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Evaluating the Effect of Economies of Scale and Learning in Health Sector: Case of Developed and Developing Countries

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Abstract

Background: The workforce is considered one of the most important factors of economic growth and development, and thus ensuring their health is very important. The learning process means saving labor costs and increasing productivity through experience. The experience of countries around the world has shown that with increasing scale, the average cost decreases due to economies of scale and learning, and this facilitates access to health services for people in the community at lower costs.

Methods: The methodology used in the present study was developed based on econometrics. To this end, a model was developed and estimated based on the theoretical literature and previous studies. Then, using inferential statistical techniques and the data from 187 countries extracted from the World Bank database, two concepts of economies of scale and learning were quantified.

Results: The results indicated that, firstly, economies of scale have been achieved in the health sectors of the counties in question, but have not yet been completely exhausted while the learning process has been realized at a rate of 0.46. Second, in developed countries, the production coefficient is close to one and insignificant, indicating that all economies of scale have been exhausted. Besides, the learning coefficient is above the global average. Third, in developing countries, a negative and significant production coefficient and the average scale indicates a lack of complete exhaustion of economies of scale. Moreover, in these countries, the realized economies of learning outweigh the economies of scale.

Conclusion: Learning and economies of scale rates in developed and developing countries are different from each other, indicating the efficiency of both components of the cost advantage in reducing costs.

Keywords: Learning process, Economies of Scale, Health sector, Developed countries, Developing countries

Introduction

Learning by doing, which has a central place in the economy, refers to the concept that workers' abilities and skills increase over time due to the repetition of a particular task, and this causes the cost of each level of production to decrease over time. This concept was introduced by Arrow (1962) to explain the effects of innovation and technological change, and as a stimulus for endogenous economic growth and development. According to him, learning in productive activities and the accumulation of gross investment is a catalyst for the experience. Lucas (1988) defines this concept to explain the increase in the return on capital crystallized in human resources and believes that learning by doing is as effective as academic education in the formation of human capital (1).

Furthermore, in the current modern economy, where different sectors of the economy are strongly intertwined with the broad concept of knowledge, rapid learning over other competitors can create a sustainable and long-term competitive advantage for an organization and lead to its efficiency over competitors. In other words, in a knowledge-based economy, paying attention to knowledge development, how to use knowledge effectively, creating a structure for using new information, and benefiting from the experience and intellectual capital is a basis for achieving core and strategic competencies for superior performance. Accordingly, different sectors of the economy are trying to achieve cost-effectiveness, resource control, efficiency, and effectiveness through economies of scale and learning (2).

Since meeting health needs is one of the most important economic necessities to ensure a healthy and efficient workforce, and improving health can lead to developing human capital, promoting productivity, reducing production costs, and enhancing economic growth, monitoring health and treatment of individuals in a society has always been considered by health system planners (3).

Accordingly, the literature on the process of learning and economies of scale, which has always been considered in psychological, management, economic, and medical research, is based on the principle that people learn, through education and gaining experience and knowledge, how to have a better performance at a lower cost by saving time or increasing production. This discussion emerged in Wright's research, at the time planners were looking for a way to predict the cost of building ships and aircraft. In Wright's study, the learning process is reported as an asymmetric relation between the average cost of production and congestion production, and this process is achieved when the workforce repeats an activity over time, and by doing it repeatedly, its skill and ability increase. This leads to higher efficiency and the identification of a predictable pattern for cost reduction in each sector (4, 5).

In modern economic analysis, the learning process is classified into individual and organizational learning and a distinction is made between intra- and extra-organizational learning. In the individual learning process, in which individuals acquire the necessary skills and abilities through experience, the experience will be a by-product or joint product of the production of goods and services and is achieved by investing in labor, training programs, and research and development (R & D) projects. This process can create external savings by sharing learning and developing knowledge to other sectors while improving workers' performance and saving on production costs (internal savings) (6).

Plaza and Rohlf have argued that learning and knowledge development is a kind of intra-sectoral investment that will reduce production costs and induce economic growth because learning is essential with the increased investment in new machinery to use advanced and innovative technology, which in turn will increase productivity and reduce production costs (7).

Currently, the learning process is measured and evaluated using the learning curve as an efficient tool to show the development of employee's performance through experience. This curve is widely used in production planning, forecasting, cost estimation, and budgeting of organizations and sub-sectors (8).

Stith showed that organizational learning by doing did not take place at the US Liver Transplant Center, and at the same time in treatment centers that offered more advanced training and academic programs, patients' survival rates increased six months after transplantation and then decreased (9). Tsai et al. studied the learning process in laparoscopic colon surgery for two groups of 15 patients and showed that in group B, where learning by doing was accomplished, the mortality rate decreased sharply (10). In another study, Good et al. analyzed the pentafecta learning curve for laparoscopic radical prostatectomy and found that the learning curve became flat after surgery in 150 to 200 people. Additionally, the learning process was faster in laparoscopic surgery using an assistant robot than a robotic laparoscopy. Thus, the learning curve was flattened in a shorter time (11).

A study by Bonastre et al. on the effects of learning on cost reduction using new health technologies in a prospective payment system in the radiation therapy ward showed that 42% of the reduction in treatment costs was due to the learning process (12).

Feizpour and Habibi analyzed learning by doing in Iranian manufacturing industries and showed that although learning occurred in most industries, compared to economies of scale, the learning rate was less effective in reducing costs, implying the effect of economies of scale on cost reduction was greater than learning (13). In another study, Norani and Khodadad showed that learning intensity was significant in all Iranian manufacturing industries and led to increased productivity and reduced costs of each production firm in Iranian industries. Furthermore, in high value-added industries, the learning rate was higher than the average learning in Iranian manufacturing industries (14). Marzban examined the role of education and health in the economic growth of some developing countries and showed that education and learning had a stronger and more significant effect on economic growth than health (15).

As mentioned earlier, providing health needs plays an essential role in improving and developing efficient and healthy manpower. Besides, since improving citizens' health can lead to the development of human capital, productivity, reduced production costs, and economic growth, factors affecting the cost reduction of each firm should be identified. On the other hand, with increasing scale, the average cost decreases due to economies of scale and learning, and this facilitates access to health services for people in the community at lower costs. Since no study has so far addressed economies of scale and learning and their effect on cost in the Iranian health sector, this study can be considered as the first step forward in this field.

Methods

The present study evaluated two static and dynamic aspects of cost advantage in health sectors of developed and developing countries. Thus, this study was an applied one in terms of its objectives, a retrospective one in terms of its methodology, and a descriptive-analytical study that employed panel data regression analysis. It should be noted that to develop an econometric model by default, costs were minimized according to the Cobb-Douglas production function and by replacing the input demand in the cost equation, the cost function fitting the Cobb-Douglas production function was obtained. Moreover, to estimate the model developed based on the average cost data of the health sector, the number of people who received the minimum health services and the cumulative population of people from the beginning of the period to year t-1 was calculated based on the data from the World Bank database; thus, the research population covered all the countries of the world. To select the sample, the countries whose data were not available in the World Bank database were excluded. In other words, the research sample included 187 countries (116 developed countries and 71 developing countries) with a total of 3553 time-country observations from 2000 to 2018 selected based on the Human Development Index. In fact, this study tried to examine whether learning has been effective in the health sector in different countries of the world or not and if yes, how intense was the realization of learning? The answer to these questions can contribute to minimizing per capita spending, which is one of the main goals of the health systems in different countries of the world.

After selecting the countries in the sample, the research model was estimated using statistical tests with Stata 16 and Eviews 11 software. Then, the two static and dynamic aspects of cost advantage in the health sectors of developed and developing countries were addressed. It should be noted that Im-Pesaran-Shin, Levin-Lin-Chu, and Fisher-Type tests were used to assess if the variables were stationary or not. In addition, the three key variables required to evaluate the dynamic and static effects of cost advantage were the average production cost, production rate, and cumulative production.

