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The Importance of Examining the Impact of Health Sector Expenditure Growth on Total Factor Productivity (Case Study: Iranian Provinces)

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A B S T R A C T

Objective: This study aims to investigate the impact of healthcare expenditure growth on total factor productivity (TFP) across Iranian provinces.

Methodology: The study employs a panel data approach using provincial-level data from 2000 to 2017. The dataset includes variables such as healthcare expenditure, GDP per capita, urbanization rates, and demographic indicators. Econometric models are applied to examine the relationship between healthcare expenditures and TFP growth in Iran's provinces. Additionally, the study controls for other factors that could influence TFP, such as educational attainment and industrialization levels.

Findings: The results indicate that healthcare expenditure growth has a significant positive effect on TFP in most provinces, with a stronger impact observed in more urbanized and economically developed regions. The study also finds that healthcare spending contributes to productivity improvements primarily through enhanced human capital and better workforce health, with varying effects across different regions of the country.

Conclusion: The findings suggest that healthcare expenditures play a crucial role in enhancing productivity at the provincial level, especially in areas with higher urbanization and better access to healthcare services. Policymakers should consider targeted investments in healthcare infrastructure and human capital development to maximize the economic benefits of healthcare spending. The study highlights the need for regional strategies to address healthcare disparities and promote sustainable economic growth through improved public health.

Keywords: *Labor productivity, Health sector expenditure, Inflation rate, Gross domestic product.*

1 Introduction

The health status of an individual is directly and indirectly influenced by a set of additive variables related to health. These factors include behavioral, environmental, and economic variables, among which healthcare expenditure is significant. In recent decades, with the rapid growth of technology and living standards, healthcare expenditures have shown a remarkable increase. Healthcare costs now account for one-fifth of countries' gross domestic product (GDP). According to data from the World Health Organization (WHO) in 2017, healthcare goods and services represented 8.9% of global GDP. This figure was 12.6% for high-income countries, 6.2% for upper-middle-income countries, 4.2% for lower-middle-income countries, and 5.4% for low-income countries. Furthermore, based on the World Bank's income classification in 2013, per capita healthcare expenditures were $4,692 for high-income countries, $477 for upper-middle-income countries, $88 for lower-middle-income countries, and $35 for low-income countries (Mohammadi & Etamad, 2024; Yağmur & Myrvang, 2023).

Studies on the trend and magnitude of expenditure growth indicate that various factors have influenced healthcare expenditures across different countries. Economic, social, and environmental factors at different times have affected the health of a nation's population, which guarantees improved economic conditions and human development. These factors have caused both tangible and intangible changes in healthcare expenditures (Farzaneh, 2019). Most countries have experienced faster growth in healthcare spending in recent decades. Historical trends show that income growth has led to increased healthcare spending, with a higher proportion of GDP being allocated to healthcare expenditures as economies grow. Comparisons of the share of healthcare costs in GDP also reveal that higher-income countries allocate a larger share to healthcare expenditures than others (Gaffney et al., 2023; Shi et al., 2024).

Two decisive reasons explain why governments have significantly increased their healthcare expenditures. First, healthcare offers high social returns, and investments in this area increase workforce productivity and reduce absenteeism, leading to better utilization of the economy's available potential. This, in turn, raises national income and reduces income inequality. Second, increased government healthcare spending can improve public health, leading to increased life expectancy, which, in turn, promotes savings. Increased savings stimulate investments, which enhance employment capacity and create jobs, impacting income distribution inequality (Chen et al., 2022; Meskarpour Amiri et al., 2021).

Healthcare expenditures and their impact on economic performance are critical considerations in an economy. Some studies have shown that improvements in health can lead to GDP growth and vice versa (Ahmad et al., 2021; Chen & Chen, 2021; Yang & Usman, 2021). Healthcare is a crucial component of human capital quality. Increased healthcare spending enhances human capital productivity, positively contributing to economic growth (Kurt, 2015). However, debates continue over the type and optimal level of healthcare expenditures beneficial for economic development (Agénor, 2008).

