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Health Expenditure and Sectoral Total Factor Productivity in Morocco: A Dynamic Panel Analysis

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Abstract: This paper analyzes the relationship between health expenditure and sectoral total factor productivity (TFP) in Morocco over the period 2014–2020. The analysis uses panel data covering 44 economic sectors. TFP is estimated from a Cobb–Douglas production function using the Olley and Pakes (1996) methodology to correct for simultaneity and selection bias. A dynamic panel model is then estimated using the System Generalized Method of Moments (GMM) to address endogeneity and unobserved heterogeneity. The results indicate strong persistence in sectoral TFP, consistent with path-dependent productivity dynamics. Household health expenditure has a positive and statistically significant effect on productivity. Public health expenditure is negatively associated with TFP, raising concerns over efficiency and resource allocation. Health-related investment and intermediate expenditures do not exhibit robust productivity effects across sectors. The findings reveal heterogeneous productivity returns across health spending components. The results point to the predominance of household-driven health investments in supporting sectoral productivity gains. Policy implications point to prioritizing household-level health support and reforming public expenditure management to reduce inefficiencies. Targeted, decentralized interventions yield higher productivity gains than broad public programs. The study provides sector-level evidence from a developing economy, informing health and industrial policy design.

Keywords: *Total factor Productivity; Health expenditure; Dynamic panel data; System GMM; Morocco.*

1. Introduction

Total factor productivity captures efficiency gains beyond capital and labor accumulation and underpins sustained economic growth (Klenow & Rodriguez-Clare, 1997). It reflects technological progress, resource allocation quality, and institutional performance (Barro, 1996; Lucas, 1988; Van Leeuwen & Foldvari, 2008; De La Fuente, 2011; Li, Li, & Liu, 2025). Research has extensively examined the roles of education, research and development, and infrastructure in shaping TFP. Far less attention has been devoted to the productivity effects of health expenditure, particularly at the sectoral level within developing economies.

Health constitutes a central dimension of human capital. Improvements in health reduce absenteeism, enhance cognitive performance, and increase effective labor supply (Raghupathi & Raghupathi, 2020). Health investment lowers production losses associated with morbidity and strengthens workforce resilience (Ohikhuare et al., 2022). Endogenous growth models formalize these channels by linking health services provision to productivity dynamics through human capital accumulation and innovation (Lucas, 1988; van Zon & Muysken, 2001; Howitt, 2005). Empirical evidence confirms positive associations between health spending and macroeconomic performance in various contexts (Amiri et al., 2021; Xu et al., 2022). Yet the magnitude and even the direction of these effects depend on expenditure composition, allocation efficiency, and production structure (Agénor, 2008; Christensen, 2017; Voordt & Jensen, 2023).

The existing empirical literature remains dominated by cross-country or aggregate national analyses. Most studies estimate the relationship between total health expenditure and GDP growth or income per capita, often treating health as a homogeneous input. Such approaches mask within-country heterogeneity and overlook differences across sectors in labor intensity, exposure to health risks, capital requirements, and absorptive capacity. They rarely distinguish between household out-of-pocket spending, public expenditure, capital investment in health infrastructure, and intermediate health-related inputs. As a result, the channels through which distinct components of health spending influence productivity remain insufficiently identified. Sector-level evidence is particularly scarce in developing economies, where institutional constraints, informality, and structural transformation may shape heterogeneous productivity responses.

Public and private health expenditures may operate through different mechanisms. Household health spending is typically closely aligned with individual needs and preventive care decisions, potentially translating into direct efficiency gains at the worker level. Public expenditure, by contrast, is mediated by administrative processes, allocation rules, and governance quality. Its impact depends on whether resources are directed toward productive investment or absorbed by recurrent consumption and inefficiencies (Rivera & Currais, 2004; Gonzalez-Paramo, 1994). Health investment in infrastructure may generate long-term gains that do not materialize within short horizons, while intermediate health consumption may primarily offset losses rather than raise frontier productivity. Disentangling these channels requires disaggregated data and an empirical framework capable of addressing endogeneity and dynamic persistence.

Morocco offers a relevant setting to examine these issues. The country combines a mixed public–private health financing system with ongoing reforms aimed at expanding mandatory health insurance coverage. Health expenditure reached 5.7 percent of GDP in 2022, with per capita spending increasing substantially over the past decade (OECD, 2019). At the same time, Morocco faces structural productivity challenges characterized by sectoral dualism, labor concentration in low-productivity activities, and uneven technological upgrading. Whether health spending contributes to productivity gains across sectors, and through which channels, remains an open empirical question.

This paper addresses that gap by providing sector-level evidence on the relationship between health expenditure and total factor productivity in Morocco. It analyzes a balanced panel of 44 economic sectors over the period 2014–2020. First, sectoral TFP is estimated using a Cobb–Douglas production function and the semiparametric Olley and Pakes (1996) method, which corrects for simultaneity and selection bias. Second, the effects of four distinct health expenditure components—household spending, public spending, health investment, and intermediate health consumption—are assessed within a dynamic panel framework using System GMM to address endogeneity and productivity persistence.

The study contributes to the literature in three ways. It provides one of the first sector-level analyses of health expenditure and TFP in a developing economy using harmonized input–output data. It decomposes health spending into distinct channels within a unified productivity framework, allowing heterogeneous effects to be identified. It integrates semiparametric TFP estimation with dynamic panel techniques to strengthen causal inference. By doing so, it clarifies how different forms of health financing relate to productivity dynamics and informs both health policy design and structural transformation strategies.

