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Estimating total factor productivity in Vietnam's agriculture: A non-parametric approach

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Abstract: This study examines changes in agricultural Total Factor Productivity (TFP) and its components—Technical Efficiency Change, Technical Change, and Scale Change—in Vietnam over a 33-year period (1986–2018). Using a non-parametric Malmquist Data Envelopment Analysis (DEA) approach, the research analyzes a panel dataset comprising one aggregate output and five input factors across 60 provinces. The findings indicate a positive trend in agricultural TFP, with an average annual growth rate of 2% and a cumulative increase of 68% over the study period. Technological Change emerges as the primary driver of productivity gains, followed by improvements in Technical Efficiency. In contrast, Scale Change negatively affects overall TFP growth. The analysis reveals notable regional disparities: provinces in the Mekong River Delta and southern Vietnam demonstrate strong performance due to mechanization, high-value crop adoption, and better market integration, while provinces facing urbanization pressures or infrastructure constraints show slower, more erratic growth. These results underscore the importance of region-specific policy frameworks and targeted investment strategies to foster balanced and sustainable agricultural development nationwide.
Keywords: *Agricultural productivity, Data envelopment analysis, Scale change, Technical change, Technical efficiency change, Total factor productivity.*

1. Introduction

The agricultural sector holds significant importance in most economies, particularly in less developed nations. Enhancing technical efficiency and agricultural productivity is a crucial policy goal in these countries. This has resulted in many development and agricultural economists' interest in determining the technical efficiency and TFP in agriculture.

Vietnam is mainly an agricultural country. After the implementation of the Doi Moi reform policy at the 6th National Congress in December 1986, Vietnam's economy has witnessed notable growth. This transition from a centrally planned economy to a market-oriented one significantly transformed the country's economic performance. Vietnam has evolved from being a net importer of food in the early 1980s to one of the world's major rice exporters since 1988. The rural areas are home to a majority of the Vietnamese population, around 75%, and agriculture is their primary source of livelihood [1]. Agriculture makes a vital contribution to Vietnam's GDP, accounting for roughly 23% of the total GDP of the country. Additionally, it employs a substantial percentage of the country's labour force, with about 62% of the workforce engaged in agricultural activities. During the period 1986–2018, agricultural output in Vietnam grew annually by 4.63%—an increase from 52,000 billion VND in 1986 to 219,000 billion VND in 2018.

The DEA method widely used for measuring productivity and efficiency. The non-parametric method (DEA) was first introduced by Farrell [2]. The model has been empirically applied and extensively evaluated, as detailed by Seiford and Thrall [3]; Fried, et al. [4]; Coelli [5]; Cooper, et al. [6]; Kumbhakar and Lovell [7]; Headey, et al. [8] and Coelli, et al. [9]. There are several studies

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measuring productivity in Vietnam related to the agricultural sector. Son Nghiem and Coelli [10] estimated TFP over the period 1976–1997 for eight regions in the Vietnamese rice industry. Minh and Long [11] assessed the agricultural production efficiency of 60 provinces in Vietnam between 1990 and 2005. Rios and Shively [12] evaluated the technical efficiency of 209 coffee farms in Vietnam's Daklak province in 2014. Linh [13] measured agricultural productivity in 60 provinces from 1985 to 2000, while Dinh Bao [14] conducted a similar analysis for the period 1990–2006. Giang, et al. [15] analyzed TFP of agricultural firms in Vietnam and its relevant determinants during 2000–2009; and Linh et al (2015) applied a DEA with a smooth bootstrap method to estimate the productive efficiency of crop farms in 12 villages across three districts in Son La Province. A thorough literature review indicates that this research is the first empirical study of the agricultural sector that measures TFP and its three components (technical efficiency, technical change, and scale change) using the DEA method with five input variables over a long-term period of 33 years (1986–2018) in Vietnam. The results of this study provide detailed answers to some basic questions about agricultural productivity and its three components in Vietnam.

2. Theoretical Framework

2.1. Concepts of Technical Efficiency, Technical Change, Technical Efficiency Change, and TFP Growth

2.1.1. Technical Efficiency (TE)

The production possibility frontier represents the highest amount of output that can be produced by a group of decision-making units (DMUs), such as provinces in this study, with specific production technology. The discrepancy between the actual production output and this maximum output for a particular combination of inputs is utilised to quantify technical efficiency (TE). This is depicted in Figure 1.

