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Innovative performance of Iranian knowledge-based firms: Large firms or SMEs?☆

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ABSTRACT

The debate over innovativeness of large firms and SMEs, which was bolded by Schumpeter, still continues under mixed empirical evidences. There are several implications for this debate including policy orientation in support of large firms or SMEs. But there is a scarce of studies in developing countries and no such study in Iran yet. The present study has explored the proportionality of increase of innovation activity versus firm size within 522 Iranian knowledge-based firms categorized in 9 industries. Innovation activity was measured by R&D expenditure while firm size stood for number of employees. Using log–log regression in the first phase, it was found that R&D expenditure confirms a significantly more than proportionate relationship with firm size, on a continuous spectrum of size, which is in line with Schumpeter's idea in favor of large firms. The second phase of the study utilized analysis of covariance to treat firm size categorically using quantitative covariate of physical capital structure. The second results complemented the first, in the sense that categories of small-, medium-, and large-sized firms had significantly different mean innovation activity under a same physical capital structure. It should be noted that these conclusive results were derived just for the industries that sufficiently had a large number of observations (firms); otherwise, the results seem mixed. Of course, the results should be interpreted within the features of the database and measurement indicators.

1. Introduction

As the role of innovation has become increasingly apparent in promoting competitiveness and growth, the literature progressively witnessed mixed arguments in favor of the statement that large firm size and economy of scale are factors associated with a faster rate of innovation. The issue was brought into mainstream economics by Schumpeter (1942), who argued that large firms operating in a concentrated market are the principal driver of technological progress. The argument was also used to justify industrial policies of support for "large firms" as national champions and saviors of economy, to allocate research and development (R&D) subsidies to them, and to relax antitrust laws. All these ideas, efforts, and policy prescriptions are based on the presupposition of the favorable effect of firm size on innovation activity via economies of scale and centralization. Accordingly, one of the questions which arises is that whether large firms or SMEs are more innovative, and hence play a dominant role in technological innovations and advancements. This has been a challenging question since a long time ago.

A specific concern here could be the distinction made between innovation, catch-up, adoption, and diffusion of technology, which may cast a shadow on the necessity of such researches in developing countries regarding innovativeness of firms and industry. In this regard, theoretical models have recognized two basic modes for advancing technology, namely, innovation and adoption. As a matter of fact, each economy utilizes both modes to some extent and there is no doubt that each economy produces only a fraction of the technologies it uses, i.e. innovation mode (Sachs and McArthur, 2002). It has been shown that assuming the role of technology adopter yields a long-term economic growth but with a permanent lag compared with the innovator economy, which is termed catch-up. The persisting lag in technology translates into a lasting gap in income levels in favor of the innovator (McArthur and Sachs, 2001; Warner, 2000). The percentage of innovation versus diffusion of technology determines the degree of "catch-up" between the innovator and the adopter economy in which diffusion denotes the absorption of innovation by the adopting economy. In addition to the economic theories, empirical evidences such as Global Competitiveness Report (McArthur and Sachs, 2001) have also supported the mentioned limits on absorption of technology (diffusion) as a source of nations' growth. This suggests the prominence of innovation to put an end to the everlasting gap with the wealthiest countries.

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Furthermore, it should be added that here by innovation, we do not mean to confine it to the products and processes introduced for the first time to the world, but to cover products and processes, which are introduced for the first time in a country via reverse engineering or catch-up. In fact, there is a distinction between R&D activity and innovation activity according to Frascati Manual, such that reverse engineering and catch-up are excluded from R&D activities (OECD, 2002), but not from innovation activities as a more inclusive area. In other words, innovative products and services are not necessarily from R&D sources but could derive from, inter alia, reverse engineering and catch-up. Having such wide definition is necessary for technological advancement of developing countries and is also compliant with measurements done in previous studies, such as Patel and Pavitt (1992).

The present paper is intended to empirically explore and compare the degree of innovativeness of large firms and SMEs. The importance of such researches lies in that national innovation system (NIS) of countries like Iran mostly consists of large state-owned enterprises besides universities, ministries, and research institutes (Soofi and Ghazinoory, 2013), while knowledge-based SMEs seem as an emerging trend in this regard. For this purpose, Iranian knowledge-based firms were chosen as the population and regression and analysis of variance (ANCOVA) were used as the statistical techniques. In next section, the literature debate over the advantage of large firms or SMEs in doing innovation is discussed, which is accompanied by some mixed empirical evidences. Then, practical issue of innovation measurement would be tackled and a conceptual model would be constructed consisting of various innovation measures. The methodology is another section where we explain the statistical methods applied, discuss the characteristics of the population, and enumerate the advantages of the available database. The paper concludes after discussing the statistical findings in the format of two tables showing more than proportionate relationships between firm size and innovation activity using R&D expenditures on a log–log scale in 9 industries, and also significant differences between the mean innovation activity of small, medium, and large firms by some reservations.

