Abstract

Catch-up of technology is related to the processes, solutions and using of these opportunities that provides us to achieve our goals in a short time. In this study, authors tried to produce a complete definition for catch-up through analyzing different research. Then with using expert opinions, a categorization for dimensions of catch-up will be prepared. We estimate the technology gap (Iran Nanotechnology) to the leaders of Nanotechnology Technology for catch-up with using the metafrontier approach that analyzed countries Have been classified by cluster analysis.

Keywords: Technology catch - up, Cluster analysis, Nano technology, metafrontier.

Introduction

For developing countries, considering the gap and the quick rate of technology growth in developed countries, those strategies are significantly important which lead to an increase in the rate of technology growth and minimizing the gap in short term. There are various ways of achieving up-to-date technology. Among the researches are those which are dedicated to the solutions and significant factors the developed technology pioneers have experienced. In another category, there are researches focusing on optimizing approach, updating paths and methods, using back-wardens advantages. Some believe the opportunity window to be the best choice, saying that the final purpose might be the same as that of developed countries, yet the path taken is not necessarily the same. They argue that considering the native strategies and circumstances is important and they believe using the opportunities is the golden key to technology catch-up. Due to this fact, they do not take the backhandedness a disadvantage, rather an advantages to use opportunities and avoiding the sequences of being pioneer. They consider using the window opportunity and avoiding dependence as strategies to quick access to successful technologies.

In this study, first we briefly present some of the definitions and notions in quick access and leap. Considering the special situation of Iran in the region and world, in case there is a significant gap, and acing that technology is amongst country's strategies according to the upstream documents, the solution will be quick access to that technology taking a minimum cost and time approach. At the end of that part, we can present some approaches to quick access to technology, each of which to be used in the specified field. In the second part, using a quantitative approach, the conditions of Nano technology in Iran is studied as compared to the Middle Eastern and international competitors. The purposes include determining technology gap, determining whether or not the path and approach Iran has taken works and determining if the path would lead to a decrease in the gap. At the end, using the significant factors mentioned in part I, suggestions could be presented to promote the approach taken by Iran about Nano technology.

Definitions of quick access and affecting dimensions

A necessary part of development process in countries beyond the pioneers of technology and economy, is learning and dominance over tasks in short terms. This is known as quick access. In this meaning, quick access does not solid copying (Lall & Pietrobelli, 2005) Countries with the longest distance with technology pioneers mostly depend only on foreign knowledge, importing technology via equipments, machinery, or under-licensed
production and even reverse engineering and copying (Burkett & Hart-Landsberg, 2003) Veblen (1915) was the first person to compare economic rating of countries and identifying the factors involved and primary industrial advantages. In 1966, Richard Nelson and Edmond Philips introduced the notion of quick access from other countries, which was among the most interesting ideas in modern economic growth. Yet, this is officially credited to Gerschenkron (1962) who stated that countries behind the technology gap are able to decrease their distance from leading countries through imitating the technologies. Gerschenkron believed the discussion on quick access must be added to the veblen's ideas. He showed that late-developed countries are able to accelerate the technology achieving growth through developed technologies of pioneer leading countries. The well-known work by Gerschenkron, "economic development in a historical prospective", was an exception at its time. He explicitly considers inability to quick access as the reason for development of Europe in the second half of the 19th century. After Nelson and Philips, Abramovitz (1986) studied and reviewed Gerschenkron's ideas. He showed that the technology gap rate depends on the followers' ability to receive technology streams from the pioneers. Abramovitz’ article, "catching up, forging ahead and falling behind" made the notion of quick access a part of standard vocabulary for development economists. (Burkett & Hart-Landsberg, 2003; Chesbrough, 2003)

Domestic structures

According to Madision and Greschenkron, growth and moving towards development in technology are not achieved by purchasing or using ready-made solutions, rather they depend on dominance and expertise on all technology components. Chandler (Grossman & Lai, 2006; Radošević, 1999) argues that importing technologies is fruitless without synchronizing with native innovative efforts and establishing relations with market demands. Infrastructure must be corrected and there is a need in investing in educational activities.