The remainder of the paper is organized as follows. Section 2 reviews the Moroccan health system and related literature. Section 3 describes the data. Section 4 presents the empirical strategy. Section 5 reports the results. Section 6 discusses the findings. Section 7 concludes with policy implications.

2. Literature Review

Morocco's health system is organized as a mixed public–private model in which the Ministry of Health and Social Protection regulates and delivers the bulk of public services, while private providers—largely concentrated in urban areas—supply complementary care. Service provision covers primary, secondary, and tertiary levels, yet regional disparities in infrastructure, personnel distribution, and access persist, particularly in rural provinces (OECD, 2019; World Health Organization (WHO), 2022).

Financing combines state budget allocations, compulsory health insurance schemes, and household out-of-pocket payments. Recent reforms generalized Mandatory Health Insurance (AMO) and integrated the former RAMED scheme into AMO-Social, expanding formal coverage and increasing the role of public financing (Ministry of Health and Social Protection, 2023). According to National Health Accounts compiled under the System of Health Accounts 2011 framework, total health expenditure reached approximately USD 9.1 billion in 2022, with per capita spending rising markedly over the past decade. The composition of spending remains heavily weighted toward current expenditure—over 90 percent of the total—while capital spending has increased in recent years due to hospital and primary care infrastructure investment. Out-of-pocket payments, though declining, continue to represent a substantial share of financing, reflecting the enduring burden on households (OECD, 2019).

Expenditure patterns reveal structural features of the system. Public facilities and hospitals absorb a significant share of current spending, while pharmacies and private practices account for a large proportion of outpatient and pharmaceutical expenditure. The dominance of recurrent expenditure over capital formation highlights constraints in service delivery capacity and efficiency.

The link between health and economic performance is well established in development economics. Early utilitarian thought associated well-being with social progress (Bentham, 1780). Modern empirical work shows that poor health conditions—such as infectious disease prevalence and malnutrition—reduce labor productivity and total factor productivity, especially in low-income settings (Cole & Neumayer, 2006). Human development frameworks explicitly position health, alongside education, as a core driver of growth and structural transformation (UNDP, 2010).

Classical growth models (Barro, 1996; Lucas, 1988) situate health at the core of human capital. Health improvements increase labor productivity, enhance quality of life, and generate broader economic benefits, reflecting both intrinsic and instrumental values (WHO, 2016). Empirical studies show that healthier individuals are more active, motivated, and innovative, contributing directly to output (Loeppke et al., 2007). Case evidence from Singapore demonstrates that effective health systems can support sustained development (Israel Akingba et al., 2018).

A substantial body of research links health expenditure to growth. In OECD countries, health investment generates long-term income gains, with public spending indirectly raising income through life expectancy improvements (Bucci et al., 2019). Studies in Pakistan (Akram et al., 2008), Turkey (Kurt, 2015), Nigeria (Onisanwa, 2014), and across Asia (Mehmood & Azim, 2014) report positive effects of per capita health expenditure on GDP. Frasholli and Hysa (2015) find similar effects in middle- and low-income contexts. Contrasting results appear in Acemoglu and Johnson (2007), Ashraf et al. (2008), and Cervellati and Sunde (2011), who show that longer life expectancy does not always accelerate per capita income. Mehrara and Musai (2011) observe only marginal effects in Iran.

Rivera and Currais (2004) extend the Solow model to include health as a publicly provided input. They report that current government health expenditure positively affects productivity, while public investment in healthcare infrastructure shows no robust effect. Barro (1996) similarly demonstrates that health enhances productivity directly—by increasing efficiency for given inputs—and indirectly—by lowering mortality and morbidity, reducing human capital depreciation, and raising returns to education.

Recent studies quantify the productivity contributions of health spending. Shen et al. (2022) estimate that medical care added 3.84% to China's TFP growth, surpassing contributions from education or emissions reduction. Ahmad et al. (2021) confirm stable long-run links between healthcare costs, GDP, and environmental factors. Salehzadeh et al. (2025) find that health expenditure growth substantially increases TFP across Iranian provinces.

3. Data Description

a. Data

Estimating sectoral TFP in Morocco requires harmonized economic data. The OECD's sectoral classification, aligned with ISIC Rev. 4, initially identifies 45 sectors. After reconciling inconsistencies in production and employment data, 44 consolidated sectors remain (see Appendix Table 1). Data gaps persist, including incomplete employment series and absent sector-specific public, household health, and R&D expenditure. Such limitations are common in cross-sectoral analysis in emerging economies. Panel data methods remain suitable for capturing sector-specific dynamics and heterogeneous growth patterns.

The dataset includes sectoral Gross Output (Y) at basic prices, Investment (I) at purchaser prices, and Labor (L) measured as employed persons, due to missing working-time data. Capital stock (K) is constructed via the Perpetual Inventory Method (PIM), assuming capital services flow proportionally to the stock. Health-related variables capture multiple channels of productivity impact: sectoral production-related health expenditure, sectoral health investment, and national public and household health spending. Data are sourced from the OECD harmonized national Input–Output Tables, 2023 edition (industry × industry format).

Sectoral health variables distinguish direct production inputs, long-term health investments, and population-level expenditures. Health intermediate consumption measures sector-specific use of occupational health services, workplace safety, and medical supplies. Defined per worker as:

$$HIC_{it} = \frac{Health\ Intermediate\ Consumption_{it}}{Employment_{it}}$$

it captures immediate productivity gains through reduced absenteeism and improved worker health.

