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The effect of intangible investment on the total factor productivity in Iran's industries

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EXTENDED ABSTRACT

INTRODUCTION

In national accounts, costs related to intangible capital include computer databases, research and development, design, brand equity, company-specific training, and organizational efficiency as investments has expanded (Corrado, Hulten, and Sichel, 2005). When this broad view of investment is included in the analysis of the sources of growth, intangible investments account for one-fifth to one-third of labor productivity growth in the industrial sector of the United States and the European Union and East and South Asia (India, China and Japan) (Liang,2021 ؛Bhattacharya and Rath,2020 ؛Rico and Cebrer-Bares,2020 ؛Hintzmann, Masllorens& Ramos Lobo,2021 ؛Corrado, Haskel, Jona- Iommi ,2013؛Corrado, Hulten,and Sichel ,2009 ؛Marrano, Haskel, and Wallis ,2009 ؛Fukao, Miyagawa, Mukai, Shinoda, and Tonogi, 2009 ؛van Ark, Hao, Corrado, and Hulten, 2009). In order to manage intangible resources as a source of growth at the macroeconomic level and a driver of value creation for individual firms, their measurement is very important(Corrado,Jonathan HaskelCecilia, Jona-LasinioMassimiliano Iommi,2012). It is obvious that many studies have focused on intangible investment, which shows the importance of this topic.

Therefore, in this research, focusing on intangible investment, intangible investment has been measured. In Iran, due to the lack of statistics on how to calculate and estimate this type of investment, few studies have been conducted in the field of intangible investment measurement. For example, in the study of Ostadzad and Hadian (2014) on the effect of research and development on economic growth and the study of Rahimi Rad, Heydari and Najarzadeh (2016) investigated the factors affecting the intensity of research and development costs in industrial workshops of Iran. But so far, this study has not been done to measure all the components of intangible investment in Iran and investigate its effect on economic variables.

In Iran, studies have been conducted to identify effective factors in determining the value of intangible assets in companies listed on the Tehran Stock Exchange. However, the measurement of intangible investment with comprehensive international definitions and separated by the four-digit ISIC code has not been done so far. As a result, in this research, it has been tried to use the approach of Corrado et al. (2005), which is a method that can be cited in most Valid studies of the countries of the world have been defined to measure intangible investment, and also according to the comprehensive definitions accepted at the international level of intangible investment, this importance has been implemented for Iran and this important economic variable has been estimated (Mashaikhi, Birami and Birami, 2013; Corrado et al, 2005; Fukao, Miyagawa, Mukai, Shinoda, and Tonogi, 2009).

Therefore, in this study, the CHS approach (a comprehensive and accepted approach that has been used in most important studies) has been used to measure intangible investment(Corrado, Hulten, and Sichel,2005). One of the important activities in the functions of Iran's economy is the activities of factory industries approved by the Iranian Statistics Center. This article first aims to estimate the share and trend of intangible capital in these activities with the CHS approach, which due to the lack of studies in this field is very important for Iran's economy.

Also, how it affects the productivity of the entire production factors is also one of the next topics of this study, which can be the way of economic approaches and important decisions in this field. In order to find answers to the research questions and approach its hypotheses, the studied time period of 1996-2018 has been used for industrial workshops with ten workers and above, separated by the four-digit ISIC code. The model used is panel data with GMM method. The results indicate that intangible investment has a positive and significant effect on the productivity of all production factors. In the continuation of the research, the workforce has been divided into

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professional and non-professional workforce. The estimation of the economic model of this research shows that the effect of skilled labor on the total productivity of production factors in Iranian industries is about 6 times compared to unskilled labor.