Since the present study focused on the health sector of developed and developing countries, the current per capita health expenditure (in dollar) was estimated based on purchasing power parity (PPP) for each country with a GDP deflator at a fixed price for the base year of 2010. Besides, the production rate in the health sector including the number of patients represented by the number of people who received the minimum health services and cumulative production by cumulative population were measured from the beginning of the period in question to year *t-1*. It is worth noting that the cost of the health sector, depending on the type of provider and function, was estimated as the sum of current health costs, health-related costs, and the cost of institutions providing health services. Hence, the current cost included medical services, rehabilitation services, long-term nursing services, ancillary medical care services, medicines, and other medical goods distributed to outpatients, public health and prevention services, health management, health insurance, and health-related costs such as medical education and training for health workers, health research and development, food and drinking water monitoring costs, and health instructions plus the costs of providing health services including the costs of managing and providing social services, and managing and providing health care services.

Since this study sought to evaluate the effect of economies of scale and learning in the health sector, it needed a well-organized model to distinguish the effects of learning and returns to scale from their effects on the cost of each unit of production. Thus, the Cobb-Douglas exponential production function with three variable inputs was used to extract the dual cost function and integrate its production function with the learning curve. Therefore, the subordinate form of the production function is written as follows:

$$y = Ax_1^{\propto_1}x_2^{\propto_2}x_3^{\propto_3} \quad (1)$$

Where *y* is the output value, x_i is the production inputs, and $\propto_i$ is the elasticity of the production inputs. This function has positive and ascending values that are multiplied by the constant value of μ in the range of $x_i > 0$ and thus the production rate is multiplied by μ^3 so that $r = \propto_1 + \propto_2 + \propto_3$. This confirms that the return is estimated as the total elasticity of production inputs and economies of scale is measured as ES = r - 1. It should be noted that if the rate of return is more than 1, it indicates economies of scale (ES> 0), and the values less than 1 indicate the absence of economies of scale (ES <0). Furthermore, to obtain the dual cost function of the above production function, it is necessary to minimize the cost function due to the limitations of the production function:

$$C = \sum_{i=1}^{3} p_i x_i = p_1 x_1 + p_2 x_2 + p_3 x_3 \quad (2)$$

Subject to

$$y = Ax_1^{\propto_1}x_2^{\propto_2}x_3^{\propto_3}$$

After forming the Lagrange function and deriving a part of it from the production inputs, the value of each production input can be estimated from the following equation:

$$x_i = \lambda y.\frac{\propto_i}{P_i} \qquad i = 1,2,3 \quad (3)$$

Then, by replacing the demand functions of each input in the objective cost function, the nonlinear form of the total cost function is specified as follows:

$$C = r\left[A \propto_1^{\propto_1} \propto_2^{\propto_2} \propto_3^{\propto_3}\right]^{\frac{-1}{r}} \left[y p_1^{\propto_1} p_2^{\propto_2} p_3^{\propto_3}\right]^{\frac{1}{r}} \quad (4)$$

By taking Ln of both sides of the above equation, the linear form of the cost function is written as follows:

(5)

$$LnC_t = LnK + (1/r)Lny_t + (\propto_1/r)Lnp_{1t} + (\propto_2/r)Lnp_{2t} + (\propto_3/r)Lnp_{3t} + \varepsilon_t$$

Since production is influenced by the level of knowledge and technological knowledge acquired by the workforce (A), to integrate the learning process into the cost function, the level of knowledge can be measured as the cumulative experience of the previous period. Furthermore, the relation between the experience and knowledge acquired by the workforce will be estimated as $A_t = f(n_t) = n_t^{\propto_c}$ so that $f' > 0$ and $n_t = \sum_{t-1} y_\tau$ are measured as the sum of the output from the beginning of the production process up to period *t-1*. This equation indicates that the higher the $\propto_c$ value (the elasticity of the experience curve), the greater the intensity of learning in that sector (16). To extract the learning curve, the experience function is replaced in Eq. (5) and is adjusted by the GNP-deflator:

(6)

$$\frac{C_t}{GNPD} \xrightarrow{Ln} Ln\acute{C}_t = LnC_t - LnGDPD \xrightarrow{yields} LnC_t = Ln\acute{C}_t + LnGDPD$$

$$LnGDPD = (\propto_1/r)Lnp_{1t} + (\propto_2/r)Lnp_{2t} + (\propto_3/r)Lnp_{3t}$$

Then, by subtracting Lny_t from both sides of the equation, the functional form of the learning curve, which covers economies of scale and learning, is specified as follows.

(7)

$$Lnc_t = \beta_0 + \beta_1 Lnn_t + \beta_2 Lny_t + \varepsilon_t$$

$$\beta_0 = Ln\acute{k} \ , \beta_1 = (\propto_c/r) \ , \beta_2 = \left(1 - {}^{r}/_{r}\right)$$

$$r = 1/(1+\beta_2) \ , \ \propto_c = \beta_1 . r = \beta_1/(1+\beta_2)$$

In fact, by estimating Eq. (6), one can indirectly obtain $\propto_c$, the elasticity of the experience curve, and *r*, the return relative to the scale. It is worth noting that the larger the value of $\propto_c$, the greater the intensity of learning. In this curve, when the density of knowledge (knowledge storage) doubles, the cost of each unit of output decreases by $d = 1 - 2^{-\propto_c}$ compared to its previous level (17).

This study was approved under the code of ethics IR.JUMS.REC.1400.010 by Jahrom University of Medical Sciences.

Results

Given that the requirement for the reliability of the results of the estimated model and prevention of spurious regression is to perform a stationary test, first, stationary tests related to panel data were performed and their results are presented in Table 1.

Table 1. The results for the stationary test of the variables

Variable		LLC	IPS	Fisher-ADF	Fisher-PP
Total number of countries	Average cost logaritm Lc	-15.68 (0.000)	-6.03 (0.000)	603.4 (0.000)	658.6 (0.000)
	Production log (Ly)	-14.76 (0.000)	-5.79 (0.000)	1552.3 (0.000)	2099.6 (0.000)
	Cumulative Production log (Ln)	-25.95 (0.000)	-128.0 (0.000)	3180.5 (0.000)	5551.3 (0.000)
116 Developed Countries	Average cost logaritm Lc	-11.42 (0.000)	-5.23 (0.000)	370.13 (0.000)	658.6 (0.000)
	Production log (Ly)	-11.38 (0.000)	-4.33 (0.000)	1160 (0.000)	2099.6 (0.000)
	Cumulative Production log (Ln)	-73.33 (0.000)	-85.19 (0.000)	1840.9 (0.000)	5551.3 (0.000)
71 Developing Countries	Average cost logaritm Lc	-10.73 (0.000)	-3.10 (0.000)	233.13 (0.000)	263.4 (0.000)
	Production log (Ly)	-11.91 (0.000)	-3.71 (0.000)	385.2 (0.000)	798.9 (0.000)
	Cumulative Production log (Ln)	-96.28 (0.000)	-97.42 (0.000)	1302.7 (0.000)	2127.6

The numbers in the parenthesis show the significance level.

The results presented in Table 1 for both groups of developed and developing countries indicate that the research variables are stationary, implying the reliability of the results and the absence of spurious regression. In addition, for further reassurance, the existence of interdependence between the cross-sections was confirmed. Therefore, the stationary test of the second generation of variables, including the cross-sectionally augmented Dicky-Fuller test of Pesaran (2006), was performed. The results of this test, like the stationary tests of the first generation of the variables, confirmed that the variables were stationary. Furthermore, to estimate the model, discriminant tests should be performed to find out if the data are pooled or panel. Afterward, the panel with fixed or random effects was developed for the learning curve in two groups of developed and developing countries, as shown in Table 2.