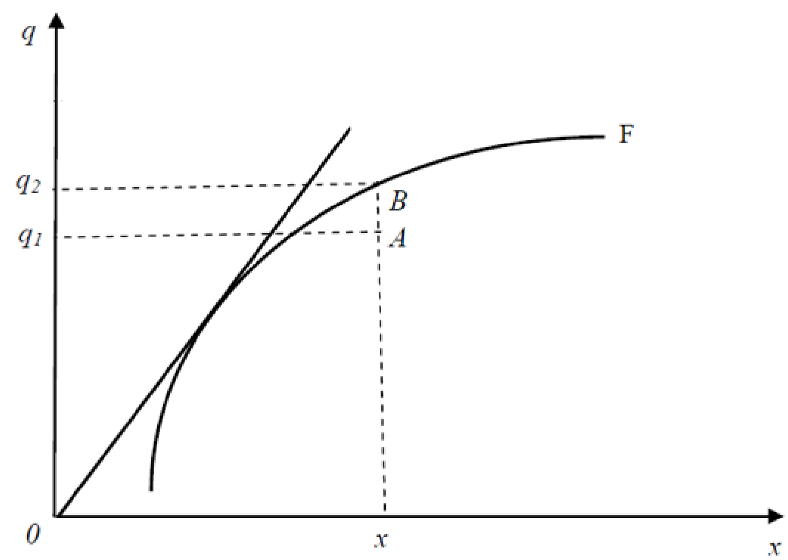

Figure 1.
Technical Efficiency (TE).

Assuming variable returns to scale technology, Figure 1 depicts the production frontier denoted by F, which represents the maximum potential output that DMUs can produce with full technical efficiency. In practice, some DMUs may not be able to achieve complete technical efficiency because of various factors, such as a lack of knowledge about the production process or organisational issues. As a result, they may produce at a point below the production frontier, such as point A in Figure 1. At point A, the DMU produces q1 output with input quantity x. However, if the DMU were fully technically

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efficient, it would produce at point B on the production frontier F, which produces q2 output with the same input quantity. The level of technical efficiency (TE) is calculated as the ratio of q1/q2.

2.1.2. Technical Efficiency Change (TEC), Technical Change (TC), and TFP Growth

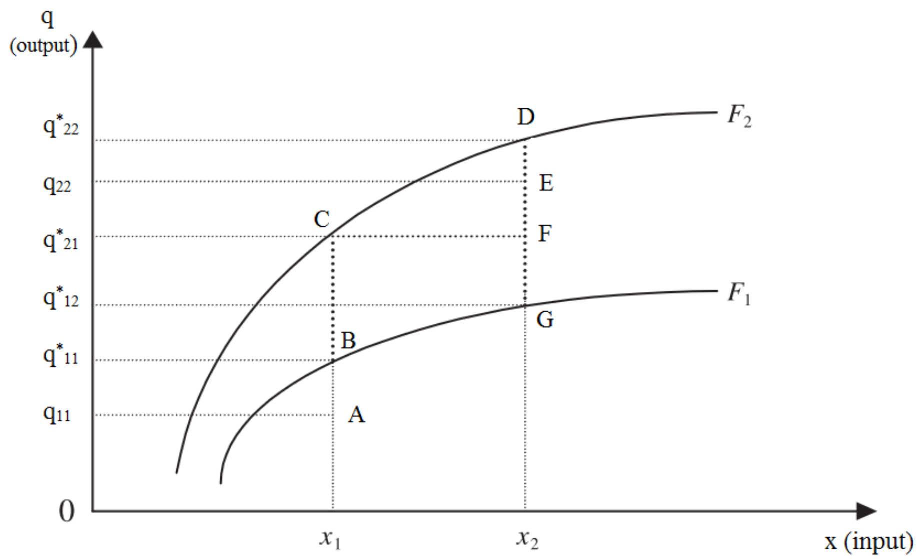

Figure 2.
TEC, TC and TFP.

Following research by Sun and Kalirajan [16] Figure 2 assumes that points A and E are actual productions at time points t1 and t2, respectively. F1 and F2 refer to the potential production frontier at time periods t1 and t2, respectively, while x1 and x2 are the level of inputs and qij reflects the level of outputs (as q11, q*11, q*12, q*21, q22, q*22). Output growth—which is the change from A to E (Q22 – Q11)—can be decomposed as follows:

Output growth = q22 – q11 = AB + BC + FE
= AB + BC + (FD-DE)
= AB - DE + BC + FD
= [(q*11 – q11) – (q*22 – q22)] + (q*21 – q*11) + (q*22 - q*21)

Where
AB = (q*11 – q11) shows that the firm is not efficient on the production frontier in period t1, and (q*22 – q22) measures technical inefficiency in period t2.
BC = (q*21 – q*11) measures technological change, which means that the same input amount (x1) but using different levels of production technologies (F1 and F2).
FD – ED = (q*22 - q*21) shows the output growth that is based on the input growth (from X1 to X2), using the same technology F2.
Therefore,
ΔY (Output growth) = ΔTEC + ΔTC + ΔX
= technical efficiency change (TEC) + technical change at x1 (TC) + contribution of input growth.

The term 'technical efficiency change' (TEC) pertains to the change in the gap between real production and ideal production on the production frontier while maintaining the same level of inputs over time. If the TEC value is more than 1, it indicates there was an enhancement in technical efficiency between time periods t1 and t2, while a TEC value less than 1 signifies a reduction in technical efficiency.

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Technical change (TC), also known as technological change, refers to changes in the production frontier over time. A TC value greater than (less than) 1 indicates the production frontier is moving outward (inward) from its starting point.

2.2. Malmquist DEA Method

According to Färe, et al. [17] it is possible to calculate the Malmquist productivity index without using price data. Their method involves defining the output distance function on the output set P(x), which is as follows:

$$d(x,y) = min\left\{\delta: (\frac{y}{\delta}) \in P(x)\right\} \quad (1)$$

The feasible production set P(x) is the set of all output vectors y that can be produced using a given input vector x. The output distance function d(x, y) measures the distance between the actual output vector y and the maximum feasible output vector for the input vector x. If y is on the boundary of the feasible production set, the output distance function will be equal to 1 or less.

The Malmquist TFP index can be used to calculate the change in TFP between two periods. This index estimates the distance functions of each period to the relevant technology using an output-oriented approach. The Malmquist TFP change index between a base period (period s) and another period (period t) is calculated based on the method proposed by Färe, et al. [17]:

$$m_0(y_s, x_s, y_t, x_t) = \left[\frac{d_0^s(y_t,x_t)}{d_0^s(y_s,x_s)} x \frac{d_0^t(y_t,x_t)}{d_0^t(y_s,x_s)}\right]^{\frac{1}{2}} \quad (2)$$

in which d_t^s, d_s^s, d_t^t, d_s^t are distance functions and y, x are the output and input vector.

The TFP change index represented by equation (2) can be expressed as the multiplication of two indices: the TEC index and the TC index.

$$M_0^t(y_s, x_s, y_t, x_t) = \frac{d_0^t(y_t,x_t)}{d_0^s(y_s,x_s)}\left[\frac{d_0^s(y_t,x_t)}{d_0^t(y_t,x_t)} x \frac{d_0^s(y_s,x_s)}{d_0^t(y_s,x_s)}\right]^{\frac{1}{2}} \quad (3)$$

Technical *efficiency change (TEC):* $TEC = \frac{d_0^t(y_t,x_t)}{d_0^s(y_s,x_s)}$ (4)

and Technical change (TC):

$$TC = \left[\frac{d_0^s(y_t,x_t)}{d_0^t(y_t,x_t)} x \frac{d_0^s(y_s,x_s)}{d_0^t(y_s,x_s)}\right]^{\frac{1}{2}} \quad (5)$$

Equation (4) can be separated into two parts to define the TEC. The first part is the pure efficiency change, which measures the change in technical efficiency related to variable returns to scale. The second part is the scale efficiency change, which measures the shift in production from variable returns to scale to constant returns to scale.