METHODOLOGY

This section presents a model that describes the relationship between intangible investment and factor productivity. Assume that the added value of the industry according to the four-digit ISIC code and ten workers and above in industry i and time t can be written as follows:

$$Q_{i,t} = A_{i,t}F_{i,t}(L_{i,t}, K_{i,t}, R_{i,t}) \quad (1)$$

On the right side, L and K are labor and capital. Similarly, R is the flow of intangible capital services and A is a change term that allows for changes in productivity as L, K, and R become returns. We get the differential from equation (1):

$$= \epsilon_{i,t}^{L}\, \Delta lnL_{i,t} + \epsilon_{i,t}^{K}\, \Delta lnK_{i,t} + \epsilon_{i,t}^{R}\, \Delta lnR_{i,t} + \Delta lnA_{i,t} \quad (2)$$

So that ϵ^X represents the production elasticity of factor X, which is basically different according to input, industry and time. To empirically examine the role of intangibles as growth drivers, existing literature is used and it is done in two stages. First, consider the condition of ϵ. For a company with the lowest cost, we have:

$$\epsilon_{i,t}^{X} = S_{i,t}^{X}, X = L, K, R \quad (3)$$

where s is the share of payments of this invoice in relation to added value. So this simply expresses the first-order condition of a firm in terms of production elasticities. If equation (1) is Cobb-Douglas, ϵ is constant over time, and equation (2) may be transformed into a regression model with constant coefficients. . If (1), for example, the elasticity of substitution is constant, then ϵ will vary over time at all levels, so (2) may be written as a regression model with interactions among all inputs. Now suppose that a firm can K, L or R variables can be used in other companies, industries or countries. Therefore, as Griliches pointed out, the industry elasticity ΔlnR in lnQ Δ is a combination of input and output elasticity. As a result, we can follow Stiroh and we have (Griliches, 1992; Stiroh, 2002):

(4) $$\in_{i,t}^{X} = S_{i,t}^{X} + d_{i,t}^{X}, X = L, K, R$$

which shows that the productive elasticities of the factors are equal to the weight of the factors. In addition, here there is the flexibility of deviation from the weight of the factors due to spillover. All this can be shown in equation

(5) $$\Delta lnQ_{i,t} = \left(s_{i,t}^{L} + d_{i,t}^{L}\right)\Delta lnL_{i,t} + \left(s_{i,t}^{K} + d_{i,t}^{K}\right)\Delta lnK_{i,t} + \left(s_{i,t}^{R} + d_{i,t}^{R}\right)\Delta lnR_{i,t} + \Delta lnA_{i,t}$$

Second, consider Δln Qi,t. As Grilichs and Shankerman pointed out, if we include the R&D inputs in conventional L and K and use a regression model to determine the R&D production elasticity, the results will be biased. The main point of this argument is that intangibles (such as research and development) are long-term assets and not intermediate inputs, and should be included as value-added investments (Griliches, 1980; Schankerma, 1981). Adding the normal as V (where the intangibles are treated as intermediates), we can write:

(6) $$\Delta lnQ_{i,t} = \left(1 - s_{i,t}^{R}\right)\Delta lnV_{i,t} + s_{i,t}^{R}\Delta lnN_{i,t}$$

So that N is a real intangible investment and we have approximated the share of intangible investment costs in nominal Q as sR. Substituting (6) into (5), we have:

(7) $$\Delta lnQ_{i,t} = \left(1 - s_{i,t}^{R}\right)\Delta lnV_{i,t} + s_{i,t}^{R}\Delta lnN_{i,t} = \left(s_{i,t}^{L} + d_{i,t}^{L}\right)\Delta lnL_{i,t} + \left(s_{i,t}^{K} + d_{i,t}^{K}\right)\Delta lnK_{i,t} + \left(s_{i,t}^{R} + d_{i,t}^{R}\right)\Delta lnR_{i,t} + \Delta lnA_{i,t}$$

If we have the above expression in terms of ΔlnVi,t:

(8)
$$\Delta lnV_{i,t} = \left(\left(s_{i,t}^{L} + d_{i,t}^{L}\right)/\left(1 - s_{i,t}^{R}\right)\right)\Delta lnL_{i,t} + \left(\left(s_{i,t}^{K} + d_{i,t}^{K}\right)/\left(1 - s_{i,t}^{R}\right)\right)\Delta lnK_{i,t} + \left(d_{i,t}^{R}/\left(1 - s_{i,t}^{R}\right)\right)\Delta lnR_{i,t} + \Delta lnA_{i,t}$$

For simplicity we have assumed that Δ lnR = lnNΔ (as in the steady-state "max consumption" case). To model the efficiency of factors, the studies of Caves, Christensen and Diewert have been used, and the ΔlnTFP index is constructed with the translog production function as follows (Caves, Christensen, & Diewert, 1982):

$$\Delta \ln TFP_{i,t} = d_{i,t}^{L}\Delta \ln L_{i,t} + d_{i,t}^{K}\Delta \ln K_{i,t} + d_{i,t}^{R}\Delta \ln R_{i,t} + \Delta \ln A_{i,t}$$