Table 2. The F-Limer and Hausman tests

Learning equation	Developed countries	Developing countries	Total number of countries
F-Limer test	F = 300.03 (0.000)	F = 78.09 (0.000)	F = 470.70 (0.000)
Hausman test	χ^2= 17.439 (0.000)	χ^2= 28.418 (0.000)	χ^2= 47.432 (0.000)

The numbers in the parenthesis show the significance level.

As can be seen in the table above, the results of testing the two equations using the F-Limer test reject the hypothesis of redundancy of fixed effects in both groups of countries in question. Thus, the model is a panel model. Furthermore, the results of the Hausman test confirm the existence of a fixed-effect panel model. The data in Table 3 show the results of testing the assumption of homogeneity of variance and non-autocorrelation of error terms in the equations of total cost and learning curve.

Table 3. The test of homogeneity of variance and non-autocorrelation of error terms

Learning equation	Developed countries	Developing countries	Total number of countries
Homogeneity of variance test	χ^2= 1723.8 (0.000)	χ^2= 613.61 (0.000)	χ^2= 2726.78 (0.000)
Non-autocorrelation test	F = 199.608 (0.000)	F = 225.24 (0.000)	F =391.929 (0.000)
Null hypothesis H_0	There is a variance of homology between the error terms. There is non-autocorrelation between the error terms.		

The numbers in the parenthesis show the significance level.

The data presented in Table 3 confirm the presence of the heterogeneity of variance and autocorrelation between the error terms in the above equations, which can be eliminated by weighing the sections and adding the term *AR(1)* to the equations. It should be noted that in modern econometrics, the feasible general least squares (FGLS) approach is used to simultaneously solve the problem of heterogeneity of variance and autocorrelation between error terms. Therefore, to estimate the final model, the FGLS approach that eliminates heterogeneity and autocorrelation simultaneously was used.

The learning curve equation can be estimated to quantify the elasticity of learning and economies scale and examine the two static and dynamic aspects of cost advantage in the health sectors in both developed and developing countries, as shown in Table 4.

Table 4. Estimating the learning curve using the feasible general least squares (FGLS) approach

Estimating the learning curve for all countries of the world				
Variable	**Coefficient**	**SD**	**t**	**Sig.**
Constant	-3.378	0.305	11.045	(0.000)
Production log ly	-0.132	0.148	-0.888	(0.374)
Cumulative production (Knowledge storage) log Ln	-0.460	0.052	-8.886	(0.000)
Discriminant statistic	F =7349.12 Prob (0.000)	D.W=1.89	$\bar{R}^2$ = 0.998	R^2=0.997
Collinearity test	VIF-Ln =1.123		VIF-Ln =1.580	
Estimating the learning curve for 116 developed countries				
Variable	**Coefficient**	**SD**	**t**	**Sig.**
Constant	3.195	0.332	11.801	(0.000)
Production log ly	0.366	0.336	1.091	(0.275)
Cumulative production (Knowledge storage) log Ln	-0.563	0.101	-5.572	(0.000)
Discriminant statistic	F =4162.42 Prob (0.000)	D.W=1.87	$\bar{R}^2$ = 0.960	R^2=0.962
Collinearity test	VIF-Ln = 1.008		VIF-Ly = 1.012	
Estimating the learning curve for 71 developing countries				
Variable	**Coefficient**	**SD**	**t**	**Sig.**
Constant	3.781	0.857	4.413	(0.000)
Production log ly	-0.119	0.038	-3.103	(0.002)
Cumulative production (Knowledge storage) log Ln	-0.340	0.0801	-4.248	(0.000)
Discriminant statistic	F=1219.49 Prob (0.000)	D.W=2.015	$\bar{R}^2$ = 0.986	R^2=0.987
Collinearity test	VIF-Ln = 1.097		VIF-Ly = 1.103	

