Original Research Article

From Healthcare Accessibility to National Output: How Technology-Driven MRI Improvements Correlate with the Gross Domestic Product

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ABSTRACT

Magnetic resonance imaging (MRI) is among the most transformative medical technologies, yet its widespread adoption in routine clinical practice remains constrained by high economic and technical barriers. According to conservative estimates from our research, expanded MRI accessibility is estimated to increase GDP by a range of 0.0095% to 0.0117% in relative terms, reflecting measurable macroeconomic benefits. Recent advances in MRI, such as AI-enabled image reconstruction for accelerated scans, cost-effective manufacturing, and the emergence of portable low-field scanners, are poised to improve accessibility and enhance diagnostic capacity. These advances are expected to correlate with national economic indicators such as the gross domestic product (GDP). This paper reviews recent innovations in MRI and focuses specifically on one economic pathway: how mortality reductions associated with improved MRI accessibility correlate with national economic output through changes in the effective labor supply. Using a health-augmented Cobb–Douglas production framework, a model that incorporates health capital as a factor influencing productivity and output and integrating data from existing clinical MRI reports into a simplified model, we conservatively estimate that such mortality improvements could generate short-run national output growth consistent with these projections. Although these short-run gains appear statistically modest, the long-term implications are far more significant. Clinical innovations not only improve healthcare outcomes but also create substantial social and economic returns when considered over extended time horizons. Our findings underscore the importance of sustained investment and research in advanced diagnostic technologies such as MRI, highlighting their dual role in promoting public health and driving economic growth.

Keywords: Magnetic Resonance Imaging (MRI); MRI Innovation; Healthcare Accessibility; Cobb–Douglas Production Function; Economic Growth; Gross Domestic Product (GDP)

INTRODUCTION

The nexus of healthcare technology and economic performance has gradually become a critical discussion in the 21st century, particularly at present, as aging has become a crucial issue to address among both developing and developed nations (1). Magnetic resonance imaging (MRI) is among the most disruptive tools in the imaging

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field, yet it is a massive financial challenge at the same time. Ever since it was first introduced to the clinic in the 1980s, MRI has revolutionized diagnostics in the field of neurology and cardiology (2, 3), as well as orthopedics and oncology. However, the initial high cost, specialized infrastructure requirements, and maintenance expenses constrain widespread deployment of these systems (4, 5), particularly in developing countries and underserved regions.

Recent technological advancements in healthcare equipment have emerged as potential solutions to address these challenges. Image reconstruction through AI integration can reduce scan time without sacrificing quality (6, 7), enabling increased patient throughput. Simultaneously, low-field MRI technology has resulted in portable devices that require minimal infrastructure and can operate within resource-deprived environments (8, 9, 10, 11). The cost is being lowered, and the machines are becoming easier to operate due to manufacturing advances. The integration of these emerging technologies presents a significant opportunity to equalize access to MRI and improve the diagnostic strength in the entire population.

The implications of these advances extend beyond direct health improvements. By diagnosing sooner and minimizing uncertainty, we will save the cost of complications (10), which may substantially burden healthcare budgets. At the macroeconomic level, there are fewer sick days, and healthier citizens demonstrate increased workforce participation (12, 13). The correlation between GDP growth and health infrastructure is established, and studies have continued to reveal that there are positive relations between healthcare and economic growth (14, 15, 16, 17, 18).

However, the presumed economic benefits of advanced diagnostic technologies, such as MRI, lack robust empirical support, with little evidence clarifying their specific impact on national productivity. The majority of the research considers the overall health outcomes or does not distinguish between different types of health infrastructure, but does not single out MRI. Not only MRI, but most of the clinical reports ignore the significance of healthcare treatments' economic impact.

