international posture in response to geopolitical and internal political economy considerations. [20], [21].

Upon the removal of restrictions on the sale of Iranian hydrocarbons, the government should take the lead in preparing Iran's formidable talent base for the innovation economy era. While much of the state of the art technology for the exploration, development, and exploitation of hydrocarbons would have to be imported from leading Western companies, Iranian innovators and entrepreneurs themselves could also be trained to draw upon artificial intelligence and other fourth industrial revolution technologies to come up with innovative approaches to solve problems, improve efficiency, and extract and produce oil and gas in a more cost-effective manner. Iranian technologists can be trained in advanced AI models and data science methodologies to optimize production, minimize disruptions, and drive operational productivity and

efficiency. Applied AI will also enable innovative entrepreneurs to predict plant upsets well before they happen with a high degree of accuracy and monitor production to provide recommendations that will maximize production volume, quality, inventory levels, and profitability.

Significantly, the upshot of the injection of entrepreneurship and innovation into the oil and gas industry would be to finally connect Iran's hydrocarbons sector to the nation's other industries and enable the Iranian petroleum industry to contribute to both employment generation, innovation, and the empowerment of the private sector.

### **Accelerating Innovation**

In an era in which innovation in all domains has become perpetual, attracting young and talented college and university graduates to the oil and gas and petrochemical industries is essential. Organizing special-purpose accelerator and incubator programs focused on the energy and oil and gas industries can foster innovative entrepreneurship in the energy sector.

Bringing the needs, problems, and opportunities of the oil and gas industry to the attention of college and university students and graduates through seminars, webinars, and other media outlets can make them aware of the needs of the oil and gas sector. It can also encourage the entrepreneurial-minded to tackle problems and develop innovative solutions with applicable outcomes.

Innovative teams should join accelerator programs in the field of oil and gas, where they can find the support and opportunities to develop prototypes in the form of minimum viable products (MVPs). Subsequently, successful entrepreneurs may receive seed funding and join an incubator program to commercialize and market their prototypes.

During the acceleration and incubation processes, operational support and seed funding should be provided to promising entrepreneurs who strive to make technological advancements that will reduce costs and increase efficiency for oil and gas companies.

Incubators should provide partnerships with entrepreneurs to help commercialize products faster and with greater impact in the highest value domestic and international markets. They should also support entrepreneurs with idea maturation, product development, value proposition tuning, business model development, go-to-market strategies, and execution. As with other industries, transforming the product development approach into a customer-driven process, validating the concept early and quickly implementing improvements will help to upgrade the oil and gas sector and connect it to the broader economy while promoting innovation and job creation.

## Impact of Sanctions on the Innovation Economy

Iran has been sanctioned by various entities over the last several decades. The United States imposed sanctions on Iran in 1979, following the hostage crisis, and expanded them in 1995 to prohibit firms from investing in the Iranian petroleum sector. The UN also sanctioned Iran in 2006, when the Iranian government refused to suspend its uranium enrichment program. The EU placed additional sanctions on Iran in 2007 in response to concerns over Iran's nuclear program and human rights violations in the country.

These sanctions targeted various aspects of Iranian commercial and public life, including bans on investments in oil, gas, and petrochemicals, exports of refined petroleum products, and business dealings with the Iranian Revolutionary Guards. This latter category included banking and insurance transactions (including with the Central Bank of Iran), shipping, and digital services.

We will review the baleful and unintended consequences of sanctions on Iran, and examine the impact of sanctions on building an Innovation Economy in Iran.