2. Innovation activity: Large firms or SMEs

Solow (1956) showed that upon a rise of the saving rate in an economy, there would be a temporary increase in the rate of capital accumulation, and a permanent increase in the level of output per capita, but not a rise in the long-run rate of growth of output per capita. In this regard, Solow assumed technological advancement as the exogenous variable (Sachs and McArthur, 2002) which was then empirically tested by him using U.S. economic data from 1909 to 1949 regarding the sources of U.S. economic growth (Solow, 1957). He surprisingly found that technological change accounted for 70% of the growth of the U.S. economy, which admitted the role of technological advancement as the key long-term driver of economic development. Having recognized two basic modes for advancing technology, namely, innovation and adoption, each economy utilizes both modes to some extent and there is no doubt that each economy produces only a fraction of the technologies it uses (innovation mode). As stated in the previous section, catch-up, adoption, and diffusion could not put a shadow on the necessity of innovation as requisite to put an end to the everlasting gap of developing countries with the wealthiest countries (McArthur and Sachs, 2001; Warner, 2000).

Regarding innovation sources, Schumpeter (1934) suggested that entrepreneurs and start-ups represent the foremost source of new ideas and technologies. However, in "Capitalism, Socialism, and Democracy," Schumpeter (1942) stated that innovation activity increases more than proportionally with firm size. Some important hypothesized reasons, which explain increase of innovation more than proportionate with firm size, are as below:

1. Since R&D projects typically involve large fixed costs, sufficient large sales are required.
2. Production of innovation involves economy of scale and scope.
3. Large diversified firms are in a better position to exploit unforeseen innovations.
4. The risk of R&D could be better distributed and lowered in large firms through defining simultaneous diverse R&D projects.
5. Large firms have better access to external finance.
6. Firms with greater market power are more relaxed of the competition, which let them advance the technology.
7. Having high market power or share let firms utilize returns of their innovations which in turn encourages them for further innovation activity (Sachs and McArthur, 2002).

There have also been some counterarguments. The often-quoted argument states that due to loss of managerial control and bureaucratization of innovative activity, there would be a decrease of returns to scale in the production of innovations. Another argument points to the inertia which may arise out of the absence of strong competitive pressures, i.e. related to market power concept (Symeonidis, 1996). The former suggested deficit could be marked as internal (intra-organizational) and the latter as external (inter-organizational). Of course, these arguments should be checked by empirical studies, which is the topic of the next section.

3. Some empirical evidence for size effect

Since Schumpeter's (1942, 1934) introduction of contradicting ideas, size has become one of the variables most studied as a determinant of innovation. In a review study conducted by Becheikh et al. (2006), it was shown that more than half (55%) of the empirical studies viewed firm size as an explanatory variable of innovating behavior. Although the results were mainly (36 studies) in favor of Schumpeter's (1942) idea that innovation activity increases more than proportionally with firm size, the assumption was refuted by some other authors to claim a negative (4 studies), insignificant (11 studies), bell-shaped (5 studies), or U-shaped (3 studies) relationship (Becheikh et al., 2006).

Scherer (1965a, 1965b), in his two early influential studies, regressed R&D employment intensity (i.e. R&D employment relative to total employment) and the number of patents on sales data of 448 firms from the 500 largest US industrial firms. As a result, an inverted U-shaped relationship was found between R&D employment intensity and sales for the total sample and also for each industry, except the chemical sector. It was found that the number of patents increased less than proportionately with sales, except for a few very large firms, which in the case was interpreted by Scherer as a rejection of the Schumpeterian hypothesis indicating a positive disproportionate effect of firm size on innovation. In another attempt using US data for 500 firms within the years of 1975 and 1976, Soete (1979) reached a mixed result that R&D intensity used to raise with size in a number of industries and to decrease with size in others. Since the effect of industry type was not controlled, the results obtained by Soete for the overall pooled sample may not be very reliable. Controlling the effect of industry for such studies has been emphasized by several scholars since firm size is likely to be correlated with industry-level variables such as technological opportunity, which are, in turn, likely to have a positive effect on innovation activity (Cohen and Levin, 1989; Symeonidis, 1996). In total, it should be said that mixed or contrary results of such studies focused on R&D do not necessarily question the results of studies targeting innovation activity in its broader meaning, since innovation activity is more inclusive than just R&D and covers catch-up, reverse engineering, non-technological innovation, etc. In fact, the assumption that R&D expenditure measures inputs of innovation activities and patents the resulting output, has become increasingly brittle such that today, strong empirical findings and better understanding of innovation concept dictate inclusion of design, testing, production, and marketing under innovation concept umbrella (Mansfield et al., 1971; Patel and Pavitt, 1992).

There have also been some efforts to indirectly question the Schumpeterian hypothesis by showing a disproportionate patent output in favor of small firms. Based on Schmookler's (1966) view, larger