Knowledge aggregation: an important remark about pioneer countries was that they aggregate knowledge in developing sections and this acted as a growth factor for them (Falvey, Foster, & Greenaway, 2004; Vedeler, 2013). Technology imparting mechanisms leading to quick access have been subject to change during time (Patel & Pavitt, 1994) Historical evidence show that technology imparting occurs through domestic aggregation of technology, as a vital factor to growth (Acemoglu & Robinson, 2000)

Primary conditions: in the literature the term primary condition is mentioned, although making examples has made it contradictory. For example, human resources expertise in central Europe such as Czech is sometimes neglected. For example Dosi (Mu & Lee, 2005) argues that primary advantages cannot predict future events.

Opportunity window: according to Gerschenkron, under special circumstances back warded countries are able to grow faster than pioneer countries. In his opinion, huge gaps provide the biggest opportunities for back warded countries to imitate and quick access which lead to convergence in development levels.,(Radošević, 1999) Perez and soete and Unger show two opposite situations for possibility of technology quick access, and optimistically claim that the current conditions will remain to be the same at future, especially in the leap direction o develop. In this regard, it has been argued that new technologies are the opportunity window for leap. Contrarily, Unger argues that developing countries, due to needing new skills and also rare entrepreneurship resources, will be "on the edge of vain rotation."

Institutional and social circumstances: Abramovitz argues that a country is able to develop rapidly in which backwardedness is not due to incompetency (Abramovitz, 1989; Radošević, 1999) However, when the country is technologically back warded, but enjoys social advantage, the situation is provided for quick growth (Silverberg & Verspagen, 1994) Abramovitz considers such facilities as international technical communications channels, international trade circumstances, and direct foreign investment as significant in knowledge distribution (Lundvall & Johnson, 1994; Manca, 2010; Mazzoleni & Nelson, 2007)

Macro policy-making and development plan: Tunzelmann (1995) shows that in dynamism perception, the appropriate technology to choose is not the one that is compatible with our advantages and talents, rather the quality of talents increase for long term advantage is significant (Mazzoleni & Nelson, 2007; Póvoa & Rapini, 2010) He believes that in any case of successful quick access, it begins with focusing on the process. Also, he argues that other things the same, the ability development opportunity will be higher as compared to the case in
which the technology is imported as key in hand or as direct foreign investment. This also applies to native technological capacity. What opportunities and circumstances for achieving the technology must be used depends on the native efforts, complementarily and imported technology perfectionism (Abramovitz, 1989; Nelson & Phelps, 1966; Radosevic, 1999)

**Investment:** Ozawa (1992) developed the development dynamic scheme of "facilitating direct foreign investment". Direct foreign investment operation acts as a catalyst for industrial development and technological leap. He tried to involve a developmental function of multi-national companies in the theory of open economic development (Dollar & Kraay, 2003) A similar attempt from Dunning undertaken in which the multi-national companies activities were taken as an exogenous variable affecting the competitive advantage and technological leap (Manca, 2010)

<table>
<thead>
<tr>
<th>Table 1: Dimensions, attributes and variables catch-up</th>
<th>Characteristics</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
<td></td>
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<tr>
<td>annual growth in money supply Average</td>
<td>Access to healthy money</td>
<td>Strong institutions</td>
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<tr>
<td>Freedom to own foreign currency bank accounts inside or outside</td>
<td>Trade liberalization</td>
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<td>Standard inflation variability in the past five years.</td>
<td>Intellectual Property</td>
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<td>Recent inflation</td>
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<tr>
<td>Size of Government</td>
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<td>Legal Structure and Security Law</td>
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<td>Will the income</td>
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<td>Freedom International Trade</td>
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<tr>
<td>Regulation of credit, labor and business</td>
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<td>Judicial independence</td>
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<td>Impartial courts</td>
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<td>Protection of property rights</td>
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<td>Integrity of the legal system</td>
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<td>Military interference in rule</td>
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<td>Publications</td>
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<td>The Scientific Basis</td>
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<td>Published information at meetings and conferences</td>
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<td>Governance indicators</td>
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<td>Informal interactions with researchers</td>
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<td>The importance of market</td>
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<td>Advisor</td>
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<td>The importance of government</td>
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<td>Patents</td>
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<td>Accountability</td>
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<td>Political Stability</td>
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<td>Government Effectiveness</td>
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<td>Regulatory Quality</td>
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<td>Rule of Law</td>
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<td>Control of Corruption</td>
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<td>Market size</td>
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<td>Market dynamics</td>
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<td>Market-driven innovation</td>
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<tr>
<td>Remember the key role of the state and the central market</td>
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<tr>
<td>The role of government as a national system of learning technology and innovation</td>
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<tr>
<td>Policies and infrastructure</td>
<td>Commitment to Innovation</td>
<td>Innovative capacity</td>
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<tr>
<td>Investments in innovation</td>
<td>Available capacity</td>
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<tr>
<td>Geographic Area</td>
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<tr>
<td>Historical records</td>
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<tr>
<td>Cost</td>
<td>Investment</td>
<td>Window of opportunity</td>
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<td>The gap</td>
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<td>The uncertainty</td>
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<tr>
<td>Market</td>
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<tr>
<td>Time to learn</td>
<td>Institutional framework</td>
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</tbody>
</table>
Cluster Analysis

By cluster analysis we mean the partitioning of data into meaningful subgroups, when the number of subgroups and other information about their composition may be unknown; good introductions include Hartigan, Gordon, Murtagh, McLachlan and Basford and Kaufman and Rousseeuw

Hierarchical methods proceed by stages producing a sequence of partitions, each corresponding to a different number of clusters. They can be either ‘agglomerative’, meaning that groups are merged, or ‘divisive’, in which one or more groups are split at each stage. Hierarchical procedures that use subdivision are not practical unless the number of possible splittings can somehow be restricted.

In agglomerative hierarchical clustering, however, the number of stages is bounded by the number of groups in the initial partition. It is common practice to begin with each observation in a cluster by itself, although the procedure could be initialized from a coarser partition if some groupings are known. A drawback of agglomerative methods is that those that are practical in terms of time efficiency require memory usage proportional to the square of the number of groups in the initial partition.(Fraley & Raftery, 1998)

At each stage of hierarchical clustering, the splitting or merging is chosen so as to optimize some criterion. Conventional agglomerative hierarchical methods use heuristic criteria, such as single link, complete link or sum of squares In model-based methods, a maximum-likelihood criterion is used for merging groups

Relocation methods move observations iteratively from one group to another, starting from an initial partition. The number of groups has to be specified in advance and typically does not change during the course of the iteration. The most common relocation method k-means reduces the within-group sums of squares. For clustering via mixture models, relocation techniques are usually based on the EM algorithm neither hierarchical nor relocation methods directly address the issue of determining the number of groups within the data. Various strategies for simultaneous determination of the number of clusters and cluster membership have been proposed (e.g. Engelman and Hartigan Bock ,Bozdogan for a survey see Bock). An alternative is described in this paper.(Fraley & Raftery, 1998)

In this study we use a Clustering with undetermined volume method and Leading technologies were selected in each continent
<table>
<thead>
<tr>
<th>Country</th>
<th>knowledge</th>
<th>Economic Incentive Regime in knowledge</th>
<th>Innovation</th>
<th>Education</th>
<th>Location</th>
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<tr>
<td>South Africa</td>
<td>5.75</td>
<td>5.49</td>
<td>6.89</td>
<td>4.87</td>
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<td>Mauritius</td>
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<td>4.41</td>
<td>4.33</td>
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<td>Botswana</td>
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<td>5.82</td>
<td>4.26</td>
<td>3.92</td>
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<td>4.5</td>
<td>4.11</td>
<td>3.37</td>
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<td>7.77</td>
<td>9.38</td>
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<td>Israel</td>
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<td>Singapore</td>
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<td>9.49</td>
<td>5.09</td>
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<td>5.02</td>
<td>4.61</td>
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<td>9.65</td>
<td>9.66</td>
<td>8.77</td>
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<tr>
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<td>9.30</td>
<td>9.47</td>
<td>9.01</td>
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<td>Denmark</td>
<td>9.25</td>
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<td>9.49</td>
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<tr>
<td>Ireland</td>
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<td>Netherlands</td>
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<td>8.79</td>
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<tr>
<td>United States</td>
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<td>9.46</td>
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<td>Costa Rica</td>
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<tr>
<td>Aruba</td>
<td>6.04</td>
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<td>Trinidad and Tobago</td>
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<td>6.36</td>
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</tr>
<tr>
<td>Chile</td>
<td>7.59</td>
<td>9.01</td>
<td>6.93</td>
<td>6.83</td>
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<tr>
<td>Uruguay</td>
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<td>6.6</td>
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<tr>
<td>Brazil</td>
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<td>4.17</td>
<td>6.31</td>
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</tr>
<tr>
<td>Argentina</td>
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<td>2.09</td>
<td>6.9</td>
<td>6.36</td>
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</tr>
<tr>
<td>Peru</td>
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<td>5.48</td>
<td>4.11</td>
<td>5.25</td>
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</tr>
<tr>
<td>Peru</td>
<td>4.95</td>
<td>5.48</td>
<td>4.11</td>
<td>5.25</td>
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<tr>
<td>Bahrain</td>
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<td>Oman</td>
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<td>5.23</td>
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<td>Middle East</td>
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<td>Qatar</td>
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<td>3.41</td>
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<td>Middle East</td>
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<td>Turkey</td>
<td>6.19</td>
<td>5.83</td>
<td>4.11</td>
<td>ASIA</td>
<td>Middle East</td>
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<td>Jordan</td>
<td>5.65</td>
<td>4.05</td>
<td>5.55</td>
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<td>Kuwait</td>
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<td>5.22</td>
<td>3.7</td>
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<td>Lebanon</td>
<td>4.28</td>
<td>4.86</td>
<td>5.51</td>
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<td>Middle East</td>
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<td>United Arab Emirates</td>
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<td>6.60</td>
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<td>2.04</td>
<td>3.07</td>
<td>2.4</td>
<td>ASIA</td>
<td>Middle East</td>
</tr>
</tbody>
</table>
The second step of analysis consists of determining the stochastic frontier. It is assumed that each country i, group k=1, 2, 3, 4 makes use of its factors according to group specific technology. The stochastic group-k frontier model to be estimated will be defined as: (Drine, 2012)

\[ y_{it}^k = f(x_{it}^k, \beta^k) \exp(V_{it}^k - U_{it}^k) \]

\[ y_{it}^k \] is the output of country, \( x_{it}^k \) is the vector of inputs and \( \beta^k \) is the vector of unknown parameters. \( V_{it}^k \) is error term identically \( V_{it}^k \sim N(0, \sigma^2_{V_{it}^k}) \)

\[ U_{it}^k = \text{non-negative error term independent from } V_{it}, \text{ which represents the technical inefficiency. Unit is distributed independently as a zero-truncated normal process.} \]

\[ T_{E_i}^k = \frac{Y_{it}^\ast}{f(x_{it}^k, \beta^k) \exp(V_{it}^k) - U_{it}^k} = \exp(-U_{it}^k) \]

\( T_{E_i}^k \) which allow us to examine the performance of the i-th country relative to the individual group frontier cannot be used to measure technological capability as countries from different regions operate under different production technologies. The metafrontier production function model for the county i is Expressed by:

\[ Y_{it}^\ast = f(X_{it}^\ast, \beta^\ast) \exp(V_{it}^\ast - U_{it}^\ast) \]

\( Y_{it}^\ast \) is the metafrontier output that dominates all group frontiers and \( \beta^\ast \) expressed the vector of parameters for the metafrontier function and results from solving the following linear program (Battese, Rao, & O'Donnell, 2004)
We estimate technical efficiency with respect to the metafrontier as:

\begin{equation}
TE^*_it = \frac{TE_{it} \times TGR_{it}}{f(x_{it}(k), \beta_{it})}
\end{equation}

The ratio is equal to one when the country's technology frontier coincides with the metafrontier. Countries closer to the metafrontier have higher technology gap ratios and are considered as more advanced technologically. An increase over time in the technology gap ratio indicates a technological catch-up for which we want to test.

The main determinants. The technical efficiency relative to the metafrontier is defined as: 

\begin{equation}
TGR_{it} = \frac{f(x_{it}(k), \beta_{it})}{f(x_{it}, \beta^{*})}
\end{equation}

The analysis uses data from balanced panel observed for the period 2000 to 2013. Table below provides average technical efficiency and technology gap scores for countries over the period 2000–2013. The average technical efficiency of the Iran relative to the metatechnology is only about 0.113. This suggests that Iran are highly inefficient relative to the metafrontier. Among the five countries, South Korea has on average the better performance with a technology gap ratio of 0.51 on average.

**Table 9**: Estimates for parameters of the stochastic frontier models

<table>
<thead>
<tr>
<th></th>
<th>Iran</th>
<th>Japan</th>
<th>turkey</th>
<th>South Korea</th>
<th>pooled frontier</th>
<th>Metafrontier</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong></td>
<td>-1.253</td>
<td>-0.007</td>
<td>1.255</td>
<td>1.538</td>
<td>1.097</td>
<td>3.196</td>
</tr>
<tr>
<td></td>
<td>(1.770)</td>
<td>(0.313)</td>
<td>(1.190)</td>
<td>(0.029)</td>
<td>(0.110)</td>
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</tr>
<tr>
<td><strong>Trend</strong></td>
<td>-0.246</td>
<td>-0.043</td>
<td>-0.100</td>
<td>-0.043</td>
<td>-0.075</td>
<td>-0.067</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.002)</td>
<td>(0.004)</td>
<td></td>
</tr>
<tr>
<td><strong>Technology</strong></td>
<td>0.494</td>
<td>1.088</td>
<td>0.943</td>
<td>0.852</td>
<td>0.882</td>
<td>0.869</td>
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<tr>
<td></td>
<td>(0.035)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.002)</td>
<td>(0.021)</td>
<td></td>
</tr>
<tr>
<td><strong>Science</strong></td>
<td>0.841</td>
<td>0.045</td>
<td>0.143*</td>
<td>0.537</td>
<td>0.161</td>
<td>0.167</td>
</tr>
<tr>
<td></td>
<td>(0.076)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.040)</td>
<td>(0.035)</td>
<td></td>
</tr>
<tr>
<td><strong>Human capital</strong></td>
<td>0.244</td>
<td>-0.013</td>
<td>0.022</td>
<td>-0.385</td>
<td>-0.042</td>
<td>-0.179</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.002)</td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.101)</td>
<td></td>
</tr>
<tr>
<td><strong>σ</strong></td>
<td>2.0143</td>
<td>0.309</td>
<td>0.94</td>
<td>0.69</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.162)</td>
<td>(0.550)</td>
<td>(0.312)</td>
<td>(0.083)</td>
<td></td>
</tr>
<tr>
<td><strong>γ</strong></td>
<td>0.97</td>
<td>0.85</td>
<td>0.99</td>
<td>0.99</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.028)</td>
<td>(0.008)</td>
<td>(0.001)</td>
<td>(0.012)</td>
<td></td>
</tr>
<tr>
<td><strong>Log-L</strong></td>
<td>380.85</td>
<td>288.89</td>
<td>111.5</td>
<td>575.06</td>
<td>137.35</td>
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</table>
Table 10: Average technical efficiency scores and technology gap

<table>
<thead>
<tr>
<th>Year</th>
<th>$\bar{TE}_t$</th>
<th>$\bar{TGR}_t$</th>
<th>$\bar{TE}_{t+}$</th>
<th>Iran</th>
<th>South Korea</th>
<th>Japan</th>
<th>Turkey</th>
<th>KSA</th>
<th>Average</th>
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<tbody>
<tr>
<td>2000</td>
<td>0.9602</td>
<td>0.1958</td>
<td>0.188</td>
<td>0.10</td>
<td>0.64</td>
<td>0.12</td>
<td>0.007</td>
<td>0.09</td>
<td>0.196</td>
</tr>
<tr>
<td>2001</td>
<td>0.9603</td>
<td>0.1882</td>
<td>0.180</td>
<td>0.09</td>
<td>0.62</td>
<td>0.11</td>
<td>0.007</td>
<td>0.09</td>
<td>0.188</td>
</tr>
<tr>
<td>2002</td>
<td>0.9592</td>
<td>0.087</td>
<td>0.083</td>
<td>0.07</td>
<td>0.24</td>
<td>0.06</td>
<td>0.006</td>
<td>0.04</td>
<td>0.087</td>
</tr>
<tr>
<td>2003</td>
<td>0.9594</td>
<td>0.2108</td>
<td>0.202</td>
<td>0.17</td>
<td>0.59</td>
<td>0.14</td>
<td>0.015</td>
<td>0.11</td>
<td>0.211</td>
</tr>
<tr>
<td>2004</td>
<td>0.9597</td>
<td>0.1993</td>
<td>0.191</td>
<td>0.16</td>
<td>0.56</td>
<td>0.14</td>
<td>0.014</td>
<td>0.11</td>
<td>0.199</td>
</tr>
<tr>
<td>2005</td>
<td>0.96</td>
<td>0.1879</td>
<td>0.180</td>
<td>0.16</td>
<td>0.52</td>
<td>0.13</td>
<td>0.012</td>
<td>0.10</td>
<td>0.188</td>
</tr>
<tr>
<td>2006</td>
<td>0.9603</td>
<td>0.1772</td>
<td>0.170</td>
<td>0.15</td>
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<td>0.12</td>
<td>0.01</td>
<td>0.09</td>
<td>0.177</td>
</tr>
<tr>
<td>2007</td>
<td>0.9605</td>
<td>0.1725</td>
<td>0.165</td>
<td>0.14</td>
<td>0.49</td>
<td>0.12</td>
<td>0.009</td>
<td>0.09</td>
<td>0.173</td>
</tr>
<tr>
<td>2008</td>
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<td>0.1625</td>
<td>0.156</td>
<td>0.14</td>
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<td>0.008</td>
<td>0.08</td>
<td>0.163</td>
</tr>
<tr>
<td>2009</td>
<td>0.9611</td>
<td>0.1525</td>
<td>0.146</td>
<td>0.13</td>
<td>0.43</td>
<td>0.10</td>
<td>0.007</td>
<td>0.08</td>
<td>0.153</td>
</tr>
<tr>
<td>2010</td>
<td>0.9614</td>
<td>0.145</td>
<td>0.139</td>
<td>0.13</td>
<td>0.41</td>
<td>0.09</td>
<td>0.006</td>
<td>0.07</td>
<td>0.145</td>
</tr>
<tr>
<td>2011</td>
<td>0.9616</td>
<td>0.1384</td>
<td>0.133</td>
<td>0.12</td>
<td>0.4</td>
<td>0.09</td>
<td>0.005</td>
<td>0.07</td>
<td>0.138</td>
</tr>
<tr>
<td>2012</td>
<td>0.9619</td>
<td>0.1312</td>
<td>0.126</td>
<td>0.11</td>
<td>0.38</td>
<td>0.08</td>
<td>0.005</td>
<td>0.06</td>
<td>0.131</td>
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<td>2013</td>
<td>0.9621</td>
<td>0.1242</td>
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<td>0.36</td>
<td>0.07</td>
<td>0.004</td>
<td>0.06</td>
<td>0.124</td>
</tr>
<tr>
<td>Average</td>
<td>0.11</td>
<td>0.51</td>
<td>0.15</td>
<td>0.013</td>
<td>0.15</td>
<td></td>
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</table>

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Table 11: Nanotechnology gap between Iran and America

<table>
<thead>
<tr>
<th>Year</th>
<th>Gap calculated per years towards the leading</th>
<th>Iran</th>
<th>leading country ((America))</th>
<th>$x_L$</th>
<th>$x_F$</th>
<th>Year</th>
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<td>1,035,159</td>
<td>13.65007</td>
<td>6.07287</td>
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<td>1381</td>
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<td>830</td>
<td>5,319,168</td>
<td>15.08683</td>
<td>6.32142</td>
<td>6</td>
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<tr>
<td>1382</td>
<td>20.3</td>
<td>1390</td>
<td>94,841,149</td>
<td>17.76771</td>
<td>6.63707</td>
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<tr>
<td>1383</td>
<td>18.7</td>
<td>3320</td>
<td>9,124,164</td>
<td>15.22644</td>
<td>7.30772</td>
<td>6</td>
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<tr>
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<td>18.3</td>
<td>2390</td>
<td>10,888,163</td>
<td>15.20319</td>
<td>6.77905</td>
<td>3</td>
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<tr>
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<td>18.0</td>
<td>2410</td>
<td>11,286,160</td>
<td>15.03909</td>
<td>6.58738</td>
<td>6</td>
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<tr>
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<td>12,298,160</td>
<td>14.92496</td>
<td>6.39565</td>
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<td>14.81108</td>
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<td>6350</td>
<td>12,879,160</td>
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<td>6.95621</td>
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<td>14.53879</td>
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<td>14,562,157</td>
<td>14.29394</td>
<td>7.76552</td>
<td>7</td>
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<tr>
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<td>14.16886</td>
<td>7.61189</td>
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<td>6.34206</td>
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</tr>
</tbody>
</table>

The technology gap

Using the model presented in part one $G = (K_L - K_F)/K_T + [(x_L^2 - x_F^2) - (K_L - K_F)/K_T]$ It can be calculated the gap between Iran and other leading countries. (Drine, 2012) Values of $K_T, K_F, K_L$ can be determined due to the time of starting nanotechnology, the initial conditions at the beginning of this process and the efficiency rate of nanotechnology in Iran. During these years, the technological growth rate of nanotechnology has been appropriate. Also suitable knowledge progress was existed. Value of 2.0 can be considered for $K_T$. As it was mentioned before, it is contemplated that the smaller amount of $K_T$, the more insufficient of knowledge progress in the relevant field. The value of $K_F$ in 0.2 and $K_L$ in 0.5 are contemplated due to the fact that, Iran’s nanotechnology considered as an essential element in the earliest years of introducing.

The following table shows the gap between Iran and America as the leading of nanotechnology from 2001 until 2014. As it is shown in the table, the results indicate no significant change towards the gap between Iran and the United States of America in nanotechnology. The amount of this gap between these countries is just about 0.3 in 13 years (16.4 in 2001 and it has reached to 16.7 in 2014). As a matter of fact, the gap should be considered as the growth rate of other technologies. As we know, there is a huge gap between Iran and the U.S in technological and sciences. Besides, if there was not a proper strategy in Iran during these years it would be definitely much more technological gap between Iran and the U.S. It can be concluded that technological efficiency is in an appropriate rate, on account of the fact that, the gap has remained fairly constant over these years. Moreover, the impact of other technologies on the scientific environment should be considered. It seems
that Iranian nanotechnology demand new avenues which is called quick access. In the matter of today’s business environment and the gap which is between Iran and its competitors.

- Therefore, seven following approaches can facilitate this process.
- Window of opportunity
- Initial condition
- Integration of Knowledge
- Internal structures
- Investment
- Macroeconomic policy and program development
- Social and institutional conditions

**Conclusion**

It is determined that Iranian approach towards nanotechnology and the selection of the paths is an accurate method and it is completely matched with other international attitudes in three steps. The initial step of investigations, which are done about the technology and efficiency, gaps between Iran and the Middle East (to achieve the vision of 1404 document). Then, the next step was about the leading countries in Asia. And the last step is the investigating about United States as the leading country of nanotechnology.

The results clearly indicated that Iran could use the gate of this opportunity to gain its goals. Iran used its crucial entrance in nanotechnology and also the proper mutation is implemented towards this golden chance. Iran could lower the technological gap between itself and the world leaders in nanotechnology and it has pursued the right direction without dependence despite of technological spillovers from other areas in leading countries. The notable point is about the analysis result about some countries like Saudi Arabia, which has gained the suitable place in nanotechnology in these years.

With respect to the strategies, which are selected in the 1404 document, If Iran wants to be supreme leather in the Middle East; it should have a better review of some emphasized topics about the gate opportunity in nanotechnology. In this research, it is attempted to evaluate the efficiency of technology and technology gap with using two indicators. Thus, the results and outputs of these two indicators should be fully consistent with each other. The results have also confirmed the given conditions but it suggests that despite of the appropriate investment policy and national perspective towards nanotechnology, Iran bears a weakness in industrial outputs and trades. Consequently, other countries in the Middle East such as Saudi Arabia, which is the main rival of Iran, are in a better position. Saudi Arabia could ameliorate its technological process and it could successfully lessen the gap between itself and Iran during the previous years. It seems that Saudi Arabia goes at a good pace in this process and it makes Iran not to make progress rapidly in the field of nanotechnological efficiency than before. Hence, it can be highly recommended that Iran should have a better domestic approach towards this issue. In addition, having suitable industrial policies and implementing facilities to ease economic and industrial outputs in this particular field.

**References**


Póvoa, L. M. C., & Rapini, M. S. (2010). Technology transfer from universities and public research institutes to firms in Brazil: what is transferred and how the transfer is carried out. *Science and Public Policy, 37*(2), 147-159.