As seen in table 4, the F and R^2 values show the goodness of fit and significance of regression equations. Besides, the variance inflation factor (VIF) value does not show a strong correlation between the variables in the model. On the other hand, considering that the production coefficient in the learning curve for all countries is -0.132, returns to scale (RTS) for the health sector of the countries are on average equal to 1.15 and all economies of scale have not completely been exhausted. However, considering that the production coefficient in this model is insignificant, it can be concluded that economies of scale have been fulfilled in the healthcare sector, and returns to scale are fixed. Moreover, the slope of the learning curve as expected for all countries is $\propto_c$ = -0.460. Furthermore, the production coefficient is positive and equal to 0.336 for the developed countries. This indicates that with increasing the scale of production, the average cost has increased and the returns to scale for the health sector in these countries are equal to 0.732 on average. However, as the production coefficient in this model is equal to $\frac{(1-r)}{r}$ and is statistically insignificant, there is no significant difference from zero. Thus, it can be concluded that in developed countries, returns to scale in the health sector have been constant and all economies of scale have been exhausted. In addition, the slope of the learning curve as a proxy for the average learning intensity is relatively high as expected and is equal to $\propto_c$ = 0.563. The production coefficient is -0.119 for the developing countries, which indicates that the average return to scale in developing countries is 1.13; in other words, the economies of scale in these countries are not completely exhausted and it is expected that with the increase of the scale, it is still possible to utilize the economies of scale. On the other hand, the average learning intensity in developing countries ($\propto_c$ = -0.384) is lower than the learning intensity in developed countries and all countries of the world. In the following section, the economies of scale and learning are discussed in detail for each country separately as shown in Tables 5 and 6.

Table 5. The frequency of learning intensity and economies of scale in developing and developed countries

116 developed countries				71 developing countries			
Learning intensity	**Number of countries**	**Relative frequency (%)**	**Cumulative relative frequency**	**Learning intensity**	**Number of countries**	**Relative frequency (%)**	**Cumulative relative frequency**
$0 < \propto_{cit} \leq 0.35$	33	28	28	$0 < \propto_{cit} \leq 0.35$	12	17	17
$0.35 < \propto_{cit} \leq 0.65$	21	18	46	$0.35 < \propto_{cit} \leq 0.65$	10	14	31
$0.65 < \propto_{cit} \leq 0.95$	16	14	60	$0.65 < \propto_{cit} \leq 0.95$	4	6	37
$\propto_{cit} > 0.95$	46	40	100	$\propto_{cit} > 0.95$	45	63	100
Average learning		$\propto_c$= 0.563		Average learning		$\propto_c$= 0.384	
Economies of scale	**Number of countries**	**Relative frequency (%)**	**Cumulative relative frequency**	**Economies of scale**	**Number of countries**	**Relative frequency (%)**	**Cumulative relative frequency**
$ES > 0, r > 1$	37	32	32	$ES > 0, r > 1$	38	53	53
$ES = 1, r = 0$	6	5	37	$ES = 1, r = 0$	5	7	60
$ES < 0, r < 1$	73	63	100	$ES < 0, r < 1$	28	40	100

Source: Research findings.

As shown in the table above, the learning intensity is above the average in 60% of developed countries and approximately 80% of developing countries. Furthermore, in 32% of developed countries and 53% of developing countries with increasing efficiency, the cost elasticity to production is less than one. In other words, the economies of scale in the health sector have not been completely exhausted, and it is expected that with the increase of the scale, it is still possible to benefit from the economies of scale. In addition, in 63% of developed countries and 40% of developing countries, the cost elasticity to production is greater than one unit, implying that all economies of scale have been exhausted.