The gap that this project addresses is a quantitative investigation of one specific economic pathway through which MRI accessibility may influence GDP: the mortality reduction channel. We model a health-enhanced Cobb-Douglas production function in which reduced mortality from improved MRI accessibility increases the effective labor supply, thereby contributing to economic growth. We use clinical mortality data from three conditions (traumatic brain injury, ischemic stroke, and breast cancer) and combine them with macroeconomic modeling to provide a conservative lower-bound estimate of the mortality-labor pathway's contribution to GDP

The findings of this research provide important insights for policymakers and investors. Countries all over the world are confronted by aging and constrained budgets (19); hence, understanding the economic returns on investment in diagnostic technology has become increasingly critical. With the technological world continually reducing the cost of the highest level of imaging, the decision makers require well-founded, data-driven models to determine where to invest to achieve the best health and economic benefits.

LITERATURE REVIEW

MRI Technology Advancements and Their Impact on Accessibility and Health Outcomes

Recent technological innovations in MRI have fundamentally transformed both diagnostic capabilities and healthcare accessibility. This section examines key technological developments and documented effects on MRI accessibility and population health outcomes.

Technology Advancement in MRI

Recent technological advances in MRI have enhanced diagnostic precision, improved patient accessibility, and streamlined clinical workflow. Table 1 shows the most significant developments, including, but not limited to, AI-driven image reconstruction, high-field and cost-effective low-field MRI systems, improvement in contrast agents, and portable/cryogen-free MRI units.

The literature review presented in Table 1 demonstrates that the qualitative importance of technological advancement in MRI has three broad effects on healthcare. First, recent innovations in MRI have enhanced the accuracy of diagnosis and scanning. The higher resolution and faster imaging are useful in neurology, oncology, cardiovascular, and pediatric imaging (9, 22, 30). Second, portable and cost-effective systems have expanded MRI utilization in underserved regions, thereby enhancing overall accessibility (8, 10). Finally, more sophisticated imaging and targeted contrast agents are other tools that promote personalized diagnosis and treatment (22, 28, 29).

In conclusion, MRI technological innovations, especially in AI, hardware, and contrast agents— are revolutionizing clinical practice, offering better image

Table 1. Major MRI technology advancements and innovations in the past 10 years

Technological Advancement/ Innovation	Key Features/ Benefits	References
AI and Deep Learning	AI-based reconstruction algorithms now enable faster MRI scans and higher image quality, reducing motion artifacts and improving diagnostic accuracy, especially in the field of musculoskeletal and abdominal imaging.	(9, 20, 21, 22)
High-Field MRI (7T and above)	Ultra-high-field MRI provides superior spatial resolution and sensitivity, enhancing the detection of subtle pathologies in neurology and oncology	(9, 20, 21, 22)
Low-Field and Portable MRI	Advances in low-field and portable MRI systems have increased accessibility, lowered costs, and enabled point-of-care imaging. This innovation is particularly beneficial to resource-limited and underdeveloped areas.	(8, 9, 10, 11)
Cryogen-Free MRI	New helium-free MRI systems offer comparable image quality to traditional systems, with lower operational costs and improved sustainability.	(10)
Advanced RF Coils	Flexible, wireless, and integrated coil arrays have improved patient comfort, signal-to-noise ratio, and scan efficiency.	(23)
Accelerated Imaging Techniques	Methods like compressed sensing, parallel imaging, and simultaneous multi-slice acquisition have significantly reduced scan times while maintaining or improving image quality.	(21, 24, 25)
Next-Generation Contrast Agents	Development of high-relaxivity gadolinium agents and magnetic nanoparticle-based agents (e.g., SPIONs, iron oxide nanoparticles) has enhanced tissue characterization and enabled targeted molecular imaging.	(26, 27, 28, 29)

quality, shorter scan times, and greater access. Such innovations are driving MRI to be individualized, effective, and more available healthcare.

MRI Accessibility and Health Outcomes

In particular, regarding the enhanced accessibility of MRI, greater MRI availability is linked to better national health, mostly by means of earlier diagnosis, less travel distance, and the facilitation of more equitable health care; however, robust quantitative data at the national level remain limited.