Health investment represents capital expenditures on workplace health infrastructure and preventive programs. It enhances long-term human capital and sectoral resilience. Allocation follows employment shares:

$$HInv_{it} = Employment_{it} \times \frac{\text{Total Health Investment}}{Population_t}$$

Household health expenditure accounts for private spending on medical services, insurance, and preventive care. Although not sector-specific, it improves workforce health and indirectly raises productivity:

$$HH_{it} = Employment_{it} \times \frac{\text{Household Health Consumption}_{\ t}}{Population_t}$$

Public health expenditure captures government spending on hospitals, clinics, vaccination, and preventive campaigns, generating economy-wide externalities. Allocation is employment-proportional:

$$PH_{it} = Employment_{it} \times \frac{\text{Public Health Consumption}_{t}}{Population_t}$$

Together, these measures isolate direct sectoral effects, long-term investments, and general improvements in population health. Price adjustments use sectoral Producer Price Indices, Gross Fixed Capital Formation deflators, and Consumer Price Indices from the High Commission for Planning (HCP[1]). Capital stock is estimated via PIM using OECD investment data to maintain consistency with the Input–Output framework.

b. Descriptive Statistics

Analysis covers 44 sectors (see Appendix Table 1), harmonized according to OECD classifications. Capital stock is constructed over the period 1995–2020. Sectoral TFP is subsequently estimated for the period 2014–2020, consistent with the availability of output and employment data.

Table 1 presents sectoral summary statistics for Morocco over 2014–2020. Variables include TFP growth, employment, output, and health-related expenditures across 44 OECD-classified sectors. All monetary values are expressed in constant 2014 USD.

Table 1: Average Sectoral Variables

Sectors	TFP growth (%)	Employment (in 1000)	Production (in M.)	Health expenditure			
				Household (in M.)	Public expenditure (in M.)	Investment	intermediate expenditure
Agriculture	4.6	3250.9	203000	148.1	289.7	4257.7	547963.6
Fishing	5.73	37.8	16100	1.7	3.4	49.4	790.1
Energy Mining	5.11	7.6	364	0.3	0.7	9.9	0.0
Non-energy Mining	0.88	28	36700	1.3	2.5	36.7	3532.6
Mining support	4.56	0.7	664	0.0	0.1	0.9	0.0
Food	-0.54	308.9	197000	14.0	27.6	404.0	9478.4
Textiles	-2.25	364.8	55100	16.6	32.6	479.0	11615.1
Wood	-1.65	39.7	5810	1.8	3.5	52.0	855.2
Paper	0.96	16.1	13200	0.7	1.4	21.1	999.2
Petroleum	-41.22	1.5	10200	0.1	0.1	2.0	142.9
Chemicals	0.92	26.4	60200	1.2	2.4	34.3	4148.3
Pharmaceuticals	-0.07	10	12000	0.5	0.9	13.1	1031.5
Plastics	-1.09	18.4	14100	0.8	1.6	24.2	1702.9
Minerals	2.19	48	38100	2.2	4.3	62.8	3547.9
Basic metals	0.6	15.2	22700	0.7	1.4	20.2	720.8
Metal products	-1.78	92.4	20100	4.2	8.2	120.6	1007.5
Electronics	0.54	5.1	5480	0.2	0.5	6.6	1871.1
Electrical equipment	2.43	32.5	31000	1.5	2.9	42.9	10220.9
Machinery	-2.34	10.5	5000	0.5	0.9	13.7	0.0

[1] HCP deflator indices: https://www.hcp.ma/Bases-de-donnees_r631.html

Motor vehicles	-1.44	84.5	63100	3.8	7.6	111.3	5034.7
Transport equipment	-0.37	11.4	6120	0.5	1.0	15.1	863.6
Other manufacturing	-2.59	73.9	19300	3.4	6.6	96.5	6464.4
Utilities supply	-0.15	25.6	35600	1.2	2.3	33.7	2227.8
Water & waste	0.58	49.7	6630	2.3	4.5	64.8	126.7
Construction	-0.92	833.1	170000	37.9	74.5	1095.0	14853.6
Trade	0	1930.7	148000	87.6	172.5	2522.1	7647.2
Land transport	-2.87	273.7	41000	12.4	24.5	358.3	5640.5
Water transport	-0.4	4.1	5280	0.2	0.4	5.4	1411.0
Air transport	-3.62	8.1	17700	0.4	0.7	10.8	3948.7
Logistics services	-1.78	32.5	17300	1.5	2.9	42.6	1977.5
Postal activities	-1.79	7.6	1910	0.3	0.7	10.0	0.0
Hospitality	0.55	364.7	41300	16.7	32.7	488.6	1599.5
Media & broadcasting	0.97	10.4	7730	0.5	0.9	13.6	14958.1
Telecommunications	2.21	25.1	34900	1.1	2.2	32.5	2178.9
IT services	3.58	29.4	10300	1.3	2.6	38.5	731.0
Financial & insurance	-2.45	77.2	80700	3.5	6.9	101.3	200065.1
Real estate	-3.56	31.4	43300	1.4	2.8	41.2	419.8
Professional activities	-3.73	127.5	43400	5.8	11.4	167.1	1796.7
Administrative services	-3.15	320.2	54200	14.6	28.7	421.0	3032.4
Public administration	0	549.6	146000	25.0	49.1	717.9	652107.6
Education	-1.1	275.2	71500	12.5	24.6	358.7	83570.0
Human health	-3.7	133.1	52400	6.0	11.9	174.5	843602.7
Arts & entertainment	-0.09	46.1	5890	2.1	4.1	60.9	35339.9
Other service	-3.04	454.4	20200	20.8	40.8	601.4	109860.3
Total	**-2.68**	**229.4**	**43000**	**10.4**	**20.5**	**300.8**	**59070.1**

Note: Employment is expressed in thousands; Production, Public Expenditure, and Health Expenditure of Households are in million USD; Investment and Intermediate Expenditure are in USD, as the amounts are too small compared to the others.