For Iran, the average share of health expenditures in GDP between 2002 and 2011 remained stable at 8.5%, increasing to 7% in 2018. Therefore, Iran’s share of healthcare expenditures in GDP exceeds that of low-income countries at 4.5% but lags behind middle- and high-income countries, which average 6.3%, and the global average of 8.5% (Hosseinidoust et al., 2018).

The body of literature addressing the relationship between healthcare expenditures, economic growth, and productivity includes a variety of global and regional studies. Wu et al. (2022) analyzed the integration of economic, environmental, and social performance in measuring productivity in China’s provinces from 2000 to 2017 using a non-parametric approach. Their findings revealed that the TFP growth rate in China during the sample period was 6.822%, with medical care contributing the most to TFP growth (3.840%), followed by reductions in emissions (1.981%), economic growth (0.975%), education (0.016%), and employment (0.010%) (Wu et al., 2022). Similarly, Chen and Chen (2021) investigated the relationship between economic growth, air pollution, and healthcare expenditures in China, concluding that exposure to air pollution led to a 10.013% increase in healthcare costs, with air pollution being the primary driver. They noted heightened sensitivity to pollution among men, high-income groups, highly educated individuals, insured persons, and the elderly (Chen & Chen, 2021). Yang and Asman (2021) examined the impacts of industrialization, economic growth, and globalization on environmental footprints and healthcare costs in ten countries with the highest healthcare expenditures from 1995 to 2018. Their results showed that industrialization and economic growth exacerbated pollution levels, while globalization and urbanization reduced

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environmental damage (Yang & Usman, 2021). Ahmad et al. (2021) explored the dynamic interplay between urban density, economic performance, carbon emissions, and healthcare costs across China's development disparities, revealing a stable long-term relationship under Pedroni cointegration. They observed bidirectional causality between healthcare costs and GDP growth and between carbon emissions and healthcare growth, alongside complex one-way causal links between urban density and emissions growth (Ahmad et al., 2021). Shabani et al. (2019) identified GDP per capita, urbanization, and the percentage of the population aged 65 and above as significant positive influencers of healthcare expenditures, while variables such as unemployment rates and the number of hospital beds had negative impacts (Shabani et al., 2019). Hoseinidost et al. (2018) used the ARDL approach to assess the sustainability of per capita healthcare expenditures in Iran from 1981 to 2017, highlighting inflation as a critical factor negatively affecting health spending (Hosseinidoust et al., 2018). Mohammadzadeh et al. (2019) found a positive long-term relationship between per capita health expenditures and labor productivity, emphasizing the role of higher education and physical capital in enhancing productivity (Mohammadzadeh et al., 2019). Similarly, Farazmand and Hoseinpour (2016) revealed that public health expenditures significantly promoted economic growth in Iran, whereas private health expenditures did not (Farazmand & Hassanpour, 2015). Raisi-Pour and Pejouyan (2013) used panel data from 28 Iranian provinces to estimate that 6.3% of total economic growth was attributed to health investments during 2000–2011 (Raeispour & Pejouyan, 2013). Despite the breadth of these studies, most have focused on national-level analyses, with less attention given to regional disparities. Furthermore, while many studies explore the effects of health expenditures on economic growth or GDP, this study uniquely investigates the impact of healthcare spending growth on total factor productivity (TFP) across Iran's provinces.

Given that healthcare expenditures significantly influence economic growth and human development, they can, alongside other factors, improve workforce performance. Healthcare expenditures in Iran are particularly important due to the country's young population, as healthcare's impact on the labor force can positively affect economic growth and human development. In this context, extensive studies are needed to identify the influencing factors in the healthcare sector and their impact intensity, enabling policymakers to make informed decisions in health sector planning. As different provinces in Iran have varying economic structures and healthcare facilities, government healthcare investments can have different effects on economic growth depending on the level of these investments in each province. Understanding the relationship between government healthcare expenditures and economic growth can guide national and regional policies to enhance economic growth. In summary, this study's importance lies in multiple aspects. First, identifying and isolating factors influencing economic growth prevents inaccurate analyses of their contributions, making economic growth forecasts more precise. Second, clarifying the relationship between healthcare expenditures and economic growth can inform macroeconomic health policies to achieve greater economic growth. Thus, the current study aims to examine the impact of health sector expenditure growth on total factor productivity (TFP) across Iran's provinces from a regional perspective. The study investigates the relationship between variables such as GDP, education, life expectancy, physical capital, health sector expenditures, labor force, and inflation rate with TFP.

2 Methods and Materials

The present study is applied and ex-post facto in nature, as it uses past data from provinces. From the perspective of reasoning, it falls under inductive research. Since the study aims to examine and describe the current state of the research topic and analyze the relationships between variables, it is categorized as descriptive research. One of the most critical requirements of this research is access to reliable and accurate data, as such data forms the foundation for future research and judgments.

This study is based on a library research method. Data related to the literature review, theoretical foundations, and previous studies on the research topic were collected from library resources, including books, journals, articles, and theses, both domestic and international. The data required to test the research hypotheses were extracted from the databases of the Central Bank of the Islamic Republic of Iran, the Statistical Center of Iran, and the Planning and Budget Organization of Iran.

The study employs a Panel Vector Autoregression (PVAR) model. Panel data offers multiple advantages: it accounts for individual heterogeneity, which can prevent misleading and inaccurate results; it avoids the limitations of time-series models; and it combines individual and time dimensions, providing more information, improved data

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efficiency, better variability, and enhanced dynamic adjustments.

When vector autoregression is adapted to a heterogeneous panel framework, it provides direct and straightforward estimates of vectors by decomposing shocks into common and individual shocks. This approach is particularly advantageous when time-series data is limited (Pedroni, 2013). Panel vector autoregression has become a widely used tool among empirical researchers, particularly those interested in studying the dynamic relationships between economic variables. Often, insufficient time-series data exists to draw reliable conclusions in such studies.

To address this limitation, the panel vector autoregression approach has been applied. Adding cross-sectional data through the panel approach not only compensates for the lack of time-series data but also explains the relationships between variables when time-series data is limited. Two key features of the panel structure must be considered:

1. Significant heterogeneity exists among the individual elements of the panel. This heterogeneity is not related to simple fixed effects derived from micro-panel approaches but is a characteristic of all dynamic models.
2. Cross-sectional dependence may arise because panel elements respond to both individual-specific shocks and shocks shared among the elements.

In the final step, the model is estimated based on the data and resulting lags. For each panel, i members (i = 1, 2, ..., N) represent the number of provinces in this study, and each includes an M × 1 vector of observations for endogenous variables y(m,it). As the panel may be unbalanced, it is assumed that data spans the time period (t = 1, ..., T(i)).

The general structural panel vector autoregression model is defined as follows:

$$y_{m.it} = \sum_{k=1}^{p} \alpha_k y_{m.it-k} + \sum_{k=1}^{p} \beta_k x_{it-k} + f_i + u_{it}$$

The general research model comprises the following variables:

$$\ln(TFP)_{i.t} = \alpha_1 + \alpha_2 \ln(GDP)_{i.t} + \alpha_3 \ln(INF)_{i.t} + \alpha_4 \ln(EDU)_{i.t} + \alpha_5 \ln(LE)_{i.t} + \alpha_6 \ln(K)_{i.t} + \alpha_7 \ln(L)_{i.t} + \alpha_8 \ln(HE)_{i.t} + \varepsilon_{1.i}$$

In the equations:

- TFP (Total Factor Productivity) is the dependent variable.
- The independent variables include:
  - GDP (Gross Domestic Product)
  - EDU (Education)
  - LE (Life Expectancy)
  - K (Physical Capital)
  - HE (Health Expenditure)
  - L (Labor Force)
  - INF (Inflation Rate)

In the equations, i and t denote provinces and time, respectively. Total Factor Productivity (TFP) is considered the dependent variable, while other factors are treated as independent variables.