Based on multiple observational studies summarized in Table 2, countries with a higher MRI scanner density (scanners per million population) tend to have better health outcomes (more life expectancy and better disease management due to early and more precise diagnosis) (31, 32). As an example, in Ghana, the access gap is 40 per cent with only 0.5 MRI scanners per million population, highlighting strong regional inequalities (33). Optimization models used in Brazil suggest that 210 more MRI units would meet 95 percent of national demand, thus reducing the average patient travel to 44km in underserved regions, likely to improve access to care in a timely fashion and, accordingly, health outcomes (34, 35). In the United States, the distribution of MRI use decreases exponentially with poverty levels (R^2 = 0.98), which indicates a close relationship between reduced access, increased poverty, and poor health outcomes (36).

Although MRI is not a therapeutic intervention in itself, it has many effects on the overall health outcomes. Health outcomes associated with enhanced MRI accessibility can be attributed to three primary mechanisms. First, increased MRI accessibility facilitates earlier disease identification and treatment, eliminating needless treatments and hospitalization (37). Second, enhancing access to MRI in underserved areas reduces the impact of regional and socioeconomic health inequalities. Lastly, more efficient utilization of health care resources can be achieved through improved access because it will reduce the cost of treatment of diseases at later stages (35, 37).

While direct national-level quantitative metrics are limited, multiple sources, as shown in Table 2, demonstrate that increased MRI accessibility improves health outcomes by enabling earlier diagnosis, reducing travel burdens, and promoting healthcare equity. Addressing disparities in MRI access is crucial for optimizing population health.

Table 2. MRI access, travel distance, and health outcomes by country

Country/ Region	MRI Density (per million)	% Population with Access	Avg. Travel Distance (km)	Health Outcome Implications	Key References
Ghana	0.5	~60%	Not specified	Delayed diagnosis, regional disparities	33
Brazil	Not specified	95% (with 210 new MRIs)	44KM (north region of Brazil), 118 KM (other region of Brazil)	Improved access, reduced delays	34, 35
United States of America	High overall, but varies	Lower in high-poverty areas	Not specified	Disparities in outcomes by economic status	36

Health Outcomes and National Output

There is a positive correlation between health outcomes and national output; however, the degree of the association is dependent on a variety of economic, social, and governance factors. Summarized in Table 3, numerous studies show that as the national output measured increases, the better the health indicators, such as longer life expectancy and lower infant and maternal mortality (14, 15, 16, 17, 38, 39, 40, 41, 42, 43). However, this relationship remains complex and is mediated by multiple confounding factors.

The correlation between national output and health outcomes is strongest for basic indicators like infant mortality but weakens when accounting for poverty, governance, and epidemiological context (18, 42, 43), as shown in Table 3. In some regions, health improvements can drive economic growth in both developed countries and less developed nations (17, 44, 45). Moreover, efficiency and allocation of health spending, not just the amount, are critical for translating economic gains into health improvements (14, 39, 42, 43). Nonetheless, there are diminishing returns after a certain point; further increases in GDP have less impact on health outcomes (18, 46).

As stated and demonstrated previously, health outcomes and national output are positively related. Economic growth correlates with positive health outcomes, and conversely, health improvements are associated with economic performance through enhanced productivity and labor force participation (17, 44, 45, 65).

In Weil's Cobb–Douglas production function framework (17), health enters production through the labor composite H, where $H = h \cdot v \cdot L$ (with h = human capital in the form of education, v = health-related human capital, and L = labor), so improvements in health raise the effective units of labor and thus increase aggregate output $Y = A \cdot K^{\alpha} \cdot (h \cdot v \cdot L)^{1-\alpha}$. In other words, better health (a higher v value) makes workers more productive—they work longer, exert more effort, and think more clearly—which raises the labor term; this increases output, generating additional indirect gains to GDP. Empirically, Weil shows that measurable health improvements (e.g., higher adult survival) translate into meaningful increases in labor input and hence GDP per worker.

METHODS AND MATERIALS

Theoretical Framework

The theoretical framework of the research is centered on the Cobb-Douglas production function. The concept of the Cobb-Douglas production function is to express economic output as the product of the quantitative factors

Table 3. Summary of how national output and related factors affect health outcomes

Factor	Correlations to Health Outcomes	Key References
GDP/GNI per capita	Higher GDP per capita is linked to better health outcomes, but the effect weakens when controlling for other factors like poverty, governance, and health system quality.	14-18, 39-43
Health Expenditure	Increased government and total health spending improve life expectancy and reduce mortality, especially when efficiently allocated. Healthcare expenditure (HCE) has a positive relation with GDP.	14, 38-40, 42-44
Governance and Institutions	Good governance and effective institutions amplify the positive impact of economic growth and health spending on health outcomes	42, 43

of production along with their elasticity. Specifically, the labor composite in the production function is approximated as the product of the employment population times the percentage of workers who are in a healthy status. Building upon this framework, we developed a health-augmented Cobb-Douglas aggregate production function to estimate the association between mortality reductions from improved MRI accessibility and economic output through the labor supply channel: $Y = A \cdot K^{\alpha} \cdot (L \cdot v)^{1-\alpha}$, where Y is the aggregate quantity of goods and services produced; A, conceptually, is the overall level of technology and efficiency in the production process; K is the value of physical assets used in production, such as machinery, buildings, and equipment; v represents and is interpreted as the ratio of human labor in the form of health, where $v \in [0,1]$; L is the labor composite, defined as the quantity of labor (the statistical employment population after adjusting mortality rate); α is the output elasticity of capital, which is how much output changes when capital input changes. $(1 - \alpha)$ is the theoretical value for the output elasticity of labor.

The approach of this research is to use the modeled health-augmented Cobb-Douglas Aggregate production function to approximate the impact of MRI accessibility (which improves the overall health level of a nation, v) on economic output. The independent variable will be the ratio of human labor in the form of health v, where $v \in [0,1]$, and the statistical employment population L. The dependent variable will be the relative percentage change in economic output, Y.

To simplify the statistical calculation, we consider the circumstance in the context of a hypothetical developing country that has no access to any MRI at first. The output of the hypothetical country before accessible to MRI is denoted as $Y_i(A, K, L_i, v_i) = A \cdot K^{\alpha} \cdot (L_i \cdot v_i)^{1-\alpha}$, and the output of the country after the ample accessibility of MRI is denoted as $Y_f(A, K, L_f, v_f) = A \cdot K^{\alpha} \cdot (L_f \cdot v_f)^{1-\alpha}$. Under the assumption that the relative change in v and L has a negligible impact on the other variables (A, K, and α), we calculate the relative percentage change in Y, which is real GDP in this case.

$$\left(\frac{Y_f - Y_i}{Y_i} = \left(\frac{L_f \cdot v_f}{L_i \cdot v_i}\right)^{1-\alpha} - 1\right)$$

Data Sources and Variables

Based on the literature review, an increase in accessibility to MRI does have a qualitatively positive impact on the variable v, defined as the ratio of human labor in the form of health ($v \in [0,1]$), yet the statistical evidence is insufficient throughout the research. Given data limitations, the variable v is assumed to increase through the process of increasing MRI's accessibility, where $v_f \geq v_i$. Within the calculation process, we restrict the condition to $v_f = v_i$.

The variable L, defined as the labour composite, will be estimated by the mortality improvement through pre- and post-implementation of MRI in the hypothetical country. L is defined such that $L(m) = E \cdot (1 - m)$ where E is the employed population before mortality adjustment (number of employed persons), m is the annual mortality rate of the employed population. In this research, we restrict attention to mortality data of breast cancer, traumatic brain injury (TBI), and ischemic stroke, as shown in Table 4, to produce a conservative, mortality-only lower-bound estimation of the effect. For the baseline, we (i) assume negligible comorbidity between

Table 4. Summary of the mortality Improvement through clinical implications of MRI: focusing on breast cancer, traumatic brain injury (TBI), and Ischemic Stroke

Injury/ Disease/ Cancer	Mortality Statistic	Population percentage	Key References
Traumatic brain injury (TBI)	Unadjusted mortality: 0.75% (MRI) vs 2.54% (no MRI); adjusted OR 0.32 (95% CI 0.12–0.86)	The overall incidence rate of TBI in the US for 2002–2006 was 579 per 100,000 persons (0.579%)	48, 49
Ischemic Stroke	1.67% (MRI) vs. 3.09% (no MRI) in-hospital mortality (OR 0.60)	Globally, 77.19 million individuals experienced an ischemic stroke in 2019. (1%)	50, 51
Breast cancer	MRI surveillance reduces breast cancer mortality in BRCA1 carriers by 80% (approximately 1 out of 800 people have it)	Approximately 13.0 percent of women will be diagnosed with female breast cancer, with a case fatality rate of 29.7%	52-56

these conditions (i.e., overlap in the same individual is negligible) (ii) focus on cases within the working population (cases outside the labor force are therefore considered negligible) (iii) a sex ratio of 1:1 for the employment population. (iv) the employment population before mortality adjustment E remains constant through the time interval of MRI implementation.

According to Aquino (47), the output elasticity of capital α is estimated in the range of 0.46 and 0.56. In our research, we will substitute α = 0.46, 0.51, and 0.56 (the average of the maximum value and the minimum value) into the production function and compare the estimation results. The overall level of technology and efficiency in the production process, A, and the value of physical assets used in production, K, will be canceled out over the calculation process, so the real-world value of the two variables will be insignificant in this research.

Parameter/ Variable Estimation

To estimate the aggregate mortality rate of the three conditions, given the assumption and data on 3.2, we calculated the aggregate of the incidence rate multiplied by the case-fatality rate:

$$m = \sum (\textit{incidence rate} \times \textit{case fatality rate})$$

$$m_i = \sum (0.579\% \times 2.54\% + 1\% \times 3.09\% + 0.5 \times 13\% \times 29.7\%) \approx 1.9761\%$$

$$m_f = \sum (0.579\% \times 0.75\% + 1\% \times 1.67\% + (0.5 \times 13\% \times 29.7\% - 0.5 \times 13\% \times 29.7\% \times 0.125\% \times 80\%)) \approx 1.9549\%$$

$$\left|\frac{m_f - m_i}{m_i}\right| = 1.07\%$$

Given that $L(m) = E \cdot (1 - m)$, the labor composite $L_i = L(m_i)$ and $L_f = L(m_f)$ will be:

$$L_i = E \cdot (1 - m_i) = E \cdot (1 - 1.9761\%) = 0.980239E$$
$$L_f = E \cdot (1 - m_f) = E \cdot (1 - 1.9549\%) = 0.980451E$$

Substitute L_i and L_f back into the Cobb-Douglas production function. Given α = 0.46, 0.51, and 0.56, the Cobb-Douglas production function is equivalent to:

$\alpha_1 = 0.46$,

$$Y_i = A \cdot K^{0.46} \cdot (0.980239E \cdot v_i)^{0.54}$$
$$Y_f = A \cdot K^{0.46} \cdot (0.980451E \cdot v_f)^{0.54}$$

$\alpha_2 = 0.51$,

$$Y_i = A \cdot K^{0.51} \cdot (0.980239E \cdot v_i)^{0.49}$$
$$Y_f = A \cdot K^{0.51} \cdot (0.980451E \cdot v_f)^{0.49}$$

$\alpha_3 = 0.56$,

$$Y_i = A \cdot K^{0.56} \cdot (0.980239E \cdot v_i)^{0.44}$$
$$Y_f = A \cdot K^{0.56} \cdot (0.980451E \cdot v_f)^{0.44}$$

Given the calculation assumption that $v_f = v_i$, we can do a conservative estimation on the relative percentage change of GDP after the implementation of MRI in a hypothetical developing country:

$\alpha_1 = 0.46$,

$$\frac{Y_f - Y_i}{Y_i} = 0.011678\%$$

$\alpha_2 = 0.51$,

$$\frac{Y_f - Y_i}{Y_i} = 0.010597\%$$

$\alpha_3 = 0.56$,

$$\frac{Y_f - Y_i}{Y_i} = 0.009515\%$$

RESULTS

Health Outcomes Correlation: Mortality Rate

The analysis shows that a positive correlation does exist and is significant between increased access to magnetic resonance imaging (MRI) and health outcomes at the nationwide level. The greater access to MRI, as outlined in Section 2.2, will enhance diagnostic accuracy, earlier disease identification, and reduce health disparity; all of which will serve to improve the health of the population. The availability of MRI, based on the conservative estimate that follows, can reduce the national mortality rate by 1.07 percent in relative terms. This quantitative result supports the qualitative evidence that has been obtained from the previous research, that MRI not only strengthens the diagnostic power of the healthcare system, but also reflects a tangible improvement in the survival rates (48, 50, 52). MRI has a direct impact on reducing preventable mortality, and,

as such, the general health condition of the country is improved. These findings also support the already existing agreement in previous studies that high-quality MRI accessibility is significantly linked to positive health outcomes (31, 32, 37).

MRI-Associated Mortality Reduction and GDP Calculations

According to conservative estimation under strict assumptions, the gross domestic product growth due to increased MRI accessibility ranges from 0.009515% to 0.011678% in relative terms, depending on the parameter of capital elasticity assumed in the Cobb–Douglas production function. Although the estimated growth represents a modest macroeconomic contribution, it must be viewed in the context of highly restrictive assumptions. Only three clinical conditions have been included in the analysis: breast cancer, traumatic brain injury, and ischemic stroke. Considering miscellaneous diseases and health conditions, the actual mortality rate improved by increased MRI access is expected to be higher, thus implying that the GDP growth statistics are a lower-bound measure.

DISCUSSION

Economic Interpretation

The conservative estimate given in this paper supports the positive correlation between the accessibility of MRI and the national economic output. Although the direct short-term payoff (within the time frame of 12 months to 2 years) may be considered comparatively small, at about 0.011% of GDP growth, evidence suggests that healthcare improvements, including enhanced MRI accessibility, are associated with economic performance (14, 17, 44). Expanding the application to include more diseases, injuries, and health-related issues, and assuming that the post-MRI, health-adjusted labor ratio (V_f) is above its original (V_i), the percentage GDP growth is expected to be higher than the estimation in the research, yet it would not yield substantial short-term returns.

According to the observational study from Aslan *et al*., the maximum GDP growth associated with increasing 1% of healthcare expenditure (HCE) is estimated to be 0.499% (44). The study also illustrates the bi-directional correlation of HCE and GDP growth for all G7 countries. The conservative estimate from our paper of GDP growth associated with enhanced MRI accessibility falls within 0.009515% to 0.011678% in relative terms, which is considered reasonable based on the previous study by Aslan *et al*. That said, even if taking miscellaneous diseases and health conditions into account, the GDP growth associated with MRI innovation will likely not exceed the value estimated from previous studies (0.499%), which remains statistically modest.

Beyond the numerical estimates, the economic relevance of MRI accessibility emerges from well-documented mechanisms by which diagnostic technology influences labor productivity and human capital. The earlier and more precise diagnosis reduces absenteeism and presenteeism, hence raising Disability-Adjusted Life Years (DALY), Quality-Adjusted Life Years (QALY), and the effective labor supply, which is captured by the labor-health composite $L \cdot v$, within the Cobb-Douglas framework (12, 13, 17, 37, 44, 65, 85). Access to MRI also precludes untreated or misdiagnosed disease in the chronic stage, saving human capital and preventing losses in productivity due to the advancement of chronic disability (37, 50, 52). These health benefits translate into reduced sick leave, lower employee turnover, and enhanced labor force participation, which increases the output per worker (12, 17, 44). Additionally, the benefits of earlier diagnosis are substantial: it reduces downstream healthcare spending, allowing governments and companies to invest and develop more, which increases physical capital K, as well as the total-factor productivity A (10, 14, 39, 44). Greater accuracy in the diagnostic process further promotes hospital workflow efficiency, decreases unnecessary imaging and hospitalization, and leads to more efficient clinical decision-making (30, 37, 60). These processes explain why even small gains in MRI availability may have extensive macroeconomic spillovers across decades-long periods, even though they appear to have only a statistically insignificant effect in short-run analyses.