Source: Authors

Geometric sectoral TFP growth in Morocco from 2014–2020 is modest and uneven across sectors. Resource-based sectors exhibit the highest gains: fishing (5.7%), agriculture (4.6%), and energy mining (5.1%), reflecting improved resource utilization. Capital-intensive industries experience contractions, notably petroleum refining (-41.2%). Medium-technology manufacturing—textiles (-2.2%), machinery (-2.3%), transport (-2.9%)—also records negative productivity dynamics. Service sectors show heterogeneous outcomes: telecommunications (2.2%), IT services (3.6%), and media (0.9%) increase modestly, whereas financial services (-2.5%), real estate (-3.6%), and professional activities (-3.7%) decline.

Employment is concentrated in agriculture (3.25 million), trade (1.93 million), construction (833,000), and public administration (550,000). Knowledge-intensive sectors, education (275,000) and health (133,000), represent smaller but significant labor pools. Intermediate health expenditure is largest in human health (843,603 USD) and public administration (652,108 USD), followed by financial services (200,065 USD), education (83,570 USD), and other services (109,860 USD). Primary industries, including mining and energy, report minimal health expenditure.

Descriptive evidence reveals structural asymmetries. Sectors with high exposure to human and health capital—public services, education, healthcare—allocate substantial resources to health. Traditional manufacturing and extractive sectors invest minimally. Productivity outcomes remain uneven, highlighting the need to examine how sectoral health expenditures affect TFP growth.

TFP growth distribution indicates sectoral polarization. Resource-based activities absorb efficiency gains, whereas petroleum, textiles, and machinery suffer persistent inefficiencies. High-employment sectors—trade, construction, other services—often display modest or negative productivity, signaling concentration of jobs in labor-intensive, low-productivity areas. High-productivity sectors—mining, telecommunications, IT—employ fewer workers, suggesting a structural mismatch between labor allocation and productivity dynamics.

Health expenditure is dominated by public funding, although household contributions are relatively higher in textiles, hospitality, trade, and transport. Low health investment in certain manufacturing sectors may limit productivity potential, reflecting disparities in the integration of health capital into production.

Table 2 summarizes descriptive statistics for TFP growth, employment, output, and health expenditure across sectors.

Average sectoral output reaches USD 4.55 billion, with cross-sectoral dispersion far exceeding temporal variation. Agriculture and trade achieve outputs up to USD 23.8 billion, while smaller sectors remain below USD 50 million. Within-sector variation is modest (USD 526 million), indicating that most heterogeneity stems from differences across sectors.

Capital stock averages USD 654 billion but exhibits extreme cross-sectoral disparity (standard deviation USD 2.4 trillion). A few capital-intensive sectors dominate, while within-sector temporal changes remain moderate (USD 199 billion). Employment averages 229,000 per sector, but distribution is highly unequal: agriculture employs over 3.2 million, whereas mechanized industries employ fewer than 1,000. Between-sector variation (568,000) dwarfs within-sector changes (59,700).

Sectoral TFP growth averages –0.59%, signaling stagnation or slight decline. Between-sector standard deviation (4.6%) reflects persistent structural differences, while within-sector variation (8.4%) captures short-term fluctuations.

Health expenditures vary markedly across sectors and categories. Public spending shows the largest disparities, household expenditures are less dispersed but higher in service sectors, and intermediate health spending remains limited except in human health and public administration. Health investment is the smallest component, yet highly volatile across sectors.

Three patterns emerge: strong cross-sectoral heterogeneity in output, capital, and health expenditures; overall productivity stagnation with extreme declines in some manufacturing sectors; and concentrated health spending in public services, while traditional and extractive sectors invest minimally, potentially constraining their productivity growth.

Table 2: Descriptive statistics of the variables

Variable		Mean	S. D.	Min	Max
Production (Million USD const. 2014)	overall	4,554.9	5,472	29.75	23,785
	between		5,501	38.49	21,484
	within		526	1353	8,685
Capital Stock (Million USD const. 2014)	overall	653,978	2,397,300	135.83	17,900,000
	between		2,412,709	152.35	15,900,000
	within		199,135	-1,220,395	2,649,648
Employment (in Thousands)	overall	229,397	565,658	665	3,655,040
	between		568,077	717.29	3,250,850
	within		59,696	-613,555	633,587
TFP Growth (%)	overall	-0.591	9.50	-95.63	31
	between		4.55	-23.06	7
	within		8.36	-73.16	24
Public Health allocation (USD const. 2014)	overall	229,787	567,375	634.76	3,940,040
	between		568,972	719.67	3,255,166
	within		67,174	-591,485	914,662
Household Health allocation (USD const. 2014)	overall	116,859	290,383	288.52	1,956,457
	between		289,866	365.30	1,660,918
	within		44,069	-499,347	412,399
intermediate Health expenditure (USD const. 2014)	overall	59,070	177,463	0	1,017,653
	between		176,859	0	843,603
	within		28,725	-230,572	233,120
Health investment allocation (USD const. 2014)	overall	300.76	757	0.62	5,228
	between		744	0.93	4,258
	within		174	-1,718	1,271