### **Baleful Consequences**

The Iranian regime has been subject to sanctions with fluctuating levels of intensity since 1979. However, until the imposition of what former US Secretary of State Hillary Clinton referred to as crippling sanctions (2012-2015) and the subsequent maximum pressure campaign orchestrated by the Trump administration against the Islamic Republic starting in 2018 when the US left the Joint Comprehensive Plan of Action (JCPOA), the accord signed between Iran and the five permanent members of the UN Security Council plus Germany in 2015 to curb Iran's nuclear program, the structural flaws and policy choices of the Islamic Republic clearly overshadowed sanctions in terms of their consequences for the economic well-being of the Iranian people. Moreover, during the decade preceding the imposition of the 2012 sanctions, the expanding stream of revenue accruing to the Iranian state due to rising oil prices enabled the Islamic Republic to mitigate the consequences of its own policies and tolerate the limited, though gradually increasing, costs that sanctions were imposing on its economy.

Due to their unilateral and targeted nature, the costs of sanctions against Iran before 2005 were limited and generally marginal. During these years, the policies and practices

of the Iranian government itself played a far more instrumental role in undermining the capacity of Iranians to promote their economic well-being.

From 1979 to the mid-2000s, sanctions against Iran were essentially unilateral, imposed solely by the US. Although these sanctions inflicted costs on Iran, which were subsequently passed on to the Iranian people, these costs were not overbearing, as non-American companies were unwilling to sever their links to the Iranian economy.

After 1996, with the passage of the Iran-Libya Sanctions Act (ILSA), the US sought to initiate the process of choking off Iran's most important source of hard currency and governmental revenue by imposing sanctions on any entity that invested more than \$20 million per annum in Iran's hydrocarbons sector. In practice, however, due to severe objections from America's European allies, full implementation of ILSA remained elusive. The imposition of the first round of UN Security Council resolutions against Iran in 2006 enabled the US to receive more cooperation from its European partners and other allies in its endeavor to increase the transaction costs on the Iranian economy. But it was not until 2012 and the imposition of comprehensive, multilateral sanctions that this cooperation reached its apogee, resulting not only in a geometric rise in the costs being imposed on Iran but also, for the first time since Iran's oil nationalization movement in the early 1950s, an effective embargo on Tehran's primary revenue stream its oil exports.

The imposition of the 2012 sanctions caused Iran's oil revenues to be cut by more than half, and substantially increased its transaction and operating costs. The removal of nuclear-related multilateral sanctions against Iran after the enactment of JCPOA enabled Iran to restore its oil exports, restore international trade, and attract investors to its economy, although the actual extent of investments never reached the level anticipated by the government. Moreover, some of the most lucrative investment pledges, particularly in the gas sector, were annulled in the aftermath of the decision on the part of the Trump administration in 2018 to restore and expand US sanctions against Iran and impose secondary sanctions against foreign entities investing, facilitating financial transactions, or purchasing hydrocarbons from it.

The new round of secondary American sanctions has also made it increasingly difficult to transfer funds into and out of the country. The resulting hard-currency crunch and revenue shortfalls have, in turn, significantly decreased the value of the Iranian currency, greatly increased the costs, and diminished the amount of both essential and non-essential imports (including medicine, medical equipment, and industrial inputs), expediting the contraction of the economy, reduced the tax base, further depleted the government's revenues, and sharply expanded the inflation, unemployment, and

poverty rates—all of which were already in double digits. The costs associated with the newly imposed round of sanctions, therefore, are no longer limited, but increasingly debilitating.

As a result, Iran is now largely unable to mitigate the worsening structural flaws of its economy. Instead, internal economic, managerial, and bureaucratic flaws have combined with sanctions to impose unprecedented levels of hardship on the lives of ordinary Iranians.

The current sanctions regime has not only reduced Iran's productive capacity, it has also contributed to economic mismanagement. Sanctions busting mechanisms have increased corruption, and attempts by the Central Bank to cover the government's budgetary shortfalls by expanding liquidity have increased the rate of inflation. The standard of living of all wage earners has plummeted substantially and an increasing number of unemployed individuals and blue-collar workers (and their dependents) living in the country's urban centers, where 71 percent of the population resides, are being pushed into penury.

The internal and external drags on the Iranian economy are now so intertwined that assigning a specific weight to their respective impact on the living standards of Iranians is difficult. However, it is clear that there has been a significant shift: Prior to the most recent round of sanctions, it was simple to demonstrate, both conceptually and empirically, that domestic Iranian policies bore a greater responsibility for the economic sufferings of the Iranian people than sanctions.

This is no longer the case. So far as the economic well-being of the Iranian population is concerned, secondary American sanctions have greatly amplified the defects of the Iranian economy. [22], [23], [24].

### **Unintended Consequences of Sanctions**

Though Iran would obviously have been far better off without them, sanctions have also had some unintended and arguably salutary effects. By shielding the Iranian economy from external competition, sanctions have, as we shall subsequently see, contributed to the spawning of a vibrant start-up movement in Iran. In particular, prohibitions and restrictions inhibiting the globally dominant American technology companies from operating in Iran have helped to pave the way for “copycat” indigenous versions of Uber, Amazon, eBay, Lift, Craigslist, and Bango, among others. Although clear replications of American companies, some Iranian copycats have become more innovative and enterprising over time, growing into monumental companies in their own rights, starting to attract investors, and casting an eye on penetrating neighboring markets. [28].

At the same time, while the plunge in the value of the Iranian currency, an indirect result of sanctions, has contributed to inflation and wreaked havoc on the Iranian manufacturing sector by making reducing the availability and making the cost of imported industrial inputs prohibitively expensive, it has also made Iran's agricultural and livestock sectors, which are not dependent on imports, more internationally competitive, allowing them to augment their exports. On the other hand, although such exports do contribute to job and value creation, their added value tends to be limited. According to the statistics put out by the Department of Customs of the Islamic Republic of Iran, in 2012, each ton of imports to Iran was valued at \$1,634, while each ton of exports had an average value of \$468.

It should be noted that the entrenchment of an innovative and entrepreneurial economy in Iran can even make the agricultural and livestock sectors more efficient by using digitalization to help farmers work more precisely, efficiently, and sustainably. Data-driven solutions can also improve water and crop use, increase agricultural yields, and boost both the productivity and value of the agriculture and livestock sectors.

An additional unintended consequence of the increasingly hostile relationship between the US and Iran, culminating in the Trump administration's attempts at suffocating the Iranian economy, has been the reassertion and the increasing entrenchment of the so-called "Eastern gaze" in Iran's foreign policy. Iran is frustrated by the Europeans, who share Iran's opposition to the Trump administration's withdrawal from the JCPOA but have proved unable to prevent their companies from bowing to American pressure to refrain from dealing with Iran. As a result, and in a bid to circumvent American sanctions, the Islamic Republic has sought to pursue closer ties with Russia and especially China, neither of which are particularly reliable partners.

Still, even though the most recent round of extraterritorial American sanctions are hitting the Iranian economy increasingly harshly, have substantially reduced Iran's productive capacity, and contributed to the promotion of economic mismanagement, their unintended consequences may have been just as profound. By helping to spawn a vibrant domestic high-tech sector that is offering increasingly sophisticated products and services, sanctions have laid the basis for Iran's transition to a knowledge-based and innovation-driven economy.

## Post-2020

The proposals presented in this report, which are designed to alleviate the shortcomings of Iran's educational system and empower the youth through a bottom-up approach

relying on the private sector, NGOs, as well as K-12 schools and higher education institutions, will help to imbue the individuals who participate in the proposed programs with the innovative and entrepreneurial skills with which to address the nation's myriad challenges. In the process of finding innovative solutions to their local problems, graduates of our programs will be able to improve their livelihoods while contributing to the economic uplift of their communities and the improvement of the conditions in their country. At the same time, the partial retreat from globalization and the increased localization of value chains that have followed in the wake of the corona pandemic, and are likely to persist in its aftermath, will provide additional opportunities for local innovation. Such innovation, in turn, will prove advantageous to laying the foundations for an innovative economy in Iran.

Even before the onslaught of Covid-19 and the collapse in oil prices, Iran's economy was in free fall because of the combined impact of draconian sanctions, internal mismanagement, and reductions in the price of oil and gas. Statistics on the recent performance of the Iranian economy are sobering and are likely to become even worse. Iran's economy shrank by 7.6 percent last year. Inflation is conservatively estimated to hover around 40 percent, while the overall unemployment rate is reaching 27 percent. In addition to having to grapple with the calamitous human costs of the virus, the country will now also be compelled to cover its budget deficit by drawing upon its foreign currency reserves, which are rapidly dwindling and increasingly difficult to access. Resorting to printing money, meanwhile, will exacerbate stagflation and will increase the country's already high rate of poverty, inequality, and unemployment, especially in the ranks of its increasingly educated youth.

However, though the coronavirus pandemic will bring enormous harm to the Iranian economy, it will also carry opportunities for innovation and entrepreneurship. Indeed, both during and especially after the pandemic begins to ebb, implementation of the proposals we outlined above will help to keep Iran in good stead, enabling it to strengthen the foundations for its transition to an innovation-based economy.

The revitalization of nationalism, increasing localization of supply chains, and proliferation of the economic, social, cultural, and medical problems that will follow in the wake of the termination of the coronavirus will provide Iran's youthful and educated population the opportunity to generate and commercialize solutions for the multitude of problems afflicting the country as a whole as well as local communities. At the same time, the infrastructure for remote instruction, with which we have become intimately familiar during the Covid-19 crisis, will be an enabler for delivering training programs.



Moreover, while Covid-19 will likely further undermine both the scale and scope of economic globalization and the integration of local and national economies into a global economy, this diminution is most unlikely to do away with the phenomenon of globalization altogether. The persistence of enfeebled globalization, meanwhile, will still afford talented Iranian entrepreneurs the opportunity to offer their innovations with broader regional and global appeal at the international level.

It should be noted, however, that Iran's window of opportunity for making the transition to an innovation-based economy is limited, and will slip away if the transformation process is not initiated and institutionalized in a timely manner. Much more so than strategic location and natural resource endowments, Iran's key comparative advantage lies in the country's prevailing demographic and educational attributes. Presently the ratio of the youth to the elderly population is decisively slanted towards the young. Roughly 70 percent of Iran's population is currently under the age of 35 and, as noted, the young are almost universally literate and increasingly educated. Because of the performance of the Iranian economy as well as institutional, educational, and international constraints, however, Iran's capacity for being able to draw upon the vigor, energy, and creativity of its youthful population to boost productivity and innovation has remained unfulfilled.

Our aim is to make a difference in this picture through quick impact practical training to both unleash and harness the stamina and inventiveness of Iran's youth and to kickstart the transition to an innovation economy. But the advantage and potency of Iran's young demographic dividend will disappear over time as, in the face of plummeting fertility rates, themselves the result of rising education levels in the ranks of females, the youth bulge gives way to an overwhelmingly greying population. Thereafter, the decline in the number of the working population and increased life expectancy will combine to strain both the government's limited resources, and diminish the economy's productive and innovative capacity.

Better to get a head start on the transition to an innovative economy through human capital development while the country's demographic profile remains favorable. Much of the required supplemental training and education for this transition can, and indeed should be provided by societal organizations, as we are proposing. However, when oil prices recover and restrictions on the sale of Iranian hydrocarbons are removed, the government itself should also create a reserve fund, whose proceeds should be used to partially cover the cost of preparing and retooling Iran's formidable talent base for the post-hydrocarbons and innovation economy era.

In time, efforts at elevating the development of a globally competitive innovation economy into an appealing national vision at the grassroots level can bring about a transformation in popular culture and consciousness which, in turn, will contribute to the ground up anchoring of an innovation economy in Iran.

## References

- [1] Statistical Center of Iran, Yearbook 2017.
- [2] Ministry of Higher Education, Yearbook 2018.
- [3] Ervand Abrahamian, *A History of Modern Iran*, New York: Cambridge University Press, 2008.
- [4] Ervand Abrahamian, *Iran Between Two Revolutions*, Princeton: Princeton University Press, 1980.
- [5] Ervand Abrahamian, "Why the Islamic Republic Has Survived," Middle East Report, March 15, 2009.
- [6] Ali Ansari, "The Revolution Will Be Mercantilized," National Interest, February 11, 2010.
- [7] Jahangir Amuzegar, "Iran's Oil As a Blessing and a Curse," Brown Journal of World Affairs, 2008.
- [8] Jahangir Amuzegar, "Iran's 20 Year Economic Perspective: Promises and Pitfalls," Middle East Policy, Vol. 16, No. 3, September 2009.
- [9] Hossein Askari, "Iran's Economic Policy Dilemma," *International Journal*, Volume 59, No. 3, Summer 2004.
- [10] Hossein Bashirieh, *State and Revolution in Iran, 1962-1982*, New York: St. Martin's Press, 1984.
- [11] John Foran, *Fragile Resistance: Social Transformation in Iran from 1500 to Revolution*, Boulder, Westview Press, 1993.
- [12] Robert Graham, *Iran: Illusion of Power*, London: Croom Helm, 1978.
- [13] Homa Katouzian, *The Political Economy of Modern Iran: Despotism and Pseudo-modernism*, New York: New York University Press, 1981.

- [14] Djavad Salehi-Esfahani, *Growing Up In Iran: Tough Times for the Revolution's Children*, Brown Journal of World Affairs, Vol. XV, Issue 1, Fall/Winter 2008.
- [15] Djavad Salehi-Esfahani, "Iran's economy 40 Years After the Islamic Revolution," Brookings Institution, March 14, 2019.
- [16] Hadi Salehi-Esfahani and M. Hashem Pesaran, "The Iranian Economy in the Twentieth Century: A Global Perspective," Working Papers 452, Economic Research Forum, March 2008.
- [17] Joseph Schumpeter, *Capitalism, Socialism, and Democracy*, 6th Edition, London: Rutledge, 1943.
- [18] K. Mohaddes and M. H. Pesaran, *One Hundred Years of Oil Income and the Iranian Economy: A Curse or a Blessing?* in P. Alizadeh and H. Hakimian, eds., *Iran and the Global Economy: Petro Populism, Islam, and Economic Sanctions*, London: Routledge, 2014.
- [19] Hadi Salehi Esfahani, Kamiar Mohaddes, and M. Hashem Pesaran, "Oil Exports and the Iranian Economy," *Quarterly Review of Economics and Finance*, Vol. 53, Issue 3, August 2013.
- [20] Hossein Askari, John J. Forrer, Hildy Teigen, and Jiawen Yang, *US Economic Sanctions: Lessons From the Iranian Experience*, Global Management Working Paper Series, The George Washington University, July 2001.
- [21] Hossein Askari, *Iran's Economic Vulnerability: Self-Inflicted, Not Sanction-Driven*, insideIRAN.org, November 10, 2009.
- [22] Suzanne Maloney, *Sanctioning Iran: If Only It Were So Simple*, Washington Quarterly, January 2010.
- [23] Richard Sabatini, *Economic Sanctions: Pressuring Iran's Nuclear Program*, NTI, June 24, 2010.
- [24] M. Hashem Pesaran and Ron Smith, "Mismanagement More Problematic Than Sanctions," Financial Tribune, December 14, 2015;
- [25] M. Hashem Pesaran, *Iran Sanctions: Now Is the Time to Negotiate*, Guardian, September 17, 2013.
- [26] Pontia Fallahi, *10 Startups in Iran to Watch Out For*," Theculturetrip.com, May 9, 2017.