(9)

where ΔlnTFPi,t= ΔlnTFPQi,t and ΔlnTFPQi,t is calculated as follows:

$$\Delta \ln TFP_{i,t}^{Q} = \Delta \ln Q_{i,t} - s_{i,t}^{L}\Delta \ln L_{i,t} - s_{i,t}^{K}\Delta \ln K_{i,t} - s_{i,t}^{R}\Delta \ln R_{i,t}$$

(10)

Obviously, these approaches have advantages and disadvantages, but the estimation of this regression potentially reveals the factors that played a significant role in TFP and were suppressed.

FINDINGS

To measure the intangible capital from Iranian factory data with four-digit ISIC code during 1996 to 2018 is 2190. The data shows that the ratio of intangible capital to production for all industries is equal to 68.41%, which shows the high impact of intangible capital on Iranian industries[1].

[1] The Statistics Center of Iran has been used to obtain the data. The years used are from 1996 to 2018. The estimated components are intangible investment, physical investment, labor force and production volume, to calculate the productivity index of production factors. The obtained data have been used separately according to the economic activity ranking classification code with version 4 from the Statistics Center of Iran. In the codes, we merged them with similar codes, and as a result, the number of codes is 132, which is the total number of data for the years 1996 to 2018 is equal to 2190, and the volume of data is worth considering for the correct estimation.

The results show that, contrary to the traditional approach, intangible investment is not included in intermediate goods, but is included as an important factor in the production function. The high number of observations has helped to estimate the model more accurately. The employment impact factor, including professional and non-professional labor force, is approximately equal to 22/, which has a positive and significant effect on TFP.Also, if the physical capital grows by ten percent, the total factor productivity will grow significantly by 2.3 percent on average in the same direction. The remarkable thing about the impact of intangible investment is that if this type of investment grows by 10 percent among various manufacturing industries, it can help to increase the TFP by 3.5 percent on average, which actually shows the role of intangible investments in factory industries in today's world.

These results indicate that the production share of Iran's industries is not only focused on physical investment and labor, and there is another type of investment called intangible investment, which is not only effective but also in the extent of its effect on industrial production is superior to the rest of the components.

By studying the world's major industries such as Microsoft, it can be found that its market value in 2006 is much larger compared to the value of its physical investment and labor force, and this difference in value is included in the area of intangible investment.

Therefore, for most industries in different countries, it is not far from reality that the amount of intangible investment has a greater impact than the rest of the effective components. As a result, the hypothesis that there is a positive and significant relationship between intangible investment on the productivity of all production factors can be accepted at the level of 99% with an impact factor of /356.

Also, for a ten percent increase in skilled labor, the TFP changes on average by approximately 0.6 percent, while this figure is approximately 0.1 percent for unskilled labor. These results show that in addition to intangible investment having a positive and significant effect on productivity, skilled labor also helps to grow the productivity of factory industries.

CONCLUSION

The importance of intangible investment is growing relative to the level of investment in the tangible assets we intend to invest with, including transport

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infrastructure, machinery and power plants, etc. As a result, the role of intangible investment becomes increasingly important for understanding and predicting productivity trends, economic growth and innovation. The importance of intangible investment, such as research and development or software, to describe productivity, competitiveness and economic growth, has long been recognized by economic literature and statisticians.Considering investment in intangibles leads to a better understanding of differences in productivity trends across countries. In this research, firstly, the measurement of intangible investment with the CHS approach for the four-digit ISIC codes of factory industries with ten employees and above was discussed. The high share of intangible investment compared to the total production of each industry shows the importance of this issue. Then the intangible investment variable was brought as the main component next to physical investment and labor in the production function. Observations showed that intangible investment had a positive and significant effect on the productivity of all production factors. Its high coefficient indicates the impact of intangible investment on TFP, and its omission in the production function caused TFP estimation to have a bias error. In order to show the impact of the professional workforce on the productivity of production factors, we separated the workforce into skilled and unskilled, and the results show that the impact of professional and expert workforce is almost six times greater on TFP.

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