$$Pure\ efficiency\ change = \frac{d_{ov}^t(y_t,x_t)}{d_{ov}^s(y_s,x_s)} \quad (6)$$

and a scale efficiency change (SEC) component

$$Scale\ efficiency\ change = \frac{d_{ov}^t(y_t,x_t)/d_{oc}^t(y_t,x_t)}{d_{ov}^t(y_s,x_s)/d_{oc}^t(y_s,x_s)} x \frac{d_{ov}^s(y_t,x_t)/d_{oc}^s(y_t,x_t)}{d_{ov}^s(y_s,x_s)/d_{oc}^s(y_s,x_s)} \quad (7)$$

where c, v denotes the variable and constant returns to scale technologies, respectively.

3. Descriptions of Data and Variables

This paper uses panel data that include data on inputs and outputs used by the agricultural sector for 60 provinces in Vietnam over a 33-year period (1986–2018). These data are collected from the GSO of Vietnam.

The output variable for this study is the aggregate agricultural output expressed in VND, while the five input variables—land, labour, tractors, threshing machines and draught animals—are measured as follows:

Land = total arable land in for each province.

Labour = the number of workers employed in the agricultural sector in each province.

Tractors = the number of tractors used for agricultural activities in each province.

Threshing machines = measured by the number of threshing machines in each province.

Draught animals = the number of buffaloes used in agricultural production.

Table 1.
Summary statistics of agricultural output and inputs for 60 provinces in Vietnam, 1986–2018.

Variable	1986		1996		2006		2016		2018	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Output	862.5	738	1,443	1,079	2,379	1,785	3,510	2,554	3,653	2,717
Land	99.7	66.3	129.4	85.7	157.3	123.1	192.1	173.0	191.8	183.9
Labour	308.4	187.0	368.0	226.0	362.1	272.1	280.3	217.7	256.5	199.5
Tractor	512.8	342.4	1,825	1,218	3,944	2,607	5,843	3,878	6,084	4,072
Animal	26.7	29.0	49.2	56.3	48.7	64.4	42.0	61.0	40.4	59.4
Machine	7,420	4,919	7,997	5,298	9,470	6,281	9,161	6,096	9,447	6,408

Source: General Statistics Office of Vietnam.

Table 1 provides a summary of the statistics on agricultural production and inputs, including land, labour, tractor, animal and machinery, for 60 provinces in Vietnam from 1986 to 2018. The data reveals that the value of agricultural production output in Vietnam increased by approximately four times between 1986 and 2018, with an average growth rate of 323.5%, from 862.5 billion VND to 3,653 billion VND. This increase can be attributed to the growth of cultivated land by 92.4%, animals by 51.3%, machinery by 27.3%, and particularly tractors by 1,086.4% over the 33-year period.

However, the use of machinery was not the only factor contributing to the increase in agricultural production. Over the same period, there was also a gradual decline in labour input of 16.8%. This suggests there was a shift of agricultural labour to other sectors with higher productivity, such as industry and services, which led to a decline in the use of labour in agriculture.

4. Empirical Results

In the paper, the DEAP software developed by Coelli [18] was used to calculate the TE, TEC, TC, SC and Malmquist TFP index.

The results of the DEAP program show the measurements of technical efficiency, change in technical efficiency, technical change, change in scale efficiency and change in TFP for each year in each province from 1986 to 2018. The results also illustrate the geometric mean of all provinces in Vietnam at the country level and the annual mean of the figure for each province. Table 2 and Figure 3 summarise results for the entire country level.

Table 2.
Technical efficiency, technical change and total factor productivity change in the agricultural production of Vietnam, 1986–2018.

Year	Technical Change (%) (TC)	Technical Efficiency Change (%) (TEC)	Scale Efficiency Change (%) (SC)	TFP Change (%) (TFPC)
1987	-0.2	7.5	2.7	10.1
1988	8.1	-1.2	-1.2	5.6
1989	-10.5	9	1.8	-0.7
1990	-12.3	11	1.7	-1
1991	2.6	-3.2	-2.8	-3.4
1992	-13.3	14.5	2.7	2
1993	1.3	-5.8	0.8	-3.8
1994	-18	0.9	-0.8	-18
1995	5.7	-1.8	-0.9	2.9
1996	6.9	-3.2	-1.1	2.4
1997	-3	6.8	2.7	6.3
1998	6.6	-2.5	-0.3	3.7
1999	-0.4	3.4	-0.6	2.2
2000	-8.5	8.5	1.1	0.3
2001	-0.7	1.2	0.4	0.9
2002	5.9	-0.3	-1.3	4.2
2003	-2.4	2.8	1.2	1.6
2004	3.5	0.5	-0.8	3.2
2005	-0.2	0.7	0.1	0.6
2006	-0.5	2.6	0.1	2.2
2007	1.4	-1.2	1.9	2.1
2008	1.9	-0.3	0.8	2.5
2009	12.3	0.2	-1	11.3
2010	2.3	-2.6	-0.7	-1.1
2011	31.1	-13.2	-3.1	10.3
2012	-7.8	6.4	2.8	0.8
2013	8.1	-2.5	-2.4	2.9
2014	-0.6	0.9	-0.7	-0.5
2015	15.8	-5.4	-3	6.3
2016	5.8	-1	0.2	5
2017	11.1	-4.3	-3.8	2.3
2018	-0.7	4.1	1.3	4.8
Mean	1.2	0.9	-0.1	2

Source: Author's calculation from the results from DEAP 2.1

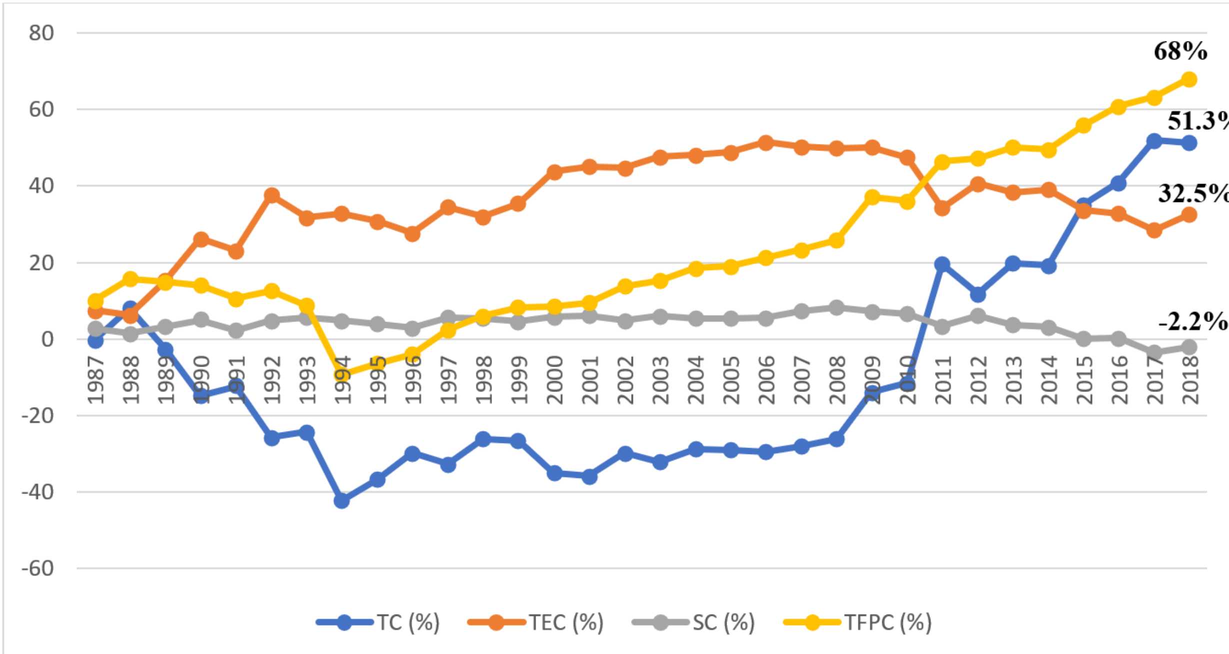

Figure 3.
Cumulative TEC, TC, TFP percentage change of Vietnam's agriculture using Malmquist DEA, 1986–2018.

The results of the cumulative value of technical change (TC), technical efficiency change (TEC), scale change (SC), and total factor productivity change (TFPC) provide valuable insights into the evolution of the Vietnamese agricultural sector from 1986 to 2018.

Technical change (TC) was the most important driver of productivity growth in Vietnamese agriculture, accounting for a cumulative increase of 51.3% over the entire study period. The annual growth rate of TC was 1.2%, indicating that agricultural productivity increased due to adopting new technology, improved management practices, and other technical improvements. The TC values tended to decrease between 1987 and 1994. They then increased after 1994, suggesting that policy reforms in the mid-1990s played a crucial role in promoting technological progress and productivity growth in the agricultural sector.

Technical efficiency change (TEC) also contributed significantly to productivity growth, accounting for a cumulative increase of 32.5% over the entire period. The annual growth rate of TEC was 0.9%, indicating that agricultural productivity increased due to improvements in the efficient use of inputs such as labour, capital and land. TEC increased steadily throughout the study period, suggesting farmers were able to adopt more efficient production practices and technologies over time.

Scale change (SC) had a relatively small impact on productivity growth in Vietnamese agriculture, accounting for a cumulative decrease of 2.2% over the entire study period. The annual growth rate of SC was -0.1%, indicating that agricultural productivity decreased slightly due to changes in the scale of production. However, the impact of SC on productivity growth was relatively small compared to the contributions of TC and TEC.

Total factor productivity change (TFPC) measures the overall productivity growth in the agricultural sector and is calculated as the sum of TC, TEC and SC. The cumulative value of TFPC increased by 68% over the entire study period, with an annual growth rate of 2%, indicating that agricultural productivity increased significantly due to improvements in technology and efficiency. The values of TFPC tended to increase after the mid-1990s, suggesting that policy reforms and investments in the agricultural sector played a crucial role in promoting productivity growth.

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Overall, the results of the cumulative value of TC, TEC, SC and TFPC indicate that improvements in technology and efficiency were the primary drivers of productivity growth in Vietnamese agriculture over the study period. While changes in the scale of production had a relatively small impact on productivity growth, policy reforms and investments in the sector played a crucial role in promoting technological progress and efficiency gains, leading to significant productivity improvements.

4.1. Provincial-Level Total Factor Productivity Change

Table 3.
The TFPC of 60 provinces of Vietnam in 1986-2018.

Province	1987	1990	2000	2010	2015	2018
Ha Noi	0.962	0.955	0.989	1.021	1.088	0.989
Ha Giang	1.232	0.961	1.029	0.969	1.120	1.011
Cao Bang	1.305	0.926	0.914	0.987	0.986	1.012
Bac Kan	1.218	1.034	1.010	0.973	0.906	0.994
Tuyen Quang	1.197	0.885	0.984	0.987	0.872	1.029
Lao Cai	1.200	0.936	1.003	0.972	1.117	1.034
Lai Chau	1.181	0.993	0.977	0.906	1.061	0.961
Son La	1.146	0.956	1.019	0.899	1.028	0.983
Yen Bai	1.288	0.880	1.002	0.974	1.112	0.992
Hoa Binh	1.115	0.946	0.988	0.937	1.142	1.050
Thai Nguyen	1.154	0.977	0.998	0.979	1.563	1.001
Lang Son	1.222	0.957	0.907	0.959	1.020	1.041
Quang Ninh	1.007	0.944	1.001	0.934	1.158	1.016
Bac Giang	1.138	0.956	1.008	1.064	1.409	1.345
Phu Tho	1.139	0.969	1.025	1.039	0.781	1.038
Vinh Phuc	1.093	0.815	1.021	1.065	0.951	1.101
Bac Ninh	0.912	1.038	1.037	0.990	1.073	0.978
Hai Duong	1.067	0.968	0.967	0.975	0.846	1.004
Hai Phong	1.010	0.886	0.985	1.059	1.141	1.053
Hung Yen	0.946	1.085	0.967	1.007	0.989	1.069
Thai Binh	0.858	1.334	0.974	1.049	1.044	1.569
Ha Nam	1.007	0.908	0.952	1.002	1.121	0.890
Nam Dinh	0.927	0.987	0.962	0.970	1.082	0.950
Ninh Binh	1.207	1.006	0.972	0.980	1.115	0.961
Thanh Hoa	1.218	0.964	0.980	0.934	1.163	0.906
Nghe An	1.211	0.941	1.024	0.960	1.000	0.937
Ha Tinh	1.209	0.955	0.978	0.927	1.052	0.989
Quang Binh	1.170	0.995	0.970	0.954	1.001	0.991
Quang Tri	1.210	1.032	1.080	0.925	1.065	1.018
TT Hue	1.184	0.949	1.006	0.941	1.052	1.084
Da Nang	1.219	0.752	0.885	1.075	1.167	1.002

Province	1987	1990	2000	2010	2015	2018
Quang Nam	1.273	0.961	0.949	1.001	1.338	1.006
Quang Ngai	1.215	0.954	0.926	0.977	1.157	1.092
Binh Dinh	1.085	1.163	0.976	1.040	1.056	0.995
Phu Yen	1.080	0.917	0.954	1.049	1.051	1.001
Khanh Hoa	1.032	0.943	0.935	0.952	0.897	1.025
Ninh Thuan	1.193	0.990	0.803	0.951	1.112	1.022
Binh Thuan	1.178	1.227	1.019	0.987	1.256	1.005
Kon Tum	1.142	0.953	1.056	1.062	1.165	1.068
Gia Lai	1.140	0.973	1.198	1.019	1.079	0.983
Dak Lak	1.004	1.032	1.222	0.925	1.030	0.989
Lam Dong	1.177	1.417	1.149	1.031	1.072	1.064
Binh Phuoc	1.147	0.984	1.043	1.027	1.069	1.054
Tay Ninh	1.128	0.961	1.020	0.975	1.012	1.070
Binh Duong	1.048	1.007	1.156	1.014	0.619	0.918
Dong Nai	1.056	0.868	0.987	1.007	0.783	0.843
BR Vung Tau	1.073	0.878	0.994	0.940	1.122	1.347
Ho Chi Minh	1.207	0.865	0.957	0.983	0.864	0.854
Long An	1.077	0.873	0.948	1.018	1.127	1.099
Tien Giang	0.998	1.080	1.232	0.891	1.192	1.250
Ben Tre	1.522	2.928	0.962	0.971	0.778	0.966
Tra Vinh	0.947	0.831	1.093	1.069	1.282	0.971
Vinh Long	1.104	1.106	1.232	0.983	1.063	1.403
Dong Thap	1.065	0.978	0.939	1.028	1.194	1.349
An Giang	0.824	1.008	0.978	0.995	1.076	1.546
Kien Giang	1.091	0.979	1.095	1.059	1.149	1.268
Can Tho	0.944	0.887	0.879	0.956	1.016	0.791
Soc Trang	1.000	0.917	0.993	1.071	1.084	1.344
Bac Lieu	0.983	1.039	1.042	0.980	1.515	1.015
Ca Mau	0.816	0.980	1.044	1.022	1.134	1.127
Mean	**1.101**	**0.990**	**1.003**	**0.989**	**1.063**	**1.048**

In addition to the national-level analysis, this study also investigates total factor productivity change (TFPC) at the provincial level for 60 provinces in Vietnam over the period 1986–2018, as presented in the Table 3. This provincial-level examination provides further insights into the spatial dynamics of productivity growth and highlights the regional disparities within the agricultural sector.

The average TFPC across provinces varied over selected years, with values of 1.101 in 1987, 0.990 in 1990, 1.003 in 2000, 0.989 in 2010, 1.063 in 2015, and 1.048 in 2018. These trends are broadly consistent with national TFP growth patterns, reflecting moderate but positive improvements in agricultural productivity over time. The TFPC gains were particularly evident in the post-2010 period, coinciding with increased adoption of new technologies and strengthened policy support for the agricultural sector. Conversely, the declines observed around 1990 and 2010 may be associated with structural adjustments and institutional reforms that temporarily impacted technical efficiency.

Substantial heterogeneity in productivity performance is observed across provinces. In 2018, several provinces achieved significant TFPC improvements, notably Thai Binh (1.569), An Giang (1.546), Vinh Long (1.403), Ba Ria–Vung Tau (1.347), and Tien Giang (1.250). Most of these provinces are located in the South and Mekong River Delta regions, where the adoption of high-value crops, increased mechanization, and efficient water resource management have contributed to productivity gains. Thai Binh, located in the Red River Delta, also demonstrated strong performance, likely due to an effective irrigation system and government policies supporting intensive rice cultivation.

In contrast, several provinces recorded relatively low TFPC values in 2018, including Can Tho (0.791), Dong Nai (0.843), and Ho Chi Minh City (0.854). These provinces are experiencing rapid urbanization and industrialization, which may reduce the emphasis on agricultural development or result in a reallocation of resources to non-agricultural sectors.

The data also reveal fluctuations in productivity growth over time at the provincial level. For example, Ben Tre exhibited an exceptionally high TFPC of 2.928 in 1990, followed by more moderate values in subsequent years, suggesting a temporary surge possibly influenced by structural changes or one-off external factors. Lam Dong, a province known for high-value crops such as coffee and flowers, consistently maintained elevated TFPC throughout the study period, indicating strong technological adoption and successful integration into agricultural markets.

By contrast, provinces such as Ha Tinh, Dak Lak, and Dong Nai showed inconsistent productivity patterns, reflecting challenges in sustaining efficiency improvements, limitations in scale economies, or infrastructural constraints. These variations underscore the importance of regionally tailored policies to support sustained productivity growth across diverse agro-ecological and socio-economic contexts in Vietnam.

5. Conclusion and Implications

5.1. Conclusion

The paper applies the non-parametric approaches, Malmquist DEA to measure the change in agricultural TFP and its components (TEC, TC and SC) in Vietnam over a 33-year period (1986–2018). It is a panel dataset of agricultural production in Vietnam for one aggregate output and five inputs in agriculture from 60 provinces during 1986–2018. In the Malmquist DEA model, the output-oriented frontiers are estimated based on the specification of variable returns to scale. The main objective of this paper is to calculate TC, TEC, SC and the change in TFP using the DEA method.

The results show that agricultural TFP in Vietnam has increased positively over the period from 1986 to 2018. The agricultural TFP growth of the DEA method was 2% per year, while the cumulative rates were 68% during 1986–2018. Technological change was the main driver of agricultural productivity growth, followed by TEC. The SC had a negative effect on TFP.

At the provincial level, the analysis revealed significant spatial disparities in TFPC. Some provinces—particularly those in the Mekong River Delta and the South—demonstrated consistently high productivity growth, driven by mechanization, high-value crop adoption, and market integration. Conversely, provinces experiencing rapid urbanization or infrastructural constraints showed lower or more volatile productivity growth. These findings highlight the critical role of localized conditions, resource allocation, and policy support in shaping agricultural performance.

Overall, these suggestions can further advance the understanding of agricultural TFP growth in Vietnam and provide policymakers with valuable insights for developing policies promoting sustainable and inclusive agricultural development.

5.2. Implications

Based on the findings of the study in measuring the change in agricultural TFP and its components (TEC, TC and SC) in Vietnam, this study has several policy implications for improving agricultural productivity in Vietnam.

(1) Investing in technological progress: The result shows that technological change is the primary driver of agricultural productivity growth in Vietnam. Therefore, policymakers should continue to invest in research and development to support the adoption of new technologies in the agriculture sector.

(2) Improving technical efficiency: The study found that technical efficiency is still a significant issue in Vietnam's agriculture sector, and technical efficiency change has a positive impact on TFP growth. Thus, policymakers should focus on providing farmers with training and information to help them use their inputs more efficiently and adopt best practices.

(3) Fostering a supportive policy environment: Government policies play a crucial role in promoting agricultural productivity growth. Policymakers should create a supportive policy environment by providing infrastructure, access to credit and other necessary resources to farmers, particularly small-scale farmers, to improve their productivity and competitiveness.

(4) To enhance agricultural productivity and reduce regional disparities in Vietnam, policy interventions must be tailored to local conditions. High-performing provinces should focus on sustaining growth through innovation, processing, and market access. Urbanizing provinces need integrated land-use planning and support for peri-urban agriculture and rural livelihoods. Meanwhile, mountainous and remote areas require targeted investment in infrastructure, technology transfer, and extension services to close the productivity gap and promote inclusive development.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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