Note: S.D.: Standard deviation
Source : Authors

4. Methodology

This study examines the impact of health expenditure on TFP using panel data from 44 Moroccan sectors over the period 2014–2020. Employing a two-step approach, the analysis first estimates a Cobb-Douglas production function to derive sector-level TFP using the Olley and Pakes (1996) methodology. In the second step, the impact of health expenditures, used as a proxy for health status, on TFP is assessed. To address potential endogeneity and dynamic relationships, the study applies the System GMM estimator.

a. Estimating The Capital Stock

Sectoral capital stock is estimated using the Perpetual Inventory Method (PIM) following Berlemann and Wesselhoft (2014). Net capital stock K_t (equation 1) at the start of period *t* is calculated as the sum of gross investment I_{t-1}, and the depreciated previous stock , with a constant geometric depreciation rate δ = 6%[2], consistent with African country estimates from the Economic Commission for Africa:

$$K_t = I_{t-1} + (1-\delta)K_{t-1} \quad (1)$$

[2] Economic Report on Africa (2010), prepared by the United Nations Economic Commission for Africa, p. 134

Recursively, PIM expresses K_t as a weighted sum of past investments, where weights follow geometric depreciation:

$$K_t = \sum_{i=0}^{\infty}(1-\delta)^i \, I_{t-(i+1)} \tag{2}$$

Estimating the initial capital stock poses a key challenge. Following Berlemann and Wesselhoft (2014), the initial stock is approximated assuming investment grows at a constant rate. Sectoral series start in 1995, when industry-level investment data first become available. The Hodrick–Prescott filter smooths investment series and mitigates short-term volatility, excluding the first five observations. The average growth rate of the first ten years is used to compute initial stock, substituting GDP growth when investment growth is negative for certain sectors:

$$K_t \simeq \frac{I_t}{\delta + g_t{}^I} \tag{3}$$

Capital stock estimates are therefore available by sector from 1995 onward, providing a consistent basis for TFP calculations.

b. Sectoral TPF Estimation

TFP is estimated using the semiparametric control function approach of Olley and Pakes (1996), which addresses simultaneity between unobserved productivity shocks and input choices, as well as selection bias from endogenous sector exit. A Cobb–Douglas production function is assumed, with the log-output equation:

$$y_{i,t} = \beta_0 + \gamma l_{i,t} + \beta k_{i,t} + \omega_{i,t} + \varepsilon_{i,t} \tag{4}$$

Where $Y_{i,t}$ denotes sectoral output, $L_{i,t}$ labor input, $K_{i,t}$ capital input, γ and β are output elasticities, $\omega_{i,t}$ is unobserved productivity, and $\varepsilon_{i,t}$ is an idiosyncratic error term.

Estimation proceeds in two stages. In the first stage (Equation 5), the joint effect of capital and productivity, $\Phi_{i,t}(i_{i,t}, k_{i,t})$, is approximated nonparametrically, using investment $i_{i,t}$ as a proxy for $\omega_{i,t}$. This relies on the assumption that investment is strictly increasing in productivity conditional on capital:

$$y_{i,t} = \beta_0 + \gamma l_{i,t} + \Phi_{i,t}(i_{i,t}, k_{i,t}) + \varepsilon_{i,t} \tag{5}$$

Were $\Phi_{i,t}(i_{i,t}, k_{i,t}) = \beta k_{i,t} + f^{-1}(i_{i,t}, k_{i,t}) = \beta k_{i,t} + \omega_{i,t}$.

This stage yields a consistent estimate of the labor coefficient γ. In the second stage, the capital coefficient β is consistently estimated by exploiting the Markov process of productivity and applying appropriate moment conditions.

TFP is then computed as the Hicks-neutral efficiency term from the estimated production function, isolating sector-specific productivity beyond labor and capital inputs.

c. Health Expenditure and Sectoral TFP: Empirical Model

Estimated sectoral TFP serves as the dependent variable in a dynamic panel framework assessing the effects of health expenditure on productivity. The model incorporates lagged TFP and sectoral health variables, including household health expenditure, public health expenditure, health investment, and intermediate health consumption. This specification captures both persistent and contemporaneous influences of health-related inputs.

Estimation uses the System GMM, combining equations in levels and first differences to address potential endogeneity, dynamic panel bias, and unobserved sector-specific heterogeneity. Standard errors are robust to heteroskedasticity, ensuring consistent inference.

The empirical specification is:

$$TFP_{i,t} = \beta_0 + \beta_1 TFP_{i,t-1} + \beta_2 HIC_{i,t} + \beta_3 HInv_{i,t} + \beta_4 PH_{i,t} + \beta_5 HH_{i,t} + \mu_i + \varepsilon_{i,t} \quad (6)$$

$TFP_{i,t}$ denotes sector-level TFP, $HIC_{i,t}$ represents sectoral intermediate health consumption, $HInv_{i,t}$ captures sectoral health investment. $PH_{i,t}$ corresponds to sectoral public health expenditure, and $HH_{i,t}$ reflects sectoral health spending household. μ_i accounts for unobserved, time-invariant sector-specific effects, while $\varepsilon_{i,t}$ denotes the idiosyncratic error term.