Table 6. The estimated coefficients, learning intensity, rate of return, and economies of scale in some countries

Country	Learning rate β_{1i}	Coefficient of production β_{2i}	Learning intensity $\propto_{ci}$	Learning progress d	Rate of return r	Economies of scale ES	Human Development Index HDI
	Developed countries by the Human Development Index						
Norway	**-0.81	**-0.71	-2.80	0.86	3.46	2.46	0.953
UK	**-0.98	**-0.92	-12.30	0.99	12.56	11.56	0.945
Switzerland	**-0.49	-0.03	-0.50	0.29	1.03	0.03	0.944
Ireland	**0.40	**0.59	0.25	-0.19	0.63	-0.37	0.938
Germany	**-0.22	**-0.54	-0.48	0.28	2.16	1.16	0.936
Iceland	-0.03	**-0.36	-0.05	0.03	1.57	0.57	0.935
Sweden	**-0.96	**-0.75	-3.90	0.93	4.06	3.06	0.933
Australia	**-0.70	**-0.07	-0.76	0.41	1.08	0.08	0.933
Singapore	**-0.43	**0.12	-0.38	0.23	0.89	-0.11	0.932
USA	**-0.23	-0.05	-0.23	0.15	1.05	0.05	0.924
New Zealand	**-1.10	**-0.60	-2.77	0.85	2.52	1.52	0.917
Iran	**-1.69	**-2.03	1.64	-2.11	-0.97	-1.97	0.798
China	**-0.64	**0.97	-0.32	0.20	0.51	-0.49	0.752
The average for all developed countries			-0.563	0.32	1	0	0.813
	Developing countries by the Human Development Index						
Egypt	**-0.60	**-0.51	-1.22	0.57	2.03	1.03	0.696
Vietnam	**-0.58	**-0.33	-0.87	0.45	1.50	0.50	0.694
Bolivia	**1.21	**1.16	0.56	-0.47	0.46	-0.54	0.693
Iraq	**-0.33	0.02	-0.33	0.20	0.98	-0.02	0.685
El Salvador	**0.18	**0.60	0.11	-0.08	0.63	-0.37	0.674
Kyrgyzstan	**-0.68	**-1.26	2.58	-4.99	-3.82	-4.82	0.674
Guyana	**-0.11	**0.39	-0.08	0.05	0.72	-0.28	0.670
Cape Verde	**-1.42	**-0.24	-1.88	0.73	1.32	0.32	0.651
Tajikistan	**-0.90	**-0.42	-1.57	0.73	1.73	0.73	0.650
Bangladesh	**-0.48	0.17	-0.48	0.28	1.20	0.20	0.608
Laos	**0.22	**0.32	0.16	-0.12	0.75	-0.25	0.604
Pakistan	**-0.66	**-0.48	-1.27	0.59	1.92	0.92	0.562
The average for developing countries			-0.384	0.23	1.13	0.13	0.549

**: Significant at 0.05 (P = 0.05).

The data presented in Table 6 indicate that in more than half of the developed countries and less than 40% of the developing countries, economies of scale have been exhausted. However, in most developing countries all economies of scale have not been exhausted, and returns to scale as a static aspect of cost advantage can play a significant role in reducing the average cost of these countries. It can also be acknowledged that developed and developing countries have used economies of scale equally. With the development of knowledge and increasing experience in nearly 60% of countries, it is still possible to make the most of the economies of learning. In addition, the average learning rate in developed countries (-0.563) is higher than the learning rate (-0.384) in developing countries. On the other hand, the rate of learning progress, which confirms a reduction in the average cost when cumulative production (the acquisition of knowledge and experience) doubles for the studied countries, indicates that the average cost of health care for all developed and developing countries has decreased by 27.30%, 32.30%, and 23.37%, respectively. Overall, it can be concluded that although the effect of economies of scale in reducing costs is almost constant in developed countries, the dynamic effects of economies of scale have been overcome by static economies of scale and have reduced costs in the health sector. However, the effect of economies of scale and learning can together play a key role in reducing costs in developing countries.

Discussion

Meeting the health needs and improving the health of members of the community can guarantee an efficient and healthy workforce and can lead to developing human capital, increasing productivity, reducing production costs, and thus benefiting from the cost advantage of economies of scale and learning in each community. In this paper, an attempt was made to integrate the K Cobb-Douglas production function and the learning power curve to quantify economies of scale and learning. Besides, it explored the effects of both static and dynamic aspects of cost advantage in the health care sector of 187 developed and developing countries over the period from 2000 to 2018.