Diminishing & Constant Economic Return to Scale

It has been supported with empirical data that there is a positive correlation between healthcare accessibility and macroeconomic performance (14, 17, 73). However, the effects of MRI on aggregate output, when analyzed only in the context of health-gaining benefits, indicate a tendency of decreasing marginal returns on a Cobb-Douglas production model. The magnitude of the contribution made by a single variable to output is formally summarized by the partial derivative of Y with that variable; increasing the health-related human capital (v) or labor (L) individually will increase the output, but with decreasing marginal propensities.

$$\frac{\partial Y}{\partial v}(1-\alpha)\cdot A\cdot K^{\alpha}\cdot(h\cdot L)^{1-\alpha}\cdot\frac{v^{1-\alpha}}{v}$$

Nevertheless, the improvements in MRI technology are inseparably connected with the general technological advancements and investment. The technological breakthrough raises the total-factor productivity parameter (A), and the corresponding rise in the manufacturing and distribution of the MRI units adds to the capital accumulation (K). When these additional mechanisms are incorporated, MRI-induced health gains, combined with technological and infrastructural change, could maintain a more balanced, stable return to scale on the national level.

Potential Policy Implications

The results are essential in relation to the policy of healthcare and the population. The empirical evidence shows that the accessibility of healthcare is positively correlated with the performance of macroeconomic programs, despite the economic return being small in the short run (14, 15, 16, 17); therefore, governments, especially those whose economies are labor-intensive, should recognize the importance of investing in the healthcare infrastructure, such as the magnetic resonance imaging (MRI) centers. Greater access to healthcare not only reduces preventable mortality but is also associated with enhanced workforce productivity in the long run, which brings about economic growth (12, 17, 65). Beyond direct implementation, governmental entities should allocate resources to MRI-related research and development. Investing in innovations such as portable MRI machines, AI-enabled diagnostic systems, and cost-effective imaging technologies can enhance healthcare accessibility while generating sustainable long-term economic returns, thereby promoting synergistic advancement of both healthcare infrastructure and economic productivity.

Limitations and Future Research

This research faces several important limitations. First, this analysis focuses exclusively on the mortality-labor pathway and does not quantify other economic benefits of MRI, such as improved worker productivity, healthcare cost savings, or technological spillovers. Furthermore, the data sources for MRI's impact on mortality were restricted to only three health conditions: breast cancer, traumatic brain injury, and ischemic stroke. Both limitations mean our estimates represent a conservative lower bound of MRI's contribution to population health and economic output. Second, broader measures of health, such as DALY and QALY, which could be utilized to estimate the value of the variable , could not be included due to data constraints, further limiting the comprehensiveness of the estimation. Third, the model assumes static conditions for several variables through the estimation process, such as employment levels, the ratio of human labor in the form of health v (which should be one of the independent variables in the calculation but is assumed constant due to source limitations), and comorbidity, which oversimplifies real-world dynamics. Finally, the time considered is short-term, thereby overlooking the cumulative and potentially larger long-term benefits despite acknowledging them. Longitudinal studies tracking MRI accessibility changes and economic outcomes across multiple countries over extended periods would provide more robust evidence of causal relationships and allow for quantification of feedback effects between health improvements and economic growth. Future research should, if possible, expand the scope of diseases analyzed, incorporate DALY and QALY metrics, and model dynamic, multi-year economic effects to better capture the systemic impact of MRI accessibility on national productivity.

CONCLUSION

This paper has explored how access to MRI has been associated with health outcomes, as well as economic output, demonstrated through a health-enhanced Cobb-Douglas production function. The conservative estimate shows a minimum 1.07% relative reduction in mortality rate when access to MRI is more widespread. Under conservative assumptions, the increase in MRI accessibility is associated with GDP growth of 0.009515% to 0.011678% in relative terms. Although the short-term economic benefits do not appear to be statistically substantial, the results complement the overall claim that healthcare and economic performance have a positive relationship. MRI is not only beneficial in terms of diagnostic and treatment results but also associated with potential workforce productivity and national output in the long run, which are not fully captured in short-run macroeconomic analysis. While individual health or capital improvements alone show diminishing returns, MRI-based technological advances, along with expanded capital and productivity gains, provide a long-term, sustainable direction toward economic and health gains.

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CONFLICT OF INTEREST

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