Given the limited cross-sectional dimension (44 sectors, 2014–2020), inference relies on t- and F-statistics rather than conventional z- or chi-squared tests. Within the System GMM framework, TFP and health measures are treated as potentially endogenous and instrumented using second- and third-order lags. To avoid instrument proliferation and improve estimation efficiency, the instrument matrix is collapsed.

5. Results

a. Sectoral TFP estimation using Olley–Pakes Method

Sectoral TFP is estimated via a Cobb–Douglas production function corrected for simultaneity and selection biases using the Olley–Pakes method. Estimated labor and capital elasticities are positive and statistically significant. The Wald test supports constant returns to scale, confirming the specification's suitability. Table 3 presents the detailed estimation results.

Table 3: Estimation Results of TFP Using the Olley–Pakes Method

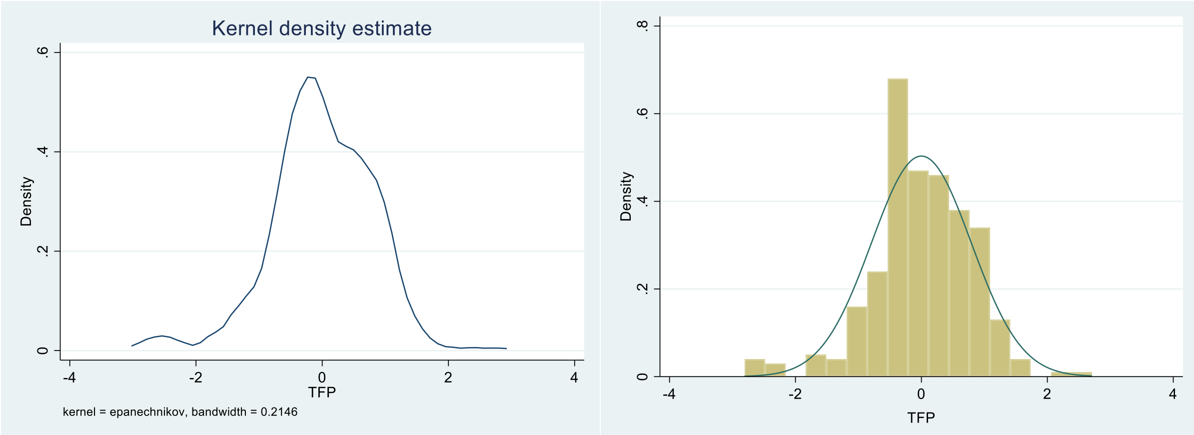
Variables	Coefficient	Std. err.	z	P>|z|	[95% conf. interval]
Labor	0.5845	0.0507	11.52	0.000	[0.4850 0.6840]
Capital	0.3464	0.0851	4.07	0.000	[0.1795 0.5133]
Wald test on Constant returns to scale: Chi2 = 0.86					p = (0.35)

Source : Authors

Labor elasticity is 0.58, implying that a 1% increase in employment raises output by 0.58%, ceteris paribus. Capital elasticity is 0.35, indicating that a 1% increase in capital expands output by 0.35%, holding labor constant. Both coefficients are significant at the 1% level (Table 3).

The Wald test evaluates the null hypothesis that the sum of elasticities equals one (constant returns to scale). The test statistic, Chi² = 0.86 with p = 0.35, fails to reject the null. The estimated sum of labor and capital coefficients (0.93) lies slightly below unity but is not statistically different from one, supporting the assumption of constant returns to scale across sectors.

Figure 1: Distribution of Estimated Sectoral TFP



Source: Authors

The Olley–Pakes method provides semi-parametric TFP estimates without assuming normality. Based on the two kernel density plots (Figure 1), the resulting TFP distribution is approximately bell-shaped, nearly symmetric, and slightly left-skewed, with no major outliers. Residuals appear well-behaved, supporting the reliability and statistical validity of the estimates.

b. Results of the Second Stage: Impact of Health Measures on TFP

Panel time-series properties were examined before estimating the dynamic effects of health measures on sectoral TFP. Unit root tests employed Levin–Lin–Chu (LLC) and Im–Pesaran–Shin (IPS) procedures. The null hypothesis of a unit root is generally rejected for household health expenditure, public health expenditure, health investment, intermediate health consumption, and TFP, indicating stationarity in levels.

Where IPS results suggested non-stationarity—specifically for public health and intermediate health consumption—LLC outcomes confirm stationarity at conventional significance levels. Reliance on LLC in such cases aligns with standard panel practice and ensures robust estimation of dynamic models.

Table 4: Unit Root Test Results

Variables	IPS (W-stat)		LLC (t*)	
	Statistic	Prob.	Statistic	Prob.
TFP	-31.632	0.0060	-34.293	0.0000
Household Health	-174.28	0.0000	-6.3282	0.0000
Public Health	-0.2186	0.4135	-7.3392	0.0000
Health Investment	-2.5227	0.0058	-6.3282	0.0000
Intermediate Health Spending	-0.4465	0.3276	-16.629	0.0000

Source : Authors

Given the results in Table 4, the model is estimated in levels using the System GMM estimator. Estimating in levels preserves persistent relationships between sectoral TFP and health measures and maintains the interpretability of coefficients, avoiding distortions associated with differencing stationary variables.

Table 5: Impact of Health Measures on Sectoral TFP

Variables	Coefficient	Robust Std. Err.	t-stat	p-value	95% CI
L.TFP(-1)	0.1568	0.0589	2.66	0.011	[0.0381 0.2756]
Ln.HH	0.2489	0.0937	2.66	0.011	[0.0599 0.4379]
Ln.PH	-0.2424	0.0667	-3.63	0.001	[-0.3770 -0.1079]
Ln.Hinv	0.0252	0.0514	0.49	0.626	[-0.0784 0.1288]
Ln.HIC	-0.0109	0.0691	-0.16	0.874	[-0.1504 0.1284]
Constant	-0.0818	0.4429	-0.18	0.854	[-0.9749 0.8113]

Source: Authors

This study employs a two-step System GMM estimator to analyze the dynamic relationship between health expenditure and sectoral TFP, addressing potential endogeneity and unobserved heterogeneity. The model is estimated on a balanced panel of 44 sectors over 2014–2020. TFP is treated as a dynamic process influenced by its own lagged values and health expenditure channels. Lagged TFP is instrumented using collapsed lags (2–3 periods) of endogenous regressors. Contemporaneous health variables enter as exogenous controls. The two-step robust estimator with finite-sample correction accounts for panel-specific autocorrelation and heteroscedasticity.

Dynamic panel results identify statistically significant drivers of TFP. Lagged TFP growth shows positive persistence (β_1 = 0.16, p = 0.011). A 1% increase in prior productivity raises current TFP growth by 0.16 percentage points, reflecting path-dependent dynamics where sectors with higher initial efficiency maintain advantages over time (Table 5).

Household health expenditure exerts a strong positive effect (β_5 = 0.25, p = 0.011). A 1% increase in household health spending raises TFP growth by 0.25 percentage points. In contrast, public health expenditure has a significant negative impact (β_4 = −0.2424, p = 0.001). A 1% increase in public spending reduces productivity growth by 0.24 percentage points, indicating potential inefficiencies or misallocation of resources.

Sectoral health investment is not statistically significant (β_3 = 0.025, p = 0.626), and intermediate health spending is also insignificant (β_2 = −0.011, p = 0.874). These results suggest that investment and intermediate expenditures alone do not meaningfully influence sectoral productivity.

Table 6: System GMM Diagnostic Tests

Test	Statistic	p-value
Autocorrelation Test (AR(1))	Z = -2.35	0.019
Autocorrelation Test (AR(2))	Z = 0.40	0.689
Overidentification Test (Sargan)	$\chi 2(9)$ = 79.59	0.000
Overidentification Test (Hansen)	$\chi 2(9)$ = 5.72	0.768

Source: Authors

Diagnostic tests (Table 6) support the validity of the System GMM specification. The AR (1) test indicates first-order serial correlation in differenced residuals (z = −2.35, p = 0.019), as expected, and does not compromise the model. The non-significant AR (2) test (z = 0.40, p = 0.689) confirms the absence of second-order serial correlation, validating instrument use and the assumption of error independence. The Hansen test fails to reject instrument exogeneity (χ^2 (9) = 5.72, p = 0.768), confirming the GMM moment conditions. The Sargan test rejects the null (χ^2 (9) = 79.59, p = 0.000), likely reflecting sensitivity to heteroscedasticity, underscoring the Hansen test's reliability in this context. Difference-in-Hansen tests corroborate instrument validity: exogeneity of level instruments is upheld (χ^2 (4) = 3.75, p = 0.441), and subset exogeneity cannot be rejected (χ^2 (5) = 1.97, p = 0.854). Joint significance of regressors (F (5,43) = 6.07, p = 0.000) confirms the model's explanatory power. Collectively, these diagnostics reinforce the robustness of the estimated relationships.

6. Discussion

The positive lag of TFP growth aligns with endogenous growth models emphasizing knowledge spillovers and cumulative causation (Romer, 1990; Aghion & Howitt, 1990). Persistence reflects virtuous cycles where prior productivity gains reduce innovation costs, amplifying future growth, consistent with dynamic increasing returns (Arthur, 1989; Bogliacino et al., 2017). The coefficient below unity indicates self-reinforcing but non-explosive growth, as effects diminish without additional innovations. These results empirically validate path-dependent TFP evolution (Durlauf, 1993), highlighting the importance of early productivity interventions to set sustainable growth trajectories.

Household health expenditure exerts robust productivity-enhancing effects by reducing absenteeism, improving cognitive capacity, and increasing labor efficiency, supporting health-led growth hypotheses (Bloom & Canning, 2001; Schultz, 1999; Neofytidou & Fountas, 2020) and Lucas' (1988) emphasis on human capital quality. In contrast, public health spending reduces TFP growth, reflecting inefficiencies, misallocation, or crowding-out effects. Cost inefficiencies and non-constant returns to scale can hinder TFP growth (Bernini, 2017). Shifts in government spending from capital investment to consumption negatively affect productivity (Aschauer, 1989). Recurrent operational costs dominating public budgets exacerbate inefficiencies (Pritchett & Woolcock, 2004).

This divergence illustrates the greater efficiency of decentralized, targeted household spending compared with centralized public allocation, consistent with subsidiarity theory in health financing (Oates, 1972) and highlighting bureaucratic constraints in weak institutional contexts (Easterly, 2001). Household expenditures, aligned with individual needs, directly enhance labor productivity (Schultz, 1999), whereas public spending may hinder TFP through misallocation or crowding-out.

Sectoral health investment is not statistically significant, consistent with Rivera & Currais (2004) and Barro (1996), who note that infrastructure returns typically emerge over extended horizons. Intermediate sectoral spending also shows no effect, indicating that operational expenditures alone do not enhance productivity without efficiency reforms (Benhabib & Spiegel, 1994). These null results challenge simplified human capital models (Lucas, 1988) but support critiques emphasizing threshold effects and institutional contingencies: health expenditures influence productivity only when complemented by skills, infrastructure, or functional markets (Benhabib & Spiegel, 1994; Acemoglu & Johnson, 2007), consistent with Easterly's (2001) 'elusive quest for growth.'