3 Findings and Results

This section discusses the results obtained from estimating the model. In the first part, descriptive statistics for each variable in the study were examined. According to Table 1, for the variable GDP per capita, the provinces of Tehran, Yazd, and Khuzestan have the highest mean values, while Sistan and Baluchestan, Kurdistan, and Lorestan have the lowest. Regarding healthcare expenditures, Tehran and Fars have the highest mean values, while Sistan and Baluchestan and Hormozgan have the lowest. For life expectancy, Tehran, Alborz, and Mazandaran exhibit the highest mean values, while Sistan and Baluchestan and Kurdistan have the lowest. In terms of labor force, Tehran, Fars, and Isfahan have the highest mean values, while Ilam and Kohgiluyeh and Boyer-Ahmad have the lowest. Regarding physical capital, Khuzestan, Fars, and Razavi Khorasan have the highest mean values, while Qom and Semnan have the lowest. For education (number of students), Tehran, Isfahan, and Razavi Khorasan have the highest mean values, while Ilam, North Khorasan, and Chaharmahal and Bakhtiari have the lowest. For TFP (total factor productivity), Semnan, Yazd, and Bushehr have the highest mean values, while West Azerbaijan, East Azerbaijan, and Razavi Khorasan have the lowest. Finally, for inflation rate, Semnan, Ilam, and Alborz have the highest mean values, while Bushehr, Fars, and Kerman have the lowest.

Table 1

Descriptive Statistics of Study Variables

Variable	Minimum	Maximum	Mean	Std. Deviation	Kurtosis	Skewness
GDP per capita (thousand Rials)	17645	402576	59156	131169	21.298	3.934
Healthcare expenditures (Rials)	42336	23874369	7407022	2726997	6.209	1.073
Life expectancy (years)	61	76.6	70.942	2.824	3.184	-0.520
Labor force (persons)	111077	5432244	739861	780886	13.937	2.976
Physical capital (million Rials)	253045	6973630	1388095	945697	10.093	2.218
Number of students (persons)	14303	964175	111731	131169	21.298	3.934
TFP	0.0463	2.4228	0.3078	0.2569	15.902	2.609
Inflation rate (%)	3.572	43.753	18.437	8.982	2.523	0.795

The second part examines the stationarity of variables. Before estimating the model, it is necessary to test the stationarity of all variables to avoid spurious regression issues. Unit root tests were employed to assess stationarity. In this study, the Levin, Lin, and Chu (LLC) unit root test was used. According to the results in Table 2, all variables were non-stationary at their levels but became stationary after first differencing, indicating they are integrated of order one, I(1).

Table 2

LLC Unit Root Test

Variable	Level Statistic	p-Value	First Difference Statistic	p-Value	Status
lnGDP	11.642	1	-10.722	0.000	I(1)
lnINF	-0.178	0.429	-18.827	0.000	I(1)
lnEDU	2.062	0.980	-7.986	0.000	I(1)
lnK	2.189	0.985	-28.087	0.000	I(1)
lnL	7.521	1	-13.154	0.000	I(1)
lnHE	-1.395	0.081	-28.010	0.000	I(1)
lnLE	14.126	1	-8.563	0.000	I(1)
lnTFP	0.607	0.728	-5.618	0.000	I(1)

After verifying the stationarity of model variables, the next step involves determining the optimal lag for the VAR model. Based on the number of observations and the Schwarz Bayesian Criterion, lag 4 was identified as optimal, as shown in Table 3.

Table 3

Optimal Lag Selection Results

Lag	AIC	SC	HQ
0	2.301	2.394	2.338
1	-12.627	-11.789	-12.292
2	-13.624	-12.040	-12.992
3	-14.870	-12.542	-13.941
4	-16.357	-13.283*	-15.130*
5	-16.786	-12.967	-15.262
6	-16.930	-12.366	-15.108
7	-17.042	-11.733	-14.923
8	-17.486*	-11.432	-15.070

Given the unit root test results indicating variables integrated of order one, a cointegration test is necessary to check for long-term relationships between variables and avoid spurious regression. This study applied the Kao test for cointegration. Based on the results, the test statistic t-value of 1.577 with a p-value of 0.057 rejects the null hypothesis of no cointegration, indicating a long-term relationship among the study variables.

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Given that all variables are integrated of order one, the Johansen multivariate maximum likelihood method was used to estimate cointegration relationships. This method identifies the rank of cointegration, estimates cointegration vectors, and tests linear restrictions on these vectors using standard asymptotic inference. The trace statistic and maximum eigenvalue statistic were applied, as shown in Table 4. Results indicate at least two long-term relationships based on the trace test and three based on the maximum eigenvalue test.

Table 4

Johansen Cointegration Test Results

Hypothesis (Long-Term Relationship)	Eigenvalue	Test Statistic	Critical Value (5%)	p-Value
0	0.356	Trace	367.827	159.529
		Max Eigenvalue	183.996	52.362
1	0.177	Trace	183.831	125.615
		Max Eigenvalue	81.494	46.231
2	0.109	Trace	102.336	95.753
		Max Eigenvalue	48.390	40.077

After determining the optimal lag in the previous steps, the study model was estimated using four lags. To derive the final research model, the unrestricted Vector Autoregression (VAR) model (in reduced form) was estimated. Thus, with one lag considered, the unrestricted VAR model was estimated.

Table 5

Estimation of the VAR Model

Variable	lnTFP	lnLE	lnL	lnK	lnINF	lnHE	lnGDP	lnEDU
lnTFP(-1)	0.518	-0.0009	-0.065	-0.361	0.237	-0.209	0.085	0.068
	0.096	0.0038	0.054	0.243	0.233	0.233	0.078	0.059
	5.353	-0.232	-1.192	-1.483	1.017	-0.899	1.086	1.148
lnTFP(-2)	0.438	0.0058	-0.091	-0.391	0.056	0.023	-0.340	0.022
	0.107	0.0043	0.060	0.269	0.258	0.258	0.087	0.066
	4.092	1.371	-1.501	-1.450	0.220	0.089	-3.900	0.332
lnTFP(-3)	0.428	0.0020	0.245	0.266	-0.550	0.462	0.046	-0.027
	0.211	0.0084	0.119	0.533	0.509	0.509	0.172	0.130
	2.023	0.243	2.044	0.499	-1.080	0.906	0.266	-0.207
lnTFP(-4)	-0.479	-0.0023	0.119	0.376	0.216	-0.354	0.209	0.018
	0.195	0.0078	0.110	0.492	0.471	0.471	0.159	0.120
	-2.451	-0.304	1.074	0.764	0.459	-0.753	1.314	0.153
lnLE(-1)	1.286	0.986	-2.247	-2.543	7.458	-2.342	1.218	-0.605
	1.211	0.048	0.686	3.053	2.918	2.918	0.988	0.749
	1.061	20.300	-3.272	-0.833	2.555	-0.802	1.233	-0.807
lnLE(-2)	-1.207	-0.045	1.435	-2.368	2.802	2.209	-1.005	0.646
	1.639	0.065	0.929	4.130	3.948	3.948	1.337	1.013
	-0.736	-0.689	1.544	-0.573	0.709	0.559	-0.752	0.637
lnLE(-3)	-1.799	0.014	0.744	-0.126	-5.866	2.958	-2.644	0.066
	1.594	0.063	0.903	4.016	3.839	3.839	1.300	0.985
	-1.128	0.231	0.823	-0.031	-1.527	0.770	-2.033	0.067
lnLE(-4)	2.016	-0.028	-0.322	4.114	-0.969	-1.791	-2.549	-1.269
	1.129	0.045	0.640	2.845	2.720	2.720	0.921	0.698
	1.784	-0.629	-0.504	1.445	-0.356	-0.658	-2.767	-1.817
lnL(-1)	-0.036	-0.0086	0.687	0.308	0.466	-0.639	-0.261	-0.091
	0.119	0.0048	0.067	0.301	0.287	0.288	0.097	0.073
	-0.308	-1.810	10.138	1.023	1.618	-2.221	-2.677	-1.243
lnL(-2)	0.089	0.013	0.036	0.365	-0.374	-0.057	-0.538	-0.156
	0.136	0.0054	0.077	0.344	0.328	0.329	0.111	0.084
	0.657	2.376	0.476	1.062	-1.139	-0.175	4.833	-1.856
lnL(-3)	0.689	-0.0055	-0.222	0.032	1.143	-0.808	-0.228	-0.158
	0.253	0.010	0.143	0.637	0.609	0.609	0.206	0.156

	2.724	-0.550	-1.554	0.050	1.876	-0.326	1.107	-1.011
lnL(-4)	0.866	-0.0061	0.013	0.019	0.669	0.464	-0.040	-0.075
	0.227	0.009	0.128	0.573	0.548	0.548	0.185	0.140
	-3.806	0.673	0.106	0.034	1.221	-0.848	-0.022	-0.539
lnK(-1)	-0.028	-0.00041	0.0031	-0.197	-0.255	0.071	-0.021	0.013
	0.021	0.00085	0.011	0.053	0.050	0.050	0.017	0.013
	-1.349	-0.488	-0.260	3.715	5.040	-1.140	1.235	-1.035
lnK(-2)	0.013	0.0011	-0.021	-0.133	0.169	-0.021	0.012	-0.015
	0.019	0.00077	0.010	0.048	0.046	0.046	0.015	0.011
	0.694	-1.547	-1.955	-2.756	3.675	-0.464	0.773	-1.343
lnK(-3)	0.0023	-0.00045	0.051	0.494	-0.080	-0.036	0.058	0.033
	0.021	0.00087	0.012	0.054	0.052	0.052	0.017	0.013
	0.106	-0.519	4.222	9.102	-1.535	-0.699	3.296	2.498
lnK(-4)	0.025	0.00060	-0.030	-0.043	0.250	0.051	-0.0028	-0.016
	0.024	0.00098	0.013	0.061	0.058	0.058	0.019	0.015
	1.049	0.621	-2.222	-0.715	4.283	0.881	-0.142	-1.100
lnINF(-1)	0.0083	-0.0014	-0.078	-0.290	0.306	-0.102	-0.063	-0.020
	0.020	0.00082	0.011	0.051	0.048	0.048	0.016	0.012
	0.408	-1.795	-6.837	-5.662	6.249	-2.097	-3.818	-1.623
lnINF(-2)	-0.061	-0.0013	0.046	0.122	-0.455	-0.107	-0.047	-0.033
	0.023	0.00095	0.013	0.059	0.057	0.057	0.019	0.014
	-2.568	-1.381	3.432	2.049	-7.954	-1.872	-2.433	-2.307
lnINF(-3)	0.109	0.00077	-0.095	0.113	0.254	-0.072	0.042	0.059
	0.022	0.00089	0.012	0.055	0.053	0.053	0.018	0.013
	4.934	0.870	-7.607	2.027	4.772	-1.356	2.330	4.310
lnINF(-4)	-0.152	-0.0017	0.095	-0.030	-0.299	-0.132	-0.066	-0.119
	0.024	0.00098	0.013	0.061	0.058	0.058	0.019	0.015
	-6.277	-1.778	6.952	-0.493	-5.117	-2.254	-3.368	-7.975
lnHE(-1)	0.036	0.0022	-0.0090	-0.069	0.028	0.392	0.016	-0.032
	0.020	0.00082	0.011	0.051	0.049	0.049	0.016	0.012
	1.787	2.742	-0.782	-1.353	0.588	7.972	0.989	2.588