On the other hand, since most countries have experienced an improvement in health outcomes by increasing the share of health care costs from GDP, health care costs in developed countries are higher compared to underdeveloped countries. Moreover, an analysis of the share of health expenditures in Iran's GDP from 2000 to 2018 shows an average share of 5.86%. Although this share is higher by 2.09% than the average expenditure of OPEC members, it is not satisfactory compared to developed countries with a share higher than 12% (18). In addition, a comparison of the share of health expenses in Iran and other countries shows that with the implementation of the health system transformation plan and during the last 15 years, the share of government payments and insurance companies in Iran has increased by 16.43%, while the repayment of treatment costs by households has decreased. Moreover, the rate of medical expenses paid by households in 2016 was estimated at 15% in Turkey, 76% in Iraq, 78% in Afghanistan, and 11% in the United States (19).

Overall, the results of this study indicated that although not all economies of scale have been completely exhausted in the health sectors in all countries, given that the coefficient of production is insignificant, the returns to scale are constant. In addition, in developed countries, with the increase in production scale, the average cost has increased, but as this increase was statistically insignificant, returns to scale in the health sector in developed countries have been constant and all economies of scale have been exhausted. In contrast, economies of scale in developing countries have not been completely exhausted, and returns to scale are increasing. This implies that by increasing the number of people receiving the minimum health care, it is possible to reduce costs significantly in the health care sector. This study also showed economies of learning have been fulfilled with average, high, and relatively lower intensity than average in all developed and developing countries, as indicated by previous studies including Tsai et al. in Taiwan (10), Sturman et al. in Australia (20), and Reime et al. in Norway (21).

Furthermore, it was found that the average economies of scale are less than the economies of learning in some developing countries such as Indonesia, Afghanistan, Iraq, Nigeria, Guinea, Sierra Leone, and Somalia. Infrastructural problems, inadequate health policies, the low number of hospital beds to patients, and lack of access to minimum health facilities are the reasons for the lower average economies of scale than the economies of learning. In addition, less than 2.5 percent of GDP is spent on health care in these countries, and economies of scale have not been fully exhausted. To change the status quo, it is essential to pay attention to infrastructure issues, finance the provision of health care services, train staff, and provide research and development services, and benefit from economies of learning (22).

However, developing countries such as Rwanda have been able to take advantage of both economies of scale and learning by taking some measures such as the correct implementation of health care policies and plans, the formation of social groups to identify diseases and preventive methods, voluntary identification of patients and pregnant women and their education, research and development in the production of drugs and vaccines and training of all personnel, compliance with horizontal and vertical justice in the provision of care, and financing and risk-sharing through the development of the insurance system over the years. It is noteworthy that in these countries, in addition to financial assistance and public participation, part of health care expenditures is funded through the government budget (19).

Besides, some developed countries such as Denmark, the Netherlands, Canada, Finland, and Belgium that have the fairest health system financially and most of their health care costs are funded by the government have been ranked high in terms of health care services due to access to modern technologies, advanced capital equipment, training staff and enhancement of their experience, and investment in research and development services (23). The learning intensity in these countries is very high and the average cost decreases significantly with increasing experience.

Conclusion

Learning and economies of scale rates are different in developed and developing countries. However, in these countries, both components play an effective role in reducing costs and they are two static and dynamic aspects of cost advantage. Moreover, developed and developing countries have equally benefited from economies of learning. With the development of knowledge and increasing experience in nearly 60% of countries, it is still possible to take advantage of economies of learning. Nevertheless, the role of economies of scale in reducing costs is almost constant in developed countries and the dynamic effects of economies of learning dominate the dynamic effects of economies of scale, reducing expenditures in the health sector. In contrast, the effects of economies of scale and learning together can play a key role in reducing costs in developing countries.

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Conflict of interest

The authors declared no conflict of interest.

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