The validity of GMM instruments and absence of higher-order autocorrelation affirm the model's suitability for causal inference in dynamic panels (Blundell & Bond, 1998). Policy implications emerge directly: household-targeted health subsidies, such as conditional cash transfers, could maximize productivity returns (Banerjee & Duflo, 2011). The negative effect of public health spending underscores the importance of institutional quality, as bureaucratic inefficiencies may undermine fiscal effectiveness (Gebrihet et al., 2024).

7. Conclusion

This study demonstrates that the relationship between health expenditure and productivity in Morocco, across 44 sectors from 2014 to 2020, is nuanced and channel-specific. Household-targeted health expenditures—including subsidies, preventive care, and insurance—consistently enhance sectoral TFP, indicating that micro-level health improvements increase labor efficiency and productivity. In contrast, public health spending may reduce productivity, reflecting bureaucratic inefficiencies, weak governance, or the crowding-out of private health initiatives. Sectoral intermediate expenditures reveal that operational costs alone cannot raise productivity without complementary efficiency reforms, highlighting structural misalignments in resource allocation and absorptive capacity. Health investment indicates that returns from infrastructure materialize only over extended horizons.

TFP persistence underscores path dependence, where early productivity gains generate virtuous cycles consistent with endogenous growth theory. The divergence between household and public health effects further exposes institutional nuances: household spending aligns with efficient human capital accumulation, while public expenditures may produce inefficiencies consistent with government failure, supporting subsidiarity in health financing. Robust GMM diagnostics validate causal inference, strengthening confidence in these findings.

From a policy perspective, results suggest rebalancing health spending strategies. Household-targeted health support can yield larger productivity dividends than centralized programs. Reforming public expenditure management is necessary to reduce inefficiencies and unlock potential contributions to growth. Productivity policies should prioritize decentralized, household-level interventions over broad public or sectoral initiatives.

Limitations remain. Health shocks, such as COVID-19, may affect result robustness, but structural break tests were infeasible given the short panel. The analysis relies on proxy indicators for sectoral health expenditures due to data constraints. Despite these limitations, the study provides a comprehensive overview of health spending's impact on sectoral productivity, forming a basis for future research.

Future work should examine mechanisms driving these divergent effects, including governance quality, resource misallocation, absorptive capacity, and potential displacement of private health initiatives. Overall, evidence confirms the central role of health as a productivity driver, while emphasizing that expenditure type and efficiency determine the magnitude of returns.

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9. Appendix

Table 1: The activity sectors based on OECD classification

code	Label	OECD code	OECD Label
AG	Agriculture	A01_02	Agriculture, hunting, forestry
FI	Fishing	A03	Fishing and aquaculture
EM	Energy Mining	B05_06	Mining and quarrying, energy producing products
NEM	Non-Energy Mining	B07_08	Mining and quarrying, non-energy producing products
MS	Mining support	B09	Mining support service activities
F	Food	C10T12	Food products, beverages and tobacco
T	Textiles	C13T15	Textiles, textile products, leather and footwear
W	Wood Products	C16	Wood and products of wood and cork
PP	Paper Printing	C17_18	Paper products and printing
P	Petrochemicals	C19	Coke and refined petroleum products
CH	Chemicals	C20	Chemical and chemical products
PH	Pharmaceuticals	C21	Pharmaceuticals, medicinal chemical and botanical products
RP	Rubber Plastics	C22	Rubber and plastics products
NM	Non-Metallics	C23	Other non-metallic mineral products
MR	Metallurgy	C24	Basic metals
FM	Fabricated Metals	C25	Fabricated metal products
EC	Electronics	C26	Computer, electronic and optical equipment
EL	Electricals	C27	Electrical equipment
M	Machinery	C28	Machinery and equipment, nec
V	Vehicles	C29	Motor vehicles, trailers and semi-trailers
TE	transport equipment	C30	Other transport equipment
OM	Other Manufacturing	C31T33	Manufacturing nec; repair and installation of machinery and equipment
U	utilities	D	Electricity, gas, steam and air conditioning supply
WW	Water Waste	E	Water supply; sewerage, waste management and remediation activities
CN	Construction	F	Construction
CM	Commerce	G	Wholesale and retail trade; repair of motor vehicles
LT	Land transport	H49	Land transport and transport via pipelines
WT	Water transport	H50	Water transport
AT	Air transport	H51	Air transport
TRS	Transport Support	H52	Warehousing and support activities for transportation
PS	Postal Services	H53	Postal and courier activities
HO	Hospitality	I	Accommodation and food service activities
TL	Media Publishing	J58T60	Publishing, audiovisual and broadcasting activities
TS	Telecom Services	J61	Telecommunications
ITS	IT Services	J62_63	IT and other information services
FL	Financial	K	Financial and insurance activities
RT	Realty	L	Real estate activities
PRS	Professional Services	M	Professional, scientific and technical activities
AS	Admin Support	N	Administrative and support services
AD	Administration	O	Public administration and defense; compulsory social security
ES	Education	P	Education
SS	Human health	Q	Human health services
AR	Arts Recreation	R	Arts, entertainment and recreation
OS	Other services	S	Other service activities
		T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use

Source: Authors