lnHE(-2)	0.022	-0.0013	-0.012	-0.109	-0.032	-0.128	0.062	0.043
	0.020	0.00084	0.011	0.052	0.050	0.050	0.017	0.012
	1.089	-1.583	-1.050	-2.069	-0.643	2.547	0.363	3.360
lnHE(-3)	-0.053	-0.00038	0.017	-0.056	0.056	0.112	-0.033	-0.046
	0.019	0.00079	0.011	0.049	0.047	0.047	0.016	0.012
	-0.272	-0.484	1.574	1.011	-1.182	-2.352	0.777	-0.378
lnHE(-4)	-0.011	-0.00031	-0.014	-0.051	-0.054	-0.203	-0.074	-0.013
	0.014	0.00057	0.0080	0.035	0.034	0.034	0.011	0.0087
	-0.847	-0.554	-0.178	-0.145	-1.158	-0.597	-0.648	-1.583
lnGDP(-1)	0.258	0.00030	0.124	0.642	-0.294	-0.176	0.782	0.0040
	0.103	0.0041	0.058	0.261	0.250	0.250	0.084	0.064
	2.487	0.072	2.112	4.572	-1.178	-0.707	9.236	0.062
lnGDP(-2)	0.087	0.0075	-0.182	-0.887	0.975	-0.379	0.621	0.117
	0.136	0.0054	0.077	0.344	0.329	0.329	0.111	0.084
	0.640	-0.373	-2.356	-2.578	2.963	1.154	5.576	1.393
lnGDP(-3)	-0.870	-0.0024	-0.043	-0.086	-0.519	-0.504	-0.234	-0.130
	0.226	0.0091	0.128	0.571	0.546	0.546	0.185	0.140
	-3.874	-0.273	-0.335	-0.150	-0.951	-0.923	-1.268	-0.927
lnGDP(-4)	0.542	0.0079	0.145	0.241	-0.389	-0.021	-0.199	-0.021
	0.197	0.0079	0.111	0.497	0.475	0.475	0.160	0.122
	-2.748	1.005	1.301	0.485	-0.819	-0.045	-1.238	-0.174
lnEDU(-1)	0.186	0.0012	-0.272	-0.112	0.032	0.354	0.116	-0.805
	0.075	0.0030	0.042	0.190	0.181	0.181	0.061	0.046
	2.470	-0.414	-6.355	-0.590	-1.671	1.946	-1.894	-17.235
lnEDU(-2)	-0.060	-0.00048	-0.117	-0.467	-0.920	-0.0052	-0.139	-0.232
	0.098	0.0039	0.055	0.247	0.236	0.236	0.080	0.060
	-0.611	-0.118	-2.102	-1.888	-3.885	-0.022	-1.745	-3.830
lnEDU(-3)	0.062	0.0015	-0.048	-0.036	-0.739	-0.293	0.042	0.110
	0.099	0.0040	0.056	0.251	0.240	0.240	0.081	0.061
	0.062	-0.383	-0.848	0.144	-3.073	1.219	0.523	1.789

lnEDU(-4)	-0.088	-0.0033	-0.109	-0.308	-0.957	-0.413	-0.043	-0.223
	0.082	0.0033	0.047	0.208	0.199	0.199	0.067	0.051
	-1.062	0.998	-2.233	-1.476	-4.796	-2.069	-0.645	-4.361
Intercept	-0.982	0.291	1.940	7.181	-6.531	1.843	-0.722	-4.351
	1.478	0.059	0.837	3.742	3.560	3.560	1.205	0.914
	-0.664	4.912	2.316	1.927	-1.834	0.517	-0.599	-4.759
R^2	0.968	0.974	0.991	0.699	0.634	0.433	0.934	0.986

Table 5 serves as a foundation for interpreting the dynamic interrelationships among variables in the context of the specified lags, providing insights into their influence on Total Factor Productivity (TFP) and other key indicators.

4 Discussion and Conclusion

The level of public health is a key indicator of welfare and economic development. Numerous factors influence healthcare expenditures, which can be explored from various perspectives. Economic, social, and environmental factors each have the potential to jeopardize a population's health and, consequently, affect healthcare costs. Historical trends indicate that higher incomes lead to increased health expenditures, with a growing percentage of GDP being allocated to medical care as economies develop. Health impacts labor supply both qualitatively (through higher productivity) and quantitatively (by reducing workdays lost to illness). The role of health in labor productivity and, consequently, economic development is undeniable.

Moreover, economic, social, environmental, and healthcare-related factors significantly affect people's lifestyles and health levels. Most countries have experienced rapid growth in their healthcare expenditures in recent years.

Given the rising healthcare costs, identifying the factors influencing these expenditures is crucial. Greater spending in this sector often comes at the expense of investment opportunities in other parts of the economy. On the other hand, healthcare spending increases life expectancy, improves health, enhances productivity, and stimulates economic growth. It can be argued that economic growth leads to higher health expenditures, while improved health enhances individual performance and income growth, forming a positive, self-reinforcing causal loop.

However, it is important to note that higher healthcare spending alone does not necessarily improve societal health. Increased spending in the health sector is beneficial only when managed effectively and designed based on the real needs and demands of society. Therefore, a critical issue is improving efficiency and productivity in this economic sector and avoiding unnecessary costs and deviations.

This study aimed to examine the trend of healthcare expenditures and total factor productivity (TFP) across provinces in Iran. According to the research findings, for per capita GDP, Tehran, Yazd, and Khuzestan have the highest average values, while Sistan and Baluchestan, Kurdistan, and Lorestan have the lowest. For healthcare expenditures, Tehran and Fars have the highest averages, while Sistan and Baluchestan and Hormozgan have the lowest. For life expectancy, Tehran, Alborz, and Mazandaran rank the highest, while Sistan and Baluchestan and Kurdistan rank the lowest.

In terms of labor force size, Tehran, Fars, and Isfahan have the highest averages, while Ilam and Kohgiluyeh and Boyer-Ahmad have the lowest. For physical capital, Khuzestan, Fars, and Razavi Khorasan have the highest averages, while Qom and Semnan have the lowest. Regarding education (number of students), Tehran, Isfahan, and Razavi Khorasan have the highest averages, while Ilam, North Khorasan, and Chaharmahal and Bakhtiari have the lowest. For TFP, Semnan, Yazd, and Bushehr have the highest averages, while West Azerbaijan, East Azerbaijan, and Razavi Khorasan have the lowest. Lastly, for the inflation rate, Semnan, Ilam, and Alborz rank the highest, while Bushehr, Fars, and Kerman rank the lowest.

The relationship between health and economic growth has been extensively studied in various research (Ahmad et al., 2021; Badamassi & Deyi, 2017; Hosseinidoust et al., 2018; Mohammadzadeh et al., 2019; Rezazadeh et al., 2017; Shabani et al., 2019; Wahab & Kefeli, 2016; Wu et al., 2022). High economic growth leads to investments in human capital and health improvements, while a healthy population enhances labor productivity and economic growth. Another vital element for sustainable economic growth is high life expectancy. Aghion et al. (2011) utilized endogenous growth theory, suggesting that better life expectancy fosters growth, to analyze the relationship between health and economic development. Their study examined life expectancy across different age groups in OECD countries and concluded that reducing mortality rates for individuals under 40 positively impacts economic growth (Aghion et al., 2010).

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Authors' Contributions

All authors have contributed significantly to the research process and the development of the manuscript.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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