CHAPTER 1

INTRODUCTION, OBJECTIVES AND HYPOTHESES

1.1 Introduction

A shortage of staple food crops to feed the whole population to an acceptable minimum standard of nutrition at all times has been a common problem in most developing countries. Since food grains dominate the diet of people in most developing countries, increasing food grain production is generally seen by their governments as the best way to solve the problem. In addition, year-by-year fluctuations in crop production also cause difficulties in maintaining an adequate food supply to meet requirements. Therefore, food security has become a central policy goal in most developing countries.

Remarkable progress in the growth of agriculture and the overall economy in Viet Nam has been achieved following a series of institutional and policy reforms adopted since the early 1980s when the country shifted from a centrally planned to a market economy (UNDP and SPC, 1990). Indeed, the country experienced the highest rate of growth of agricultural value added, agricultural exports and gross domestic production in South and South-East Asia in the past decade (see Table 1.1).

After being a net rice importer for nearly 30 years Viet Nam re-emerged as the third largest rice exporter by 1989, nearly attaining the leading position it held in the world rice market during the pre-war period (Nguyen, 1995).

This study aims to examine the trends, patterns and determinants of rice productivity changes in Viet Nam over the period from 1976 to 1995.

Table 1.1

Average Annual Growth Rate of Gross Domestic Product, Agricultural Value Added and Agricultural Exports in Selected South and South-East Asian Countries, 1980-1992 (%)

Selected Countries	Gross Domestic Product	Agricultural Gross Value Added	Agricultural Exports
Viet Nam	*7.3*	*5.2**	*23.6*
Indonesia	5.3	3.2	6.6
Malaysia	5.2	4.0	3.9
Thailand	7.6	4.0	6.0
Philippines	1.1	2.1	-5.4
India	5.6	3.0	-2.5
Pakistan	6.5	4.1	6.0
Nepal	4.6	4.6	4.3
Bangladesh	3.8	2.6	4.0
Sri Lanka	3.9	2.3	0.4

Sources:

Viet Nam: 1980-1984 ADB Key Indicators.

1986-1990 Economy and Trade of Viet Nam.

1990-1992 Viet Nam Statistical Yearbook.

Other Countries: Bautista, 1992.

Viet Nam has a comparative advantage in rice production. The importance of rice in the subsistence sector can be seen in terms of cropping intensity, contribution to GNP, labour utilisation, nutrition supply and foreign-exchange earning. Rice is the single most important crop, contributing over 60 per cent of average daily caloric intake and providing farmers with a large share of household income. Most rice production is of Indica varieties. Rice covers more than 60 per cent of the cultivated land under field crops (see Table 1.2).

Table 1.2

Rice and Other Crop Cultivation in Viet Nam, 1976-1995

	1976		1987		1995	
	000 ha	%	000 ha	%	000 ha	%
Total	6564	100	8641	100	10496	100
Rice	5293	80	5588	64	6765	64.4
Other	1271	20	3053	36	3731	35.6

Source: CGPRT Centre, 1993 and GSO, 1996.

The average yield of rice per ha in 1995 in Viet Nam was 3.66 tonnes (GSO, 1996). In terms of contribution to GNP, rice production contributed about 16 per cent per annum over the period 1976 to 1995. Furthermore, within the agricultural sector, rice production was the largest contributor to GNP (GSO, 1995) and employed 70 per cent of the rural population, including full-time and part-time participants (Nguyen, 1995). In addition, rice production supported manufacturing industries such as rice polishing and rice production for animal feed (see Table 1.3).

Table 1.3

Annual Rate of Growth of Rice in Viet Nam, 1976-81 to 1988-95

Time Period	1976-1981	1982-1987	1988-1995
Area	1.14	0.08	2.09
Yield	0.82	2.81	2.83
Rice Output	1.91	2.6	4.92

Source: CGPRT Centre, 1993 and GSO, 1996.

1.2 The Research Problem

Having assessed the achievements gained by economic reform in Vietnam, international economists have agreed that the biggest success has been recorded in the field of agriculture (Nguyen, 1995). Viet Nam remains a predominantly rural society, with the mass of its population dependent on agriculture, especially on rice production. The recent growth of rice output in Viet Nam could be attributed to an increase in the use of inputs and total factor productivity growth. However, there has not yet been a comprehensive analysis of the sources of rice-output increases. The purpose of this study is to analyse, identify and quantify the driving forces behind this growth.

1.3 Objectives of the Study

In relation to the problem outlined, the general objective of this study is to analyse productivity changes in the rice industry in Viet Nam over the period 1976 to 1995.

Focusing on the 20-year period, some specific objectives are to:

(a) measure and compare the total factor productivity (TFP) of rice production between the regions and over the study period;

(b) measure the contributions of input growth and TFP growth to rice production growth; and

(c) investigate the influence of changing policy regimes upon TFP.

1.4 Hypotheses

The following hypotheses are formulated to guide the study:

1. There has been no change in output in the rice industry over the study period.

2. There have been no differences in TFP changes in rice production between the regions over the study period.

3. The rates of TFP growth in pre- and post-reform periods have been equal.

4. Contributions of TFP and total input to growth of rice output have been equal.

1.5 Organisation of the Dissertation

The study has six chapters. Following this introductory chapter, Chapter 2 provides background of agriculture and rice production in Viet Nam over the study period from 1976 to 1995. Chapter 3 presents a review of relevant literature with special reference to productivity and technical change measurements in agricultural production. Chapter 4 outlines the methods of analysis. Chapter 5 describes the data used in this study and their limitations. Chapter 6 presents the results of the study and discussion of the results. The final chapter provides a summary of the study and policy implications, and concludes with some suggestions for further research.

CHAPTER 2

BACKGROUND

2.1 Introduction

Located in the centre of South-East Asia, Viet Nam forms an S-shaped strip on the eastern seaboard of the Indochinese peninsula, linking to the Asian continent and bordering the Pacific Ocean. The total territory of the state of Viet Nam comprises 331,114 sq. km of land and a vast area of sea, including a large continental shelf with archipelagoes in the Gulf of Bac Bo, in the East Sea and in the Gulf of Thailand (Kim, 1994). Viet Nam stretches 1650 km from north to south. The greatest width from east to west is 600 km and the narrowest only 50 km. With a border 3,700 km long, Viet Nam is adjacent to China in the north and Laos and Kampuchea in the west.

By the end of 1994 the Vietnamese population was about 77.7 million (Kim, 1994). Population densities vary widely, from sparsely inhabited highland provinces to the densely settled provinces of the Mekong and Red River Deltas.

The Vietnamese economy is now in transition. In terms of its internal organisation it is moving from a highly centralised command economy to a more decentralised system in which the role of the market is greatly enhanced. External economic relations are undergoing adjustments through which it is intended that the relative importance of trade will be oriented toward a market economy.

Initial economic reforms were instituted in the early 1980s, later followed by the "Doi Moi" policies of 1987, which attempted to shift the country more fully towards a market economy. However, by late 1988 an economic crisis, intensified by a sharp reduction in

Soviet assistance, prompted a further round of reforms. In early 1989, the most integrated package of monetary, price and exchange-rate reforms to date was implemented. The thrust of the reforms was to decontrol prices and stabilise the economy. Price controls on most goods and services were abolished, a new land law was put into effect and as part of trade liberalisation efforts, state trading companies were stripped of their monopoly control of imports and exports. Viet Nam still faces formidable challenges in the near future. A large fiscal deficit, high debt, growing unemployment and inflationary pressures could undermine recent economic progress.

2.2 Agriculture in the Vietnamese Economy

Agriculture occupies 21.9 per cent of the country's total area, with an area of 6.942 million ha. Viet Nam has an extremely small area of arable land per capita (1,073 sq. m). The distribution of arable land among different regions of the country is also uneven. In the Red River Delta where the pressure of the population on land is highest, only 519 sq. m of arable land are available per person, or 2,397 sq. m per person actively engaged in agriculture. In the Mekong River Delta, these figures are 1,729 sq. m and 4,627 sq. m, respectively. In other regions, where the conditions for intensive rice cultivation are less favourable, the land/labour ratio is higher. On the basis of soil characteristics, land availability can be divided into eight geographical regions (see Figure 2.1):

1. Mountainous Area
2. Midland Area
3. Red River Delta
4. North Central Coast
5. Central Duyen Hai
6. South-West Viet Nam
7. North-East Viet Nam
8. Mekong River Delta.

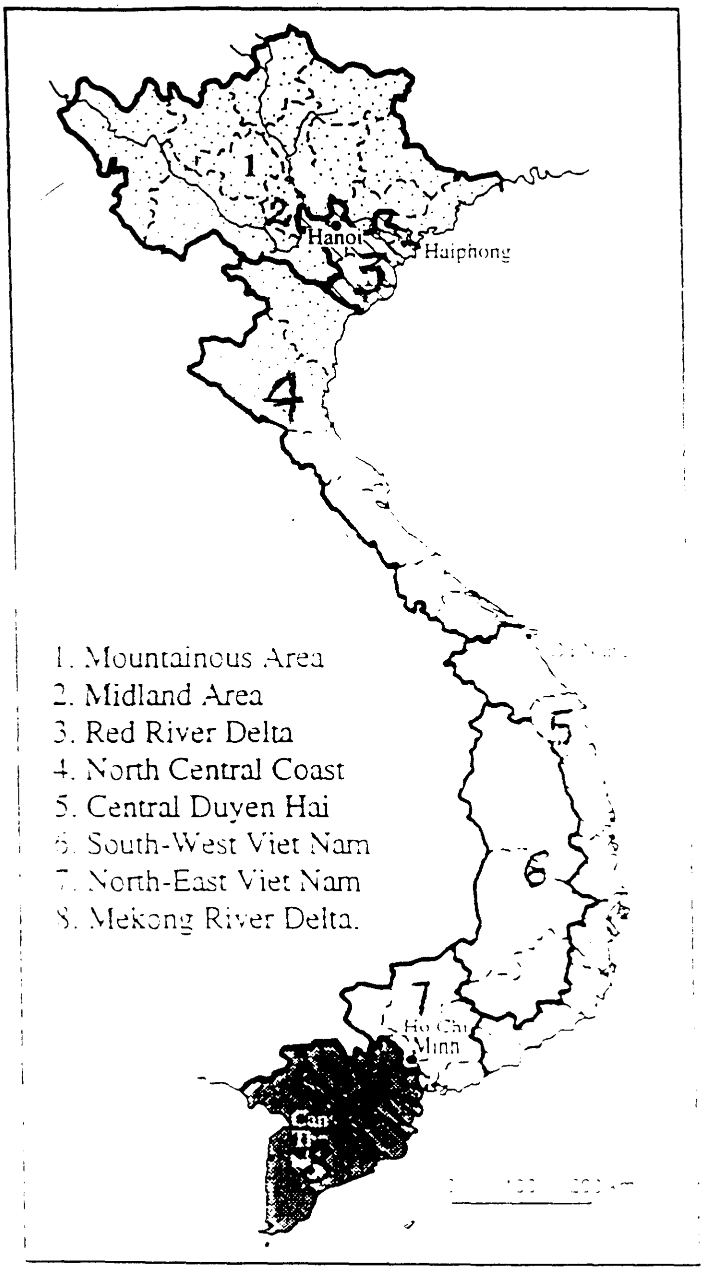


Figure 2.1: Geographical Regions in Viet Nam.

The length and the topography of the country make it suitable for the cultivation of tropical as well as subtropical crops. However, agriculture has always been dominated by rice cultivation. Food grain production, more than 85 per cent of which consists of paddy, accounts for nearly 50 per cent of gross agricultural production. Other crops include maize, potato, sweet potato and cassava. Industrial crops and animal husbandry account for 24 and 26 per cent of the value of gross agricultural production, respectively (GSO, 1991).

The 100-odd years of French colonial occupation of Viet Nam continued the traditional agricultural basis of the economy, with the adjunct of large commercial plantations for cash crops, and some mining and forestry. Agricultural products were the principal exports. The Japanese occupation of WWII, and the independence struggle from the 1940s to 1975, caused severe disruption to the Vietnamese economy. The 21-year division of the North and South from 1954 to 1975 meant the application of different government economic policies to the two halves of the country. This saw the development of different trade, aid and investment links, and the emergence of different economic patterns.

With reunification and the inauguration of the Socialist Republic of Viet Nam in 1975, the government decided that the immediate national economic priorities were the development of agriculture and light industries (Resolution of Vietnamese Communist Party, 1976). Whereas North Viet Nam adopted the socialist form of government in the late 1950s, the collectivised agricultural production system and state control of agricultural prices and marketing were introduced in South Viet Nam only in 1976 after the unification of the country. Unlike North Viet Nam, where collectivisation involved unified management of labour, state ownership of land and capital, and payments through work points, agriculture in South Viet Nam continued to be operated on a family farm basis, despite efforts to collectivise, except for plantation crops such as rubber and a few state farms. Nonetheless, changes in the nature of the land allocation, land rights, fixed capital ownership, labour sharing and marketing consistent with the socialist system have had adverse effects at the farm level (Nguyen, 1995).

Land was redistributed according to family size, land quality and access to irrigation. Lack of long-term security of tenure and common reassignments of land, discouraged private investment in land development for enhancing sustainability of long-term productivity. Tractors, threshers and water pumps were appropriated by the state for common use. The prohibition of private ownership of such fixed capital not only caused a sharp decline in investment, especially in the supply of inputs, but also promoted their inefficient use and maintenance. Although farmers decided on levels of input use and technologies to be adopted, the sharing of labour resources in production teams, particularly for power-intensive operations such as land preparation and threshing, generally lowered work efforts. Moreover, as the state gained a monopoly of the distribution of input supplies as well as international trade in agricultural outputs and inputs, implementation of a barter exchange between fertilisers and paddy resulted in a relatively unfavourable output-input price ratio.

As agricultural production stagnated and farmers' unrest grew under the socialist system, a series of institutional and policy reforms was adopted by the beginning of 1987 that changed the production system. In 1981, the annual contract system replaced the collective or cooperative system as farm lands were allocated to households, even in the north, with an obligation to sell a contracted level of output to the state at a fixed price. The household was then free to use the residual for home consumption or sell to private traders.

By 1988, long-term cultivation rights of 10 to 20 years were granted that were transferable within the family. Consumer subsidies and the dual-price system were also phased out, and by 1989, prices, wages, foreign exchange rate and interest rates were decontrolled and allowed to find their market level. While the government continued to have a monopoly on international trade of agricultural outputs and inputs, the monopoly rights of state enterprises ended as rights to export and import were also granted to provincial and other local enterprises.

The general economic and agricultural reforms of the late 1980s caused a major increase in food production. But a smooth continuation of this new pattern is not assured because

Vietnamese agricultural production will continue to be vulnerable to adverse climatic conditions, especially typhoons and floods in central Viet Nam and droughts in the north. Increased food production has lately caused a fall in food prices, while non-food prices have continued to rise, thus reducing farmers' incomes.

2.3 Rice Production in Viet Nam: 1976 to 1995

Post-war rice production in Viet Nam may be categorised by the country's three stages of agrarian reform. The period 1976 to 1981 can be considered as the period of collectivisation. In this period Vietnamese agriculture was unified . The period 1981 to 1987 can be regarded as the period of the contract system and the period after reform from 1987 up to 1995 can be seen as the transition to family farming.

2.3.1 Total rice production

In 1976, total rice production in Viet Nam was 11.821 million tonnes (mt). It increased to 24.963 million tonnes in 1995 (see Table A1), indicating that production of rice more than doubled in 20 years.

The growth in production was not uniform across all regions, nor was it uniform over time (see Figure 2.2). Approximately 50 per cent of all rice is produced in the Mekong River Delta and 20 per cent is produced in the Red River Delta (GSO, 1995). In the Mekong River Delta, rice production was 4.665 mt in 1976 (see Table B1) and increased to 12.831 mt in 1995, almost three-fold growth. In the Red River Delta gross rice production over the period 1976 to 1995 shows an increase of 1.720 mt. Over the period 1976 to 1995 gross rice production in Viet Nam increased from 11.821 mt to 24.964 mt.

2.3.2 Area under rice cultivation

In 1976, the total rice area harvested was 5.293 million ha. By 1995, it had increased to 6.766 million ha (see Table B2). Rice in most regions is by far the dominant crop, accounting for about two-thirds of the cultivated area. Cultivated area planted to rice is declining in both absolute and relative terms, although the growth rate of production has been relatively high because of productivity growth (see Figure 2.3).

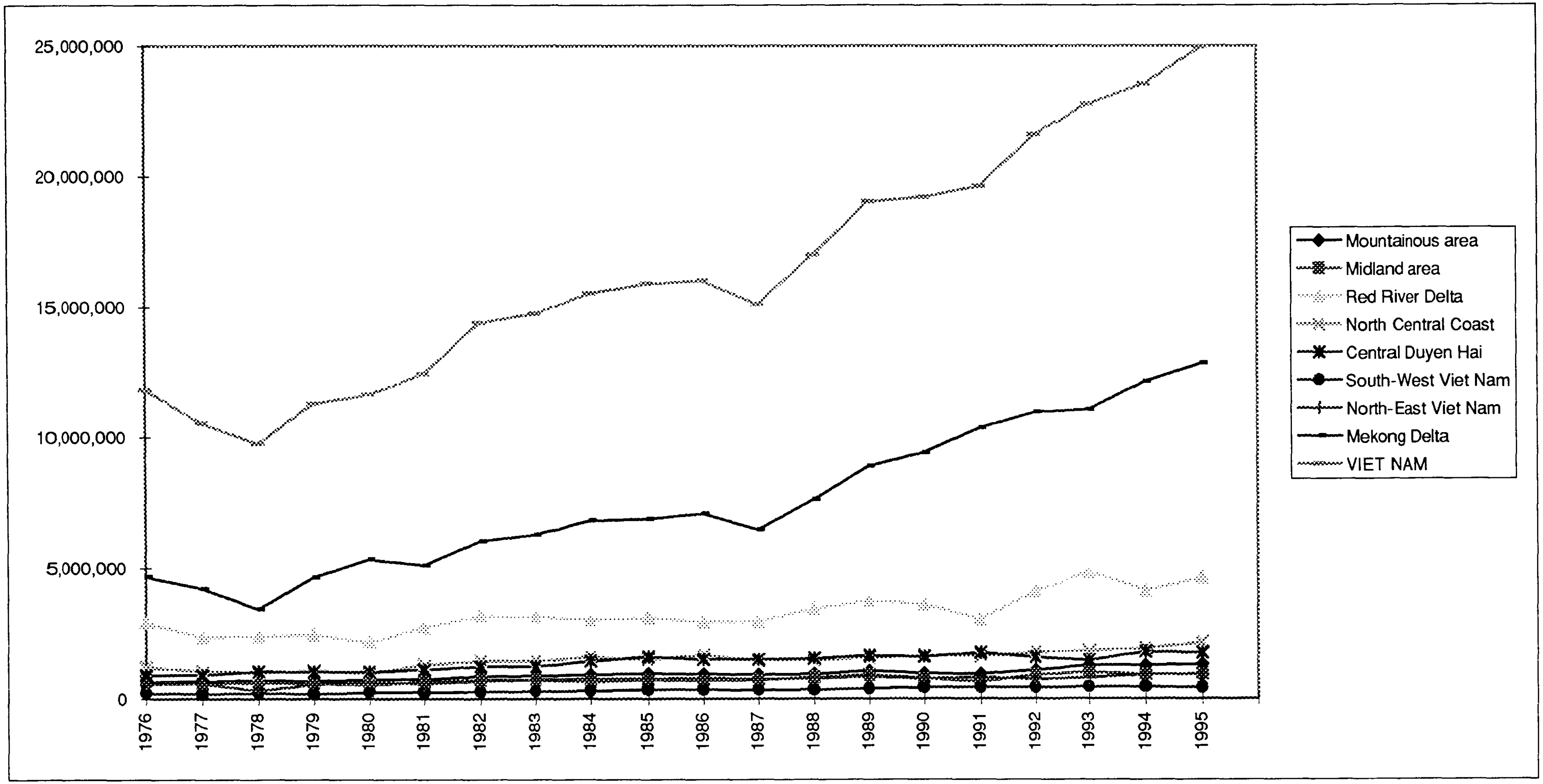
2.3.3 Rice yield

The average rice yield in 1976 was 2.00 tonnes per ha, increasing to 3.21 tonnes per ha in 1995 (see Table B3). Over the period 1976 to 1981 the average rice yield was only 1.9 tonnes per ha, but it increased to 2.8 tonnes per ha over the period 1987 to 1995. However, there are differences in rice yield between regions (see Table B3 and Figure 2.4).

2.4 Conclusion

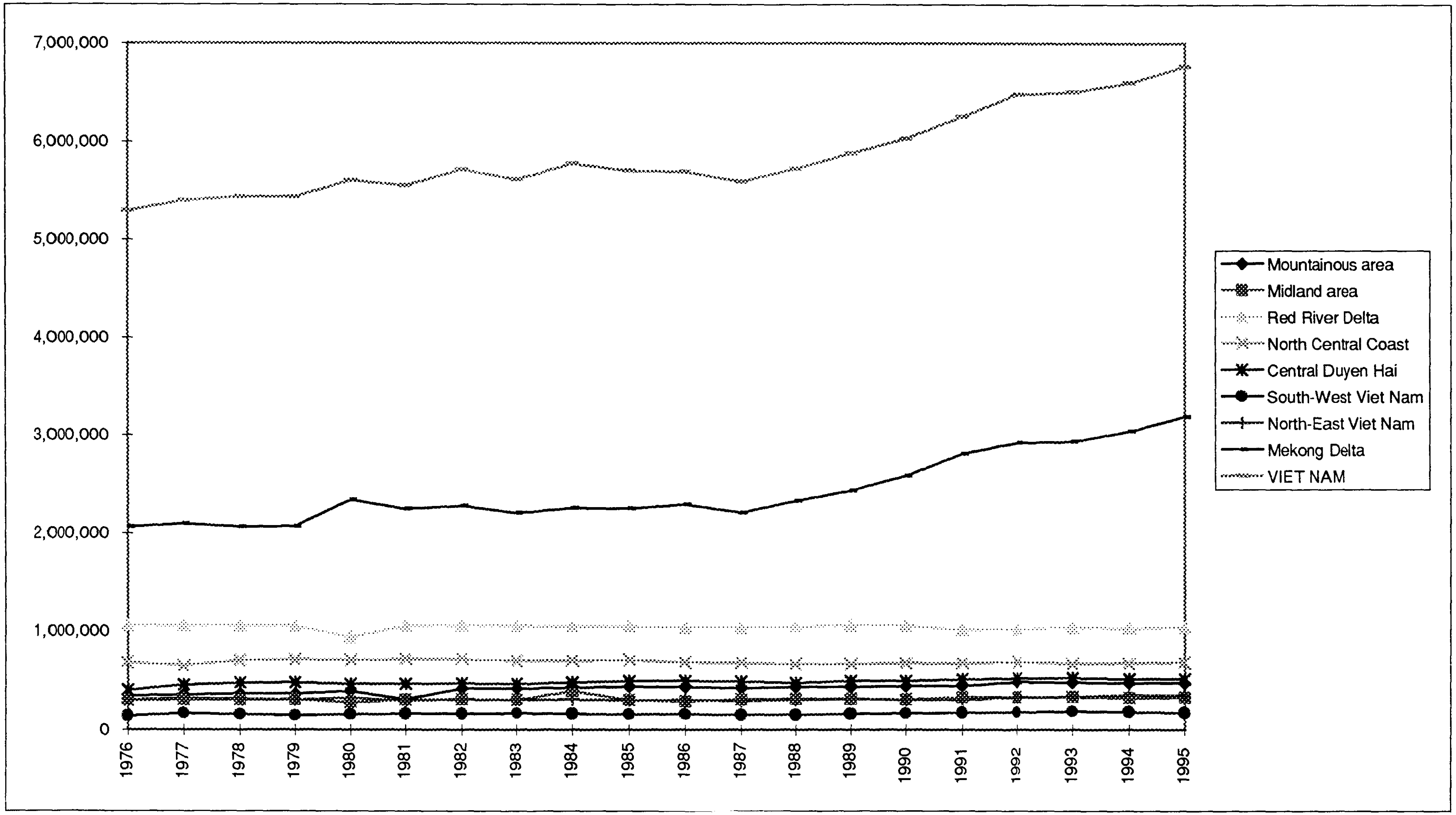
After the implementation of the economic renovation, agricultural production in Viet Nam has been changed. Since 1989, Viet Nam's agricultural sector has not only produced adequate food to feed 77 million people, but also has a surplus of over 1.7 mt of rice for export (Nguyen, 1995). The achievements suggest that entering the 90-th decade of this century, Vietnamese agriculture has come into a new era.

Figure 2.2: Production of Rice, Viet Nam and Regions, 1976-1995 (t)



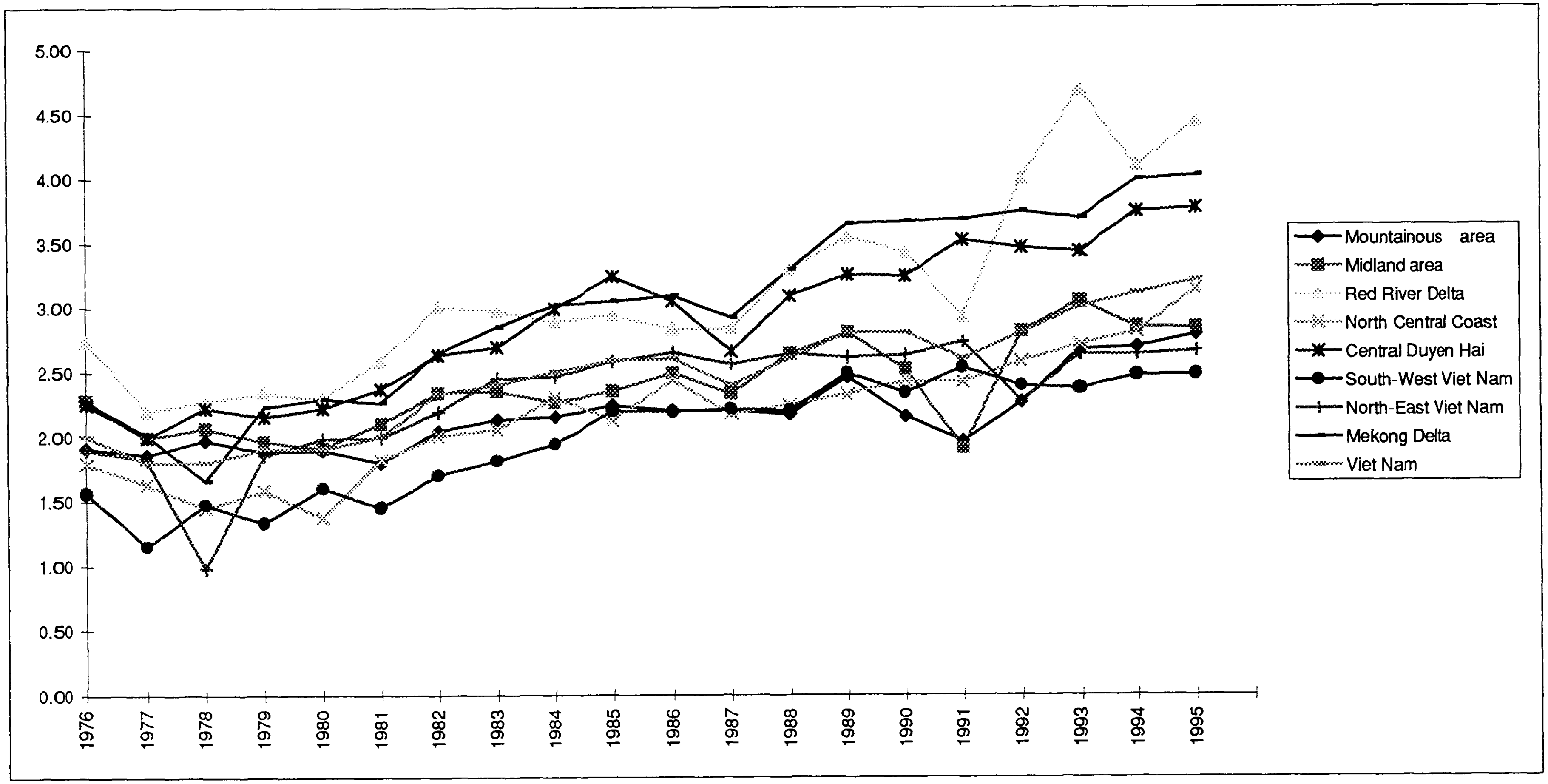
Source: Appendix B, Table B1.

Figure 2.3: Area Harvested of Rice, Viet Nam and Regions, 1976-1995 (ha)



Source: Based on Appendix B, Table B2.

Figure 2.4: Yield of Rice, Viet Nam and Regions, 1976-1995 (t/ha)



Source: Based on Appendix B, Table B3.

CHAPTER 3

LITERATURE REVIEW

3.1 Introduction

A number of studies measuring productivity are found in the literature. These studies include theoretical modelling and empirical applications in agriculture as well as in non-agricultural industries. This chapter is a review of literature relevant to the present work. Section 3.2 discusses concepts of productivity and technical change. Two fundamental approaches of technical measurements, namely, the productivity index approach and the production function approach, are discussed in section 3.3. Section 3.4 is a review of index numbers and TFP measurement using index numbers. Finally, agricultural applications using index numbers are discussed in section 3.5.

3.2 Productivity and Technical Change

The terms of productivity and efficiency have been used regularly in the media over the last ten years by a variety of commentators. They are often used interchangeably, which is unfortunate since they are not precisely the same. The terms, technical change and technological change, are often used interchangeably too. Some authors make the distinction that technological change refers to the act of producing new knowledge, whereas technical change is the incorporation of new knowledge in the production process. The concepts of productivity and technical change are closely related in empirical studies and theory, according to Peterson and Hayami (1977).

3.2.1 Definition of productivity

Productivity is a measure of the physical output produced from the use of a given quantity of inputs. Agricultural production uses a range of inputs including land, labour, capital and services. If the farm is not using its inputs as efficiently as possible, then there is scope to lower costs and increase profitability through productivity improvement.

Productivity improvements can be achieved in three ways. One avenue is to improve the state of the technology by inventing new production processes. A second way is to implement procedures such as better organisation of labour, so as to use the existing technology more efficiently. Third, scale economies may be exploited.

3.2.2 Forms of technical change

Technical change is a major source of increased output over time. When the production function shifts upward as a result of technical change, the supply function shifts to the right (increases). The supply function can shift further due to decreases in the price of inputs, which may also be caused by technical change. According to Buse and Bromley (1975), technical change is a dynamic concept which can take several forms.

- A change in efficiency of production inputs. This change may be neutral or non-neutral. Technical change is said to be neutral when the marginal rate of substitution (MRS) between inputs is not affected. Non-neutral technical change occurs when increases in efficiency differ among inputs, leading to disproportionate changes in the levels of inputs used for a given price.
- A change in the quality of inputs, often termed "embodied". For example, new and improved varieties of rice are less subject to attack by insects and disease.
- A change in the economies of scale. New technology may make it possible to realise economies of scale which were not achievable previously.
- A change in the elasticity of factor substitution, or the ease with which one factor is substituted for another.

It is easy to confuse technological change with factor substitutions which arise from changes in relative factor prices. In reality it is very difficult to separate the two, particularly as changing relative factor prices stimulate the search for new technologies. For example, increases in labour costs cause producers to shift to more capital-intensive production processes; this is the initial response to relative price changes; in the long run this shift has stimulated the search for new labour-saving technologies.

3.2.3 Effects of input growth, technological change and efficiency improvement on production growth

According to Fan (1991), in traditional productivity theory, total production growth consists of movements along the production function and shifts of the production function as suming that the farm is perfectly efficient in production. The growth rate of total factor productivity (TFP) is the growth rate of total output minus the growth rate of total input; hence, technological change is considered the unique source of productivity growth, and the effects of efficiency improvement on productivity growth are ignored. The assumption of perfect efficiency in production is unrealistic. Differences among farms between realised output and potential output are caused by differences in the capacity to use new technology and in the motivations of farmers. If this assumption is relaxed, total production growth can be attributed to efficiency improvement as well as to increased inputs and technological change. Different policy reform inferences may be drawn inasmuch as technological change and efficiency improvement represent fundamentally different sources of growth in production. We can use the following approach to capture all these effects on production growth.

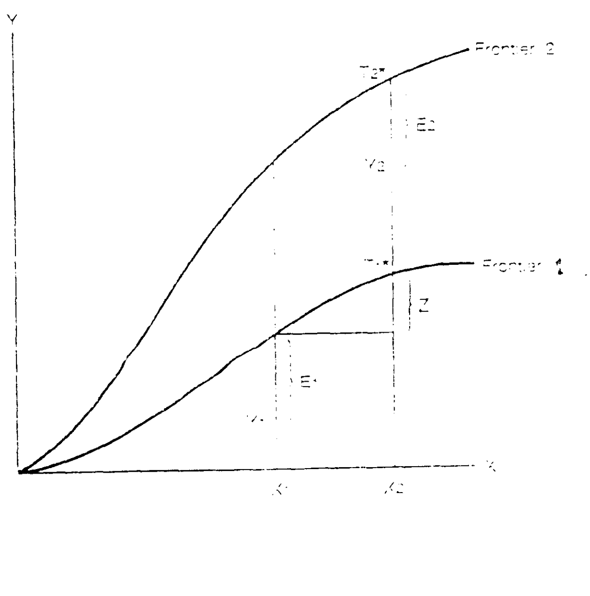


Figure 3.1: Effects on Production Growth of Input Increase, Technological Change and Efficiency Improvement

Source: Fan (1991).

Technological change is defined as a shift of the frontier production function. Efficiency improvement is defined as the decrease in the distance between the farm's realised output and its potential output. The different sources of production growth are shown in Figure 3.1. In time periods 1 and 2, the producer faces production frontiers 1 and 2, respectively. If production were perfectly efficient, output would be T*1 at time 1 and T*2 at time 2. However, the producer's realised output is Y1 at time 1 and Y2 at time 2 owing to production inefficiency. Technological change is measured by the distance between frontier 2 and frontier 1, i.e., T*2-T*1. Inefficiency is measured as the distance between the frontier and the output realised by the producer, i.e., E1 at time 1 and E2 at time 2. Hence, the improvement of efficiency over time is the difference between E1 and E2. The contribution of output change is measured as Z. Therefore, total production growth can be decomposed to three effects: input growth, technological change and efficiency improvement. It can be defined as:

$$Y2-Y1=Z+(T^*2-T^*1)+(E1-E2) \tag{3.1}$$

3.3 Measurement of Technical Change

Technical change generally is defined in terms of either a productivity index or a production function. According to Ruttan (1979), technical change means the production of a greater output with a given quantity of resources. In other words, technical change results in an increase in output per unit of input. He also views technical change in a production function context and defines it as a change in the parameters of the production function or the creation of a new production function. These two ways of defining technical change are entirely consistent with each other. A productivity index implies the existence of a production function and vice versa. The popular arithmetic productivity indexes such as the Laspeyres and Paasche type indexes imply an underlying linear arithmetic production function. Conversely, as Domar (1961) pointed out, a Cobb-Douglas production function is simply a geometric index of inputs, each weighted by its elasticity of production.

Technical change is also often labelled as the residual or unexplained portion of the output growth. As Abramovitz (1956) stated, technical change is a "measure of output ignorance". It is believed that the residual is largely due to the errors in the total input measures and that it can be reduced by adjusting for the input quality changes (Peterson and Hayami, 1977). Some prefer to define technical change as the enhancement of the stock of knowledge being applied in the production process (Yotopoulos and Nugent, 1976).

There are two principal methods of technical change measurement. They are the production function approach and the productivity index approach.

3.3.1 Production function approach

An approach to measuring technical change is to estimate all the parameters of the production function for different periods of time and compare them (Yotopoulos and Nugent, 1976). A similar method can be followed in cross-sectional analysis of the agricultural production function, when there are differences in the technical efficiency or structure of production function among homogeneous groups of cross-sectional units. In such a case, unbiased estimates can be obtained. The respective groups can be interpreted as an indicator of technical change (Peterson and Hayami, 1977). However, Griliches (1963) argued for the superiority of the production function approach to the conventional factors shares approach in accounting for the sources of economic growth. The reason for this was that to measure the part of change in output resulting from the level of a particular input, the latter should be weighted by the coefficient of the input in the production function. Because the agricultural sector has been in continuing disequilibrium, the weighting system based on factor shares would be incorrect for productivity comparison.

The production function approach can be estimated without making any assumptions about neutrality of technical change, returns to scale, or industry equilibrium. However, estimation of a production function with a flexible functional form such as the translog, and using aggregate data, required that the outputs be aggregated into a single index, so input-output separability must be assumed. For sufficient degree of freedom, and to mitigate the multicollinearity problem, it is necessary to aggregate input data into a small number of categories, which can be done only under an input separability assumption (Capalbo and Antle, 1988).

3.3.2 Productivity index approach

The most frequently used measures of productivity are the partial productivity indexes of labour or land and the total or multifactor productivity often labelled as the "residual", or the index of technical progress. The partial productivity measures provide some useful information with respect to a particular input. Partial productivity, however, is a biased measure of technological change, because it includes the effect of factor substitution together with the effect of advances in the production techniques (Peterson and Hayami, 1977). If there is some substitution going on between factor inputs, the partial productivity would vary, even without any change in the technology.

TFP is more meaningful since it takes account of factor intensity as well. TFP is defined as the ratio of the total output index to the index of all factor inputs. There is no conceptual problem about the definition of factor productivity.

However, there is disagreement regarding the indexation procedures used to aggregate heterogeneous output and inputs in measuring productivity growth. The major disagreement centres on the form of the production function on which the index procedure is based, and on the weighting scheme used for the aggregation. Index number calculation can be used when econometric methods are infeasible. There are no degree of freedom problems or statistical reliability problems in working with small samples.

3.4 Review of Index Numbers and Measurement Using Index Numbers

3.4.1 Index numbers

Index numbers have a long and distinguished history in economics, with some of the most important contributions due to Laspeyres and Paasche dating back to the late nineteenth century (Selvanathan and Rao, 1994). But it was the work of Irving Fisher and his book, the *Making of Index Numbers* published in 1922, that recognised the possibility of many statistical formulae to derive appropriate index numbers. Much of the work of Fisher falls under the atomistic approach to index numbers. The atomistic approach treats prices and quantity observations as independent and considers the index number construction as one of a statistical problem of measuring the central tendency. The suitability or preference for one formula over another competing formula is determined using the test approach, where each formula is examined to check if it satisfies a set of intuitive requirements postulated as tests. Time reversal, factor reversal and transitivity tests are some of the commonly used tests in this regard.

However, it has long been recognised that treating price and quantity observations as unrelated is untenable and goes against the grain of standard economic theory which postulates the existence of functional relation between prices, quantities and other economic variables. This has led to the alternative route of the functional approach introduced by Frisch (1936). It postulates and utilises the inter-relationships to form the foundations for the definition of a cost-of-living index and other index numbers used in measuring changes in the levels of output and productivity. The functional approach has had a long history, including the work of Konus in 1924. Since then, this approach has been enriched by the works of others, for instance, Samuelson, Franklin Fisher and Diewert. In particular, Diewert's work has formalised the derivation of various index number formulae using the functional approach. It was in his work the concepts of exact and superlative index numbers were introduced to describe the theoretical properties of various index number formulae.

The four most commonly used index number formulae are the Laspeyres, Paasche, Fisher and Tornqvist.

• **The Laspeyres index**

$$\text{Laspeyres index} = P^{l}_{st} = \frac{\sum_{i=1}^{N} P_{it} Q_{is}}{\sum_{i=1}^{N} P_{is} Q_{is}} = \sum_{i=1}^{N} \frac{P_{it}}{P_{is}} W_{is} \tag{3.2}$$

where $W_{is} = \frac{P_{is} Q_{is}}{\sum_{i}^{N} P_{is} Q_{is}}$ is the value share of i-th commodity in the base period s.

• The Paasche index

$$\text{Paasche index} = P_{st}^{P} = \frac{\sum_{i=1}^{N} P_{it} Q_{it}}{\sum_{i=1}^{N} P_{is} Q_{it}} = \frac{1}{\sum_{i}^{N} \frac{P_{is}}{P_{it}} W_{it}} \tag{3.3}$$

The Paasche index makes use of current period quantities Q_{it} and current value share weights.

• The Fisher index

The gap between the Laspeyres and Paasche indexes led Fisher to define a geometric mean of the two indexes as a possible index number formula:

$$\text{Fisher index} = P_{st}^{F} = \sqrt{P_{st}^{l} P_{st}^{P}} \tag{3.4}$$

• The Tornqvist index

Many TFP studies that have been conducted in the last decade are based on the TT index applied to output and input quantities. The Tornqvist index is a weighted average of the price relatives, with weights given by the simple average of the value share in periods s and t. The Tornqvist index is usually applied in its log-change form as follows:

$$\ln P_{st}^{TT} = \sum_{i=1}^{N} [\frac{W_{is} + W_{it}}{2}][\ln P_{it} - \ln P_{is}] \tag{3.5}$$

Though there are many more formulae of interest, we restrict ourselves to these above formulae.

3.4.2 TFP measurement using Tornqvist Index Numbers

• The CCD-TFP-binary comparisons

$$\ln \frac{TFP_t}{TFP_s} = \ln TFP_t - \ln TFP_s$$

$$=\frac{1}{2}\sum_{i=1}^{N}(W_{is}+W_{it})(\ln y_{it}-\ln y_{is})-\frac{1}{2}\sum_{j=1}^{K}(\gamma_{js}+\gamma_{jt})(\ln x_{jt}-\ln x_{js}) \qquad (3.6)$$

where:

Y and X represent output and input quantities, respectively;

W and γ represent value shares for outputs and inputs, respectively.

The formula in (2.6) is the most widely used form for TFP index calculations. It can be written as:

$$\ln\frac{TFP_t}{TFP_s}=\ln\frac{Tornqvist\ Output\ Index}{Tornqvist\ Input\ Index} \qquad (3.7)$$

The formulae (3.6) and (3.7) are applied for two time periods or regions, s and t (binary comparisons).

• Transitivity and multilateral-CCD TFP indexes

Routine application of the formula in (3.6) to multilateral comparisons involving more than two regions leads to the problem of transitivity. This problem is considered in the next chapter. The application of a binary TFP index formula yields inconsistent results. Following Caves, Christensen and Diewert (1982a), the TT index for multilateral comparisons is:

$$\ln(TFP_t^* / TFP_s^*)=\ln TFP_t^*-\ln TFP_s^* \qquad (3.8)$$

where:

TFP_t^* / TFP_s^* is a transitive TFP index.

3.5 Agricultural Application Using Index Numbers

The purpose of this brief section is to identify a few studies which illustrate the application of the productivity index approach to agriculture.

Lawrence and McKay (1980) examined inputs, outputs and productivity change in the Australian sheep industry. The Tornqvist quantity indexes of output and input were computed for the period 1952-77 from Australian Sheep Industry Survey data. TFP and partial productivity indexes show that while the ratio of capital employed per unit of labour has increased, materials, services and livestock have been the inputs for which the quantity used has increased most rapidly. On the output side, there has been a move towards greater diversification with both crop and cattle enterprises on "sheep properties" increasing in relative importance.

Ball (1984) calculated TFP for measuring productivity growth in U.S. agriculture over the postwar years. His estimates reflected (1) a disaggregated treatment of outputs and inputs and (2) indexing procedures that did not impose prior restrictions on the structure of production. He found that productivity grew at an average annual rate of 1.75 per cent during the 1948-79 period, compared with the 1.70 per cent estimated by the U.S. Department of Agriculture.

Cooke and Sundquist (1991) used Tornqvist input quantity indexes to derive total and partial productivity measures for U.S. cotton production across time, region and scale to find the causes of decline in U.S. cotton productivity growth. Five regions, three years and three size categories were chosen. All inputs were grouped into one of the six input categories of capital, labour, energy, fertiliser, material and land.

Ehui and Spencer (1993) used the approach based on the concept of interspatial and intertemporal TFP, paying particular attention to evaluation of natural resources stock and flows. Using a data set available at the International Institute of Tropical Agriculture, they computed TFP indexes for four cropping systems in south-west Nigeria using major soil nutrients as the natural resource stock. Results show that sustainability and economic viability measures are sensitive to changes in the material inputs and outputs.

It was found that there have been many applications of the productivity index approach to agriculture in developed countries such as USA, Canada and Australia. There are only a few applications to the agriculture of developing countries, such as Viet Nam.

3.6 Conclusion

Two fundamental approaches to the measurement of productivity and technical change, viz., the productivity index approach and the production function approach, were discussed. Different authors have different opinions about the superiority of one over the other. Both approaches have strengths and limitations. As a result, the choice between them is based on the research objectives, data requirements, availability of data and the appropriateness of assumptions. The reasons for choosing the productivity index number approach for the study are considered in the next chapter.

CHAPTER 4

METHODOLOGY

4.1 Introduction

This chapter is devoted to the method and analytical framework of the study. Multilateral Tornqvist index numbers are used in the context of productivity measurement. Multilateral Tornqvist index numbers are used to compare input, output and TFP of price and quantity changes over time, as well as to measure differences in the levels across eight rice-producing regions in Viet Nam. Since we are interested in output, input and TFP comparisons, the theoretical aspect of transitivity in multilateral comparisons and the choice of method are presented first in section 4.2. Section 4.3 describes the multilateral-Tornqvist (CCD) index formula which will be employed in the study for calculating input, output and TFP for the rice industry in Viet Nam over the period 1976-95. The method used to calculate trends is presented in section 4.4.

4.2 The Choice of Appropriate Index Number Method

The Tornqvist index

Since we are interested in output, input and TFP comparisons, first we give our notation. Let:

s,t represent two time points or regions;

p_{is}, p_{it} represent prices of the i-th output for observations s and t (i=1,2,...,N);

y_{is}, y_{it} represent quantities of the i-th output for observations s and t (i=1,2,...,N);

r_{js}, r_{jt} represent prices of the j-th input for observations s and t (j=1,2,...,K); and

x_{js}, x_{jt} represent quantities of the j-th input for observations s and t (j=1,2,...,K).

The Tornqvist-output index is specified as:

$$\ln TOT_{st} = \frac{1}{2}\sum_{i=1}^{N}(w_{is} + w_{it})(\ln y_{it} - \ln y_{is}) \tag{4.1}$$

where:

$\ln TOT_{st}$ represents the Tornqvist index;

$w_{it} = \frac{p_{it}y_{it}}{\sum p_{it}y_{it}}$ *and* $w_{is} = \frac{p_{is}y_{is}}{\sum p_{is}y_{is}}$ are the value shares of the i-th output in periods s and t.

and all other notation is as defined earlier.

Diewert (1976) established that the Tornqvist index is superlative by showing that it is exact for the homogeneous translog aggregation function (Christensen, Jorgensen and Lau, 1971, 1973), a flexible functional form which has been widely used in recent empirical economic research.

The Tornqvist index is quite flexible as it is based on a homogeneous translog production function which provides a second order approximation to an arbitrary production function at any given point (Christensen, Jorgensen and Lau, 1973). It can precisely reflect an arbitrary set of substitution possibilities at any given feasible point. Furthermore, the Tornqvist index is approximately consistent in aggregation, i.e., an overall Tornqvist index of Tornqvist indexes of sub-aggregate groups is approximately equal to a Tornqvist index of all the basic components within those sub-aggregate groups (Diewert, 1976). However, the index is essentially a binary index involving a comparison of two sets of quantities. Despite its elegant properties, this index has not played any significant role in the context of interregional comparisons mainly because it fails to satisfy the transitivity requirement when applied in the context of multilateral comparisons.

Transitivity

We are interested in input, output and productivity level comparison across a number of rice-producing regions in Viet Nam (there are eight regions). Thus, we are typically interested in all pairs of comparisons. For a pair of regions (s,t), let I_{st} (s,t = 1,2,...,M) represent the required index (where M=8). Then we have a matrix of comparisons among all pairs of regions

$$\begin{bmatrix} I_{11} & I_{12} \cdots\cdots I_{1M} \\ I_{21} & I_{22} \cdots\cdots I_{2M} \\ \\ I_{M1} & I_{M2} \cdots\cdots I_{MM} \\ \\ \end{bmatrix}$$

This matrix represents all multilateral comparisons involving 8 regions and ideally we would like these comparisons to be consistent, i.e., to satisfy the property of transitivity. Internal consistency requires that a direct comparison between any two regions s and t should be the same as a possible indirect comparison between s and t through a third region r. For example, if a set of index numbers suggest that region s produces 10 per cent more than region r and region r produces 20 per cent more than region t, then we should find that region s produces 32 per cent more than region t (i.e., $1.1\times1.2=1.32$). Unfortunately, none of the above four index numbers formulae, including Fisher and Theil-Tornqvist, satisfies the property of consistency.

4.3 Multilateral-Tornqvist (CCD) Index Number Formula

As noted above, when the Tornqvist index in (4.1) is applied to multilateral comparisons involving more than two regions, we encounter the problem of lack of transitivity. Caves, Christensen and Diewert (CCD) (1982a) suggest a simple average procedure that leads to modified Tornqvist indexes that are consistent. The CCD procedure can be aptly described as a two-step procedure when the first step involves the computation of the binary Tornqvist indexes and the second step involves the modification suggested by CCD based on a simple unweighted geometric mean (Selvanathan and Rao, 1991). The CCD multilateral indexes can apply to cross-section data, time series data and panel data. The attractions of the multilateral method are quite clear in the case of cross-section data.

4.3.1 Multilateral-Tornqvist (CCD) output index

Caves, Christensen and Diewert (1982b) define the output of one region relative to the output of all other regions as the geometric mean of the bilateral output comparisons between this region and each of the regions. As a result, the multilateral-Tornqvist (CCD) output index (MTOI) between observations s and t is defined as:

$$\ln MTOI_{st} = [\frac{1}{2}\sum_{i=1}^{N}(w_{it}+\overline{w_i})(\ln y_{it}-\overline{\ln y_i})-\frac{1}{2}\sum_{i=1}^{N}(w_{is}+\overline{w_i})(\ln y_{is}-\overline{\ln y_i}\,] \tag{4.2}$$

where:

$\ln MTOI_{st}$ represents a multilateral-Tornqvist (CCD) output index;

$\overline{w_i}=\frac{1}{M}\sum_{t=1}^{M} w_{it}$;

$\overline{\ln y_i}=\frac{1}{M}\sum_{t=1}^{M}\ln y_{it}$; and

M is the total number of observations (regions and years).

4.3.2 Multilateral-Tornqvist (CCD) input index

Proceeding as above we obtain the multilateral-Tornqvist (CCD) input index (MTII) as:

$$\ln MTII_{st} = [\frac{1}{2}\sum_{j=1}^{K}(\Upsilon_{jt}+\overline{\Upsilon_j})(\ln x_{jt}-\overline{\ln x_j})-\frac{1}{2}\sum_{j=1}^{K}(\Upsilon_{js}+\overline{\Upsilon_j})(\ln x_{js}-\overline{\ln x_j})\,] \tag{4.3}$$

where:

$\ln MTII_{st}$ represents a multilateral-Tornqvist (CCD) input index;

$\ln x_j = \frac{1}{M}\sum_{t=1}^{M}\ln x_{jt}$; and

$\overline{\gamma}_j = \frac{1}{M}\sum_{t=1}^{M}\gamma_{jt}$.

4.3.3 Multilateral-Tornqvist (CCD) TFP index

The TFP index is formed as the ratio of the output and input indexes. Thus, the multilateral-Tornqvist (CCD) TFP index (MTTFPI) is:

$$
\begin{aligned}
\ln MTTFPI_{st} =& [\frac{1}{2}\sum_{i=1}^{N}(w_{it}+\overline{w_i})(\ln y_{it}-\overline{\ln y_i}) - \frac{1}{2}\sum_{i=1}^{N}(w_{is}+\overline{w_i})(\ln y_{is}-\overline{\ln y_i}]\\
&-[\frac{1}{2}\sum_{J=1}^{K}(\gamma_{jt}+\overline{\gamma}_j)(\ln x_{jt}-\overline{\ln x_j}) - \frac{1}{2}\sum_{j=1}^{K}(\gamma_{js}+\overline{\gamma}_j)(\ln x_{js}-\overline{\ln x_j})]
\end{aligned}
\tag{4.4}
$$

where:

$\ln MTTFPI_{st}$ represents the TFP index, and all other notation is as defined earlier.

The rice industry in Viet Nam consists of eight rice-producing regions. In this study we utilise 20 years of annual observations. Hence the total number of observations is $8\times20=160$ (M=160). This study used five inputs (K=5) and a single output (rice) (N=1). To calculate output, input and TFP indexes, we use region 1 (Mountainous Area) in 1976 as a base. Details about the 20 years of price and quantity data on inputs and output can be seen in Chapter 5.

All calculations in the study are conducted by using DO LOOPS in the SHAZAM Econometrics Package (White, 1993).

Assumptions

Caves, Christensen and Diewert (1982b) discuss the economic theory behind the Tornqvist TFP index. They observe that it assumes constant returns to scale and that it assumes that there is no technical or allocative inefficiency. This implies optimising behaviour involving revenue maximisation and cost minimisation. These assumptions can obviously be questioned in the case of Vietnamese rice farming, where plot sizes are quite small and central planning may interfere with optimal behaviour. In this study we note these possible problems and suggest that in any future analysis of these data the frontier production function methods discussed in Coelli (1995) should be investigated since these methods do not rely upon the above-mentioned assumptions.

4.4 Measurement of Trends

The annual percentage changes in input, output and TFP are measured by fitting the following logarithmic trend line by regression:

$$\ln Y_t = a + b_t + e_t \tag{4.5}$$

where:

Y_t is the variable (index number series) being considered;

t is a linear time trend;

a and b are constants to be estimated; and

e_t is an error term.

4.5 Conclusion

The problem to which multilateral comparative techniques have most often been applied is that of multi-country (multi-regional) output comparisons. Indexes such as the multilateral Tornqvist (CCD) indexes can be used for time series as well as cross-sectional comparisons and for comparisons of time series/cross-sectional data. Multilateral Tornqvist (CCD) indexes are a suitable method for the present case, in which we examine and compare TFP in the rice industry between eight regions over the period from 1976 to 1995.

CHAPTER 5

DATA

5.1 Introduction

In the previous chapter, the multilateral-Tornqvist (CCD) index numbers were discussed and chosen to specify quantity and price indexes of output and inputs, as well as total factor productivity (TFP) indexes for the rice industry in eight rice-producing regions of Viet Nam over the period from 1976 to 1995. Index numbers were used to measure price and quantity changes over time and differences in the level across the regions. In this section, the data requirements, measurement of variables and sources of data are described. Some issues related to data collection in agriculture in Viet Nam are then discussed.

5.2 Data Requirements and Sources

In order to estimate the multilateral-Tornqvist-CCD indexes of output, input and TFP (see equations 4.2, 4.3 and 4.4) for the rice industry in Viet Nam, there must be available time series and cross-sectional data of quantity and price of inputs and output. Output in the study is rice. Inputs consist of seed, chemical fertilisers, human labour, pesticide and animal services (all data are listed in Appendix A). Apart from the five inputs included, there are still other inputs excluded because of lack of data such as organic fertiliser, irrigation for rice cultivation. However, these missing inputs are believed to form a relatively minor proportion of total inputs.

Data were available taken from series published by the General Statistic Office (GSO), the Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) for the years 1976 to 1995 of eight rice-producing regions in Viet Nam (160 observations in total).

The starting year of 1976 was chosen because official data on agriculture, especially on rice production for both northern and southern Viet Nam were available from this point on. Prior to 1976 data pertained only to northern rice-production regions.

In terms of consistency of the series of data, there was no inconsistency in the measurement of available data in publications between the two above-mentioned publishing organisations. There were only small differences in measurement of rice output data. In the sources published by GSO, rice output data were measured in 100 kg/ha, whereas rice output data in sources of CGPRT Centre were measured in tonnes per hectare (t/ha). The conversion had to be made.

Data on output quantities and input quantities from 1976 to 1990 were taken from the *CGPRT Crops in Viet Nam* (CGPRT Centre, 1993). The data for the remaining period from 1990 to 1995 were taken from *Statistical Data of Viet Nam's Agriculture in Years 1950-1990* (GSO, 1992) and *Statistical Data of Viet Nam's Agriculture, Forestry and Fishery, 1985-1995* (GSO, 1996).

Time-series regional data of quantities of output and inputs have been published, but this has not been the case for prices of both output and inputs. However, there were available data for values of output and inputs, so price data were obtained by simply dividing the values by the quantities to obtain implicit prices.

5.3 Measurement of Variables

As noted above, the rice industry in eight regions is assumed to produce one output (rice) using five broad input types. In some cases, direct measures of the costs and quantities of these variables are available. In other cases, only cost information is available. For such cases, the implicit variables had to be calculated. The output and inputs used are as follows:

- Output variable:

  Rice output per hectare (t/ha).

- Input variables:

  Seed quantities used per hectare (kg/ha)

Fertiliser (N, P, K) used per hectare (kg/ha)

Human labour (labour-days worked) per hectare (d/ha)

Pesticide used per hectare (kg/ha)

Animal services (hours/ha).

5.3.1 Output quantities

The physical quantity of rice production measured in tonnes is annually reported to the General Statistical Office in Hanoi. Both the output quantities and yield (t/ha) of rice production are compiled at provincial, regional and national levels. Since the study aims to calculate input, output and TFP indexes in the rice industry, the yields of rice production for each region from 1976 to 1995 were used to find the output quantity indexes. The output variables were extracted directly from CGPRT Centre (1993) and GSO (1996) (see Appendix A).

5.3.2 Input quantities and input prices

Seed input quantities were measured in quantity used per hectare (kg/ha). As with the seed input quantities, the input quantities of pesticide were measured in quantity used per hectare (kg/ha). The data on input quantities of seed and pesticide for rice production in each region were obtained from CGPRT Centre (1993) and GSO (1996).

Labour input data were measured in labour-days worked per hectare (one labour-day worked equals 8 working hours). All operations related to rice production, from land preparation to rice harvesting and storing, were included here. The number of part-time employees was converted to a full-time equivalent measure then aggregated into one measure as labour-days per hectare. Those data for all eight rice-producing regions were taken from CGPRT Centre (1993) and GSO (1996) (see Appendix A).

Chemical fertiliser input was measured as the total nutrients of nitrogen (N), phosphorus (P) and potassium (K) used in each year for each region. The data on these inputs were obtained from CGPRT Centre (1993) and GSO (1996). Since there was a lack of data on input quantities of fertiliser K and P for region number 7 (North-East Vietnam), it was excluded from this study.

Animal services were measured in hours worked by animals per hectare. Data were collected for each province and each region from GSO (1992, 1996) and Annual Reports and other supplementary sources (see Appendix A).

The index formulae require both a quantity and a price for each output and input. However, it was not possible to derive a measure of price for each of them, due to a lack of agricultural survey data in Viet Nam. Under these circumstances, input prices were derived by dividing the input costs by input quantities.

A summary of mean, minimum and maximum of quantities and prices of inputs and outputs for each region is given in Tables 5.1 to 5.8.

5.4 Some Issues Related to Agricultural Data Collection in Viet Nam

The analysis covers the period from 1976 to 1995, following the unification of North and South Viet Nam. Prior to 1976, official data on agriculture pertained only to North Viet Nam. No agricultural census has yet been conducted and nowhere has there been any systematic and nationwide agricultural sampling survey. All agricultural data have been compiled by the General Statistical Office through its district officers, and are based on either administrative records or subjective estimates. Data on seed did not account for the availability of seed from other sources at the local level; it covered annual sales alone. Data on chemical fertilisers and pesticides were simply the record of sales by district statistical officers. Many indicators commonly used in the analysis and evaluation of agricultural performance are not available. For example, data on landless labourers and land ownership are not applicable because, in principle, all land is state-owned and there are no landless farmers. Data on prices also reflect the nature of the economic system. Farm-gate and wholesale prices were similar until 1986 because of the food subsidy system. Since the implementation of more market-oriented policies in 1987, these prices have started to diverge.

Despite data limitations, the study attempts to measure productivity changes and analyse sources of productivity growth in the rice industry in Viet Nam.

Table 5.1

Mean, Minimum, Maximum of Output Quantity, Input Quantities and Input Prices for Region 1 (Mountainous Area), 1976-95

	Mean	Minimum	Maximum
Output quantity (t/ha)	2.17	1.80	2.79
Input quantities (kg/ha)			
Seed	126.40	120.00	130.00
Fertiliser N	70.90	59.00	77.00
Fertiliser P	29.94	28.80	31.20
Fertiliser K	33.82	30.80	35.84
Pesticide	1.37	0.26	4.20
Labour (labour-day worked)	375.40	360.00	388.00
Animal services (hours)	285.00	222.00	343.00
Input prices (dong/ha)			
Seed	266.35	0.36	795.60
Fertiliser N	512.52	1.12	1399.00
Fertiliser P	477.00	1.18	1253.20
Fertiliser K	256.55	0.64	714.80
Labour	417.22	0.70	1252.00
Pesticide	7142.24	0.70	22899.00
Animal services	8.45	0.02	24.40

Sources: Based on Appendix A, Tables A1-A14.

Table 5.2

Mean, Minimum, Maximum of Output Quantity, Input Quantities and Input Prices for Region 2 (Midland Area), 1976-95

	Mean	Minimum	Maximum
Output quantity (t/ha)	2.39	1.91	3.05
Input quantities (kg/ha)			
Seed	134.55	125.00	145.00
Fertiliser N	72.71	69.00	76.82
Fertiliser P	86.18	82.80	89.70
Fertiliser K	46.96	44.80	48.16
Pesticide	1.43	0.32	4.30
Labour (labour-day worked)	389.35	300.00	480.00
Animal services (hours)	293.00	228.00	353.00
Input prices (dong/ha)			
Seed	261.94	0.36	786.24
Fertiliser N	660.68	1.08	1861.50
Fertiliser P	165.26	0.41	439.00
Fertiliser K	256.40	0.64	714.50
Labour	433.56	0.69	1253.90
Pesticide	6997.08	1.99	25444.00
Animal services	9.03	0.02	25.98

Sources: Based on Appendix A, Tables A1-A14.

Table 5.3

Mean, Minimum, Maximum of Output Quantity, Input Quantities and Input Prices for Region 3 (Red River Delta), 1976-95

	Mean	Minimum	Maximum
Output quantity (t/ha)	3.11	2.20	4.60
Input quantities (kg/ha)			
Seed	134.95	125.00	150.00
Fertiliser N	79.43	73.60	84.00
Fertiliser P	98.27	82.80	96.60
Fertiliser K	33.78	28.00	35.80
Pesticide	1.67	0.33	4.00
Labour (labour-day worked)	387.85	350.00	420.00
Animal services (hours)	293.30	229.00	354.00
Input prices (dong/ha)			
Seed	244.88	0.36	736.00
Fertiliser N	819.46	1.13	2392.60
Fertiliser P	166.78	0.41	438.00
Fertiliser K	256.63	0.64	715.50
Labour	522.91	0.70	1525.00
Pesticide	8208.88	1.99	25444.00
Animal services	11.08	0.02	32.6

Sources: Based on Appendix A, Tables A1-A14.

Table 5.4

Mean, Minimum, Maximum of Output Quantity, Input Quantities and Input Prices for Region 4 (North Central Coast), 1976-95

	Mean	Minimum	Maximum
Output quantity (t/ha)	2.18	1.30	3.14
Input quantities (kg/ha)			
Seed	128.90	125.00	140.00
Fertiliser N	78.01	73.60	83.10
Fertiliser P	87.47	82.80	92.00
Fertiliser K	46.97	44.80	48.30
Pesticide	1.27	0.21	3.90
Labour (labour-day worked)	397.55	375.00	420.00
Animal services (hours)	239.20	229.00	354.00
Input prices (dong/ha)			
Seed	242.71	0.36	722.50
Fertiliser N	819.71	1.03	2393.80
Fertiliser P	166.75	0.41	438.00
Fertiliser K	256.58	0.64	714.90
Labour	514.78	0.72	1525.00
Pesticide	6475.04	1.90	24807.00
Animal services	12.18	0.02	35.95

Sources: Based on Appendix A, Tables A1-A14.

Table 5.5

Mean, Minimum, Maximum of Output Quantity, Input Quantities and Input Prices for Region 5 (Central Duyen Hai), 1976-95

	Mean	Minimum	Maximum
Output quantity (t/ha)	2.80	1.99	3.45
Input quantities (kg/ha)			
Seed	156.55	145.00	170.00
Fertiliser N	82.56	78.20	82.00
Fertiliser P	92.17	87.40	98.90
Fertiliser K	32.22	28.00	39.20
Pesticide	1.41	0.23	4.80
Labour (labour-day worked)	396.90	370.00	420.00
Animal services (hours)	295.90	229.00	355.00
Input prices (dong/ha)			
Seed	228.49	0.55	710.50
Fertiliser N	819.49	1.13	2392.90
Fertiliser P	231.97	0.41	657.00
Fertiliser K	256.54	0.64	714.70
Labour	672.13	1.00	2015.00
Pesticide	7386.69	1.57	30532.00
Animal services	13.57	0.02	40.50

Sources: Based on Appendix A, Tables A1-A14.

Table 5.6

Mean, Minimum, Maximum of Output Quantity, Input Quantities and Input Prices for Region 6 (South West Viet Nam), 1976-95

	Mean	Minimum	Maximum
Output quantity (t/ha)	1.99	1.15	2.53
Input quantities (kg/ha)			
Seed	126.05	120.00	130.00
Fertiliser N	79.20	70.50	85.10
Fertiliser P	55.75	36.00	82.80
Fertiliser K	21.79	16.80	25.50
Pesticide	1.65	0.30	5.10
Labour (labour-day worked)	301.45	285.00	320.00
Animal services (hours)	292.60	228.00	352.00
Input prices (dong/ha)			
Seed	260.75	0.60	788.30
Fertiliser N	814.92	1.06	2392.50
Fertiliser P	232.19	0.41	655.00
Fertiliser K	237.69	0.46	714.00
Labour	474.63	0.90	1516.00
Pesticide	8547.06	1.99	32441.00
Animal services	12.05	0.02	35.2

Sources: Based on Appendix A, Tables A1-A14.

Table 5.7

Mean, Minimum, Maximum of Output Quantity, Input Quantities and Input Prices for Region 7 (North East Viet Nam), 1976-95

	Mean	Minimum	Maximum
Output quantity (t/ha)	2.36	1.82	2.73
Input quantities (kg/ha)			
Seed	116.55	100.00	129.00
Fertiliser N	88.56	77.00	94.30
Fertiliser P	1.00	1.00	1.00
Fertiliser K	30.66	22.40	34.00
Pesticide	1.81	0.33	6.60
Labour (labour-day worked)	198.25	180.00	210.00
Animal services (hours)	295.20	230.00	355.00
Input prices (dong/ha)			
Seed	240.22	0.51	726.00
Fertiliser N	815.55	1.13	2395.00
Fertiliser P	1.00	1.00	1.00
Fertiliser K	256.12	0.64	714.80
Labour	932.62	1.71	2750.00
Pesticide	9017.05	1.99	31982.00
Animal services	12.63	0.02	37.7

Sources: Based on Appendix A, Tables A1-A14.

Table 5.8

Mean, Minimum, Maximum of Output Quantity, Input Quantities and Input Prices for Region 8 (Mekong Delta), 1976-95

	Mean	Minimum	Maximum
Output quantity (t/ha)	3.00	1.66	4.02
Input quantities (kg/ha)			
Seed	232.15	195.00	700.00
Fertiliser N	83.47	71.30	101.00
Fertiliser P	61.06	59.80	64.40
Fertiliser K	23.63	16.00	28.00
Pesticide	1.88	0.33	5.50
Labour (labour-day worked)	81.57	50.00	90.00
Animal services (hours)	281.30	220.00	340.00
Input prices (dong/ha)			
Seed	188.18	0.38	565.00
Fertiliser N	735.99	1.13	2175.00
Fertiliser P	1046.10	2.00	3046.00
Fertiliser K	282.49	0.64	839.90
Labour	1685.1	3.20	5050.00
Pesticide	9607.89	1.99	34985.00
Animal services	14.39	0.03	50.30

Sources: Based on Appendix A, Tables A1-A14.

CHAPTER 6

RESULTS AND DISCUSSION

6.1 Introduction

Indexes of output and input quantities were computed for eight rice-producing regions in Viet Nam for the period from 1976-77 to 1994-95. The multilateral Tornqvist (CCD) index number formula was chosen to compute TFP indexes and then all indexes were regressed upon time trends to find average annual growth rates of output, input and TFP. In this chapter, empirical results are presented and discussed. Sections 6.2, 6.3 and 6.4 present the output quantity indexes, input quantity indexes and TFP indexes, respectively, over time and across regions. Average annual growth rates of output, input, and TFP are also presented in these sections. The relative contributions of input growth and TFP growth to rice output growth are provided in section 6.5. Discussions of the impact of agricultural reforms on rice productivity as well as factors causing the differences in rice productivity are considered in section 6.6.

6.2 Output Quantity Indexes

Figure 6.1 and Table 6.1 present changes of output indexes and average annual growth rate of output in eight rice-producing regions in Viet Nam from 1976 to 1995.

In this study, a single output measure (rice) is compared with an aggregate index of all inputs. It should also be noted that all quantity indexes are presented on a per hectare basis.

It can be seen from Table 6.1 that growth output of rice (per hectare) in the rice industry in Viet Nam increased over time. For the whole study period the average annual growth rate was 2.32 per cent per annum.

Table 6.1

Average Annual Rate of Rice Output Growth, 1976-95 (%)

	Reg1	Reg2	Reg3	Reg4	Reg5	Reg6	Reg7	Reg8	VN
1976-81	-0.80	-0.70	-0.23	-0.38	1.50	1.46	0.74	0.74	0.48
1981-87	1.45	0.60	4.60	0.97	0.70	2.30	1.27	3.60	2.32
1987-95	2.10	1.68	4.75	4.04	3.80	3.07	3.32	5.05	4.12
1976-95	0.92	0.52	3.04	1.79	1.99	2.94	2.31	3.12	2.32

Note:

R1 is Mountainous Area **R2** is Midland Area **R3** is Red River Delta **R4** is North Central Coast
R5 is Central Duyen Hai **R6** is South-West Viet Nam **R7** is North-East Viet Nam **R8** is Mekong Delta

Sources: Based on Appendix C, Tables C1-C8.

Temporal differences in growth rate of rice production

The pattern of growth rate in rice production in Viet Nam follows the pattern of growth rate in agricultural production in Viet Nam generally. Many factors influence the growth rate of rice output, including use of inputs (seed, fertiliser, pesticide), area under rice cultivation, proportion of rice-cultivation area under irrigation, and farmer's experience in rice farming, and especially agricultural reform. This last factor is one of the most influential in the productivity of the rice industry.

It can be seen from Table 6.1 that the average annual growth rate of rice production in Viet Nam in the period 1976-81 was only 0.48 per cent per year. It increased to 2.3 per cent in the second sub-period (1981-87) and to 4.12 per cent per annum in the period of the second agricultural reform (1987-95).

It can be observed that the growth rate of Vietnamese rice output in the reform period from 1981 to 1995 was significantly higher than in the pre-agricultural reform period (1976-1981). In the mid-1970s, even though cultivated land area planted to rice began to decline, crop area showed a positive growth rate as cropping intensity increased due to the expansion of irrigation and adoption of shorter-growth-duration varieties (Nguyen, 1995).

It was estimated that approximately 57 per cent of the rice area was irrigated and about 60 per cent of this area received assured water. There may be up to 500,000 ha under upland farming and approximately 34 per cent of the total rice area that is either deep flooded or under floating rice. Thus, about 25 per cent of the total rice area is under assured irrigation, 32 per cent under partial irrigation and the rest either drought or flood prone (FAO, 1994).

As can be seen from Table B3, growth rates of yields also were much higher during the reform periods. It is now quite common to obtain 10 t/ha/2 crops and in some cases up to 21 t/ha/3 crops under irrigation, as a result of improved practices. Relative contributions of yields to growth in output were higher in the early 1980s; it could be that the institutional reforms increased work efforts and adoption of the high-yielding modern seed and fertiliser technology.

In the late 1980s, the relative contribution of increased cropping intensity to rice output was significant, because market reforms provided greater provincial revenues which were invested in irrigation and development and dissemination of shorter-growth-duration varieties (FAO, 1994).

Regional differences in rice output growth rate

Rice is produced across eight regions in Viet Nam. However, rice production is concentrated in the two biggest river deltas, the Red River Delta in the north and the Mekong River Delta in the south.

It is clear from Table 6.1 that there were differences in the output growth rates of rice between regions. Among the four rice-producing regions in the north, the Red River Delta has the highest output growth rate with 3.04 per cent per year. In the south, the highest output growth rate of rice production belongs to the Mekong Delta at 3.12 per cent per annum over the study period. Approximately 40 per cent of the rice-cultivated area was in the Mekong Delta, which also had the highest per hectare yield and produced more than 50 per cent of the rice produced in Viet Nam.

From Table 6.1 it can be seen also that, over the study period, rates of growth of output in four rice-producing regions of the north (Mountainous Area, Midland Area, Red River Delta and North Central Coast) were, on average, smaller than those in the southern rice-production regions. For example, the average annual rates of rice growth in the four northern regions were 0.92 per cent, 0.52 per cent, 3.04 per cent and 1.79 per cent per annum, respectively, while the rates of rice output growth in the southern regions (Central Duyen Hai, South-West, North-East and Mekong Delta) were 1.99 per cent, 2.94 per cent, 2.31 per cent and 3.12 per cent per annum, respectively. In particular, in the period from 1976 to 1981 there was no output growth in any of the four regions of the north (see Table 6.1).

Growth rates of rice output in southern regions were also higher than in the northern regions both before and after the reform period on average. Northern Viet Nam is more densely populated with smaller farm size than southern Viet Nam. Southern Viet Nam, especially the Mekong Delta, has a greater potential for expanding irrigation. This is partly due to the higher rate of growth in yield because of better water control, higher adoption of high-yielding modern varieties, increased use of fertilisers and increased area planted in the dry season when yields are higher (FAO, 1994).

It should be emphasised that the output growth rate of rice in the mountainous regions of the north was lower in comparison with that in the delta regions. For example, region 1 (Mountainous Area) and region 2 (Midland Area) had output growth rates of just 0.91 per cent and 0.19 per cent per annum, respectively (see Table 6.1). These regions have unsuitable conditions for rice production due to the poor quality of soil, lower rainfall rate, and backward practices in rice cultivation (FAO, 1994).

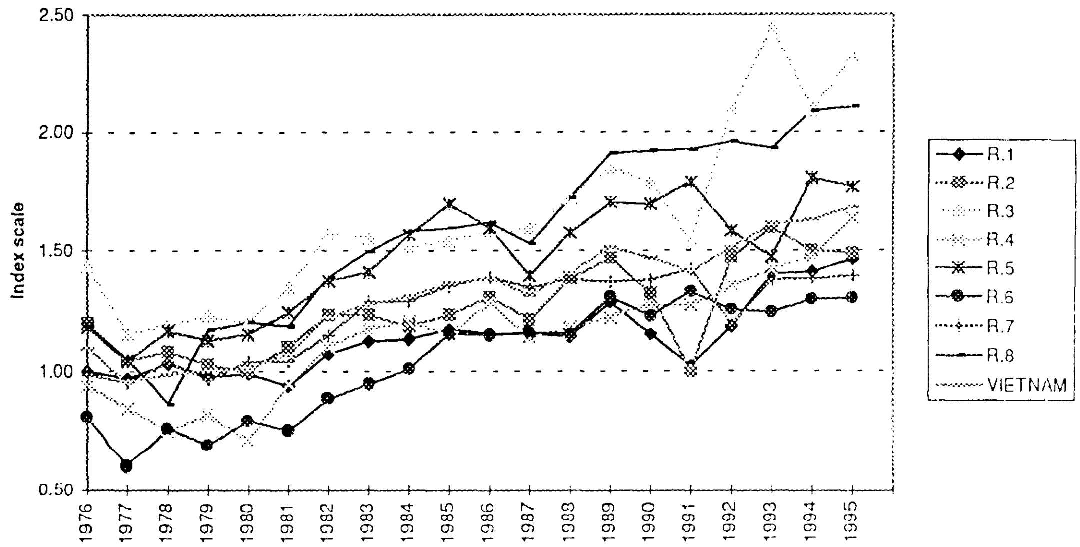
Regional differences in level of output quantity

Figure 6.1 presents the multilateral output indexes for eight rice-producing regions in Viet Nam over the study period. It can be seen that region 3 (Red River Delta), region 5

(Central Duyen Hai) and region 8 (Mekong Delta) had output indexes higher than 1.7 in 1995.

Figure 6.1

Output Indexes for the Rice Industry in Viet Nam, 1976-95



Note:

R1 is Mountainous Area **R2** is Midland Area **R3** is Red River Delta **R4** is North Central Coast
R5 is Central Duyen Hai **R6** is South-West Viet Nam **R7** is North-East Viet Nam **R8** is Mekong Delta

Sources: Based on Appendix C, Tables C1-C8.

All three of the above-mentioned regions had decreased levels of output in the early part of the first sub-period (1976-81). The three regions are the main rice producers in Viet Nam, the north (region 3), central Viet Nam (region 5) and the south (region 8).

All three of these (3, 5 and 8) regions, despite occasional sharp fluctuations, had higher levels of output both at the beginning and at the end of the study period. Region 3 (Red River Delta) showed the most dramatic rise between 1991 and 1993, reaching a peak of almost 2.5 in 1994.

Region 1 (Mountainous Area), region 2 (Midland Area) and region 4 (Central Duyen Hai) all show a gradual upward trend of output levels from 1977, and achieved levels of above 1.5 by 1995. Like the previous group (regions 3, 5 and 8), these three regions declined briefly in output levels at the beginning of the study period. A sharp decline was shown by regions 1 and 2 from 1989 to 1991, when both fell to approximately their levels in 1976.

The lowest levels of output quantity were found in region 7 (North-East Viet Nam) and region 6 (South-West Viet Nam), below 1.2 in 1995. As with the previous regions, there was a decline at the start of the study period and a gradual upward trend thereafter until 1991, when region 7 declined sharply to 1.1 before rising to 1.3.

The general declines in levels of output in 1976-77 and 1990-91 are probably explained by the serious floods in those years in all regions.

6.3 Quantity Indexes of Aggregate Inputs

Figure 6.2 presents the changes in input use for rice production in Viet Nam, and Table 6.2 shows the average annual growth rates of total inputs for the industry. Five inputs were included in the study (see Chapter 5). It can be seen from Table 6.2 that inputs increased over the study period at 0.65 per cent a year.

Table 6.2

Average Annual Rate of Rice Input Growth, 1976-95(%)

	Reg1	Reg2	Reg3	Reg4	Reg5	Reg6	Reg7	Reg8	VN
1976-81	0.80	1.20	0.47	0.50	0.90	1.10	0.60	0.60	1.02
1981-87	0.35	0.20	1.20	0.60	0.30	0.50	0.54	0.30	0.62
1987-95	0.90	0.08	0.75	0.34	1.10	0.77	0.72	1.10	0.74
1976-95	0.68	0.49	0.80	0.48	0.56	0.79	0.92	0.46	0.65

Note:

R1 is Mountainous Area **R2** is Midland Area **R3** is Red River Delta **R4** is North Central Coast
R5 is Central Duyen Hai **R6** is South-West Viet Nam **R7** is North-East Viet Nam **R8** is Mekong Delta

Sources: Based on Appendix C, Tables C1-C8.

Temporal differences in growth rate of input

Table 6.2 shows that there were differences between sub-periods in the growth rate of input use. The average annual rate of growth in input use before the first agricultural reform (1981) was 1.02 per cent per annum. The rates in the first sub-period (1981-87) and the second (1987-95) were 0.62 per cent and 0.74 per cent, respectively.

The relatively high rate of growth in input use in the first sub-period can perhaps be explained as follows. The sub-period from 1976 to 1981 was the period of collectivisation, in which the cost of inputs was borne by the co-operatives, not the farmers themselves, so that there was a strong tendency for greater use of inputs, such as seed and fertiliser.

In the second sub-period it was found that the average annual rate of growth in input use declined in most rice-producing regions, with the exception of region 3. This decline is probably explained by the impact of agricultural reform, which is discussed in the following section.

Regional differences in input growth rate

It is clear from Table 6.2 that there were regional differences in average annual input growth rates. Region 8 (Mekong Delta) had the lowest average annual growth rate in input use, at 0.46 per cent per year; in contrast, the second-largest rice-producing region, the Red River Delta, had an annual growth rate of inputs of 0.8 per cent per annum, nearly double that of region 8. This difference can probably be explained by the fact that conditions for rice production in the south were more favourable than in the north. For example, the proportion of rice-producing areas which was irrigated was higher in the south, encouraging use of complementary inputs, such as labour and fertilisers. In addition, the first agricultural reform gave farmers in the south the opportunity to use inputs more efficiently than before. If we compare region 8 in the south with region 3 in the north, it is clear that the growth rate of input use was four times greater in the northern region.

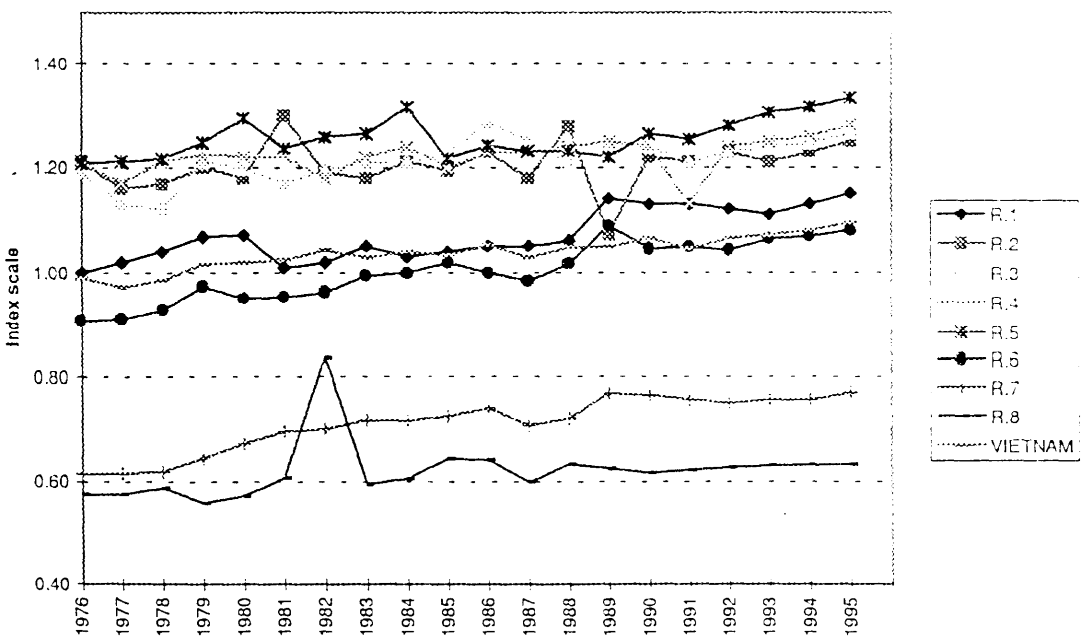
The Mountainous Area (region 1) had a higher average growth rate of input use than the other regions, at 0.68 per cent per annum (see Table 6.2). More details about this issue will be presented in the next section.

Regional differences in level of input use

Figure 6.2 illustrates the regional differences in level of input use. The regions fall into three distinct groups. The highest level of input use is found in regions 2 (Midland Area), 3 (Red River Delta), 4 (North Central Coast) and 5 (Central Duyen Hai). The middle level consists of regions 1 (Mountainous Area) and 6 (South-West Viet Nam). The lowest level of input use is found in regions 7 (North-East Viet Nam) and 8 (Mekong Delta).

Figure 6.2

Input Indexes for the Rice Industry in Viet Nam, 1976-95



Note:

R1 is Mountainous Area **R2** is Midland Area **R3** is Red River Delta **R4** is North Central Coast **R5** is Central Duyen Hai **R6** is South-West Viet Nam**R7** is North-East Viet Nam **R8** is Mekong Delta

Sources: Based on Appendix C, Tables C1-C8.

Beginning with the last group, we can see that both regions showed little fluctuation in level of input use, except for region 8 in 1982 when it rose sharply to 0.8. The reason for this rise was unfavourable weather which resulted in the use of three times the normal amount of seed (700 kg/ha; see Table B1). Other inputs were unaffected.
The low level of input use in region 7 may well be explained by the influence of the many agricultural research institutions in Ho Chi Minh City, offering opportunities for the farmers to benefit from advances in agricultural technology.

The middle group of regions consists of mountainous areas in both north and south, with comparable costs for transport of inputs, and with comparable unfamiliarity with modern agricultural technology. It is therefore not surprising that the levels of input use in regions 1 and 6 are very similar.

The regions which have the highest levels of input use show little difference from one another, except for the sharp fluctuation in region 2 between 1988 and 1992, the reason for which is not clear. Perhaps the neglect of farming, which was partly a result of the second agricultural reform, with hired labour replacing the farmers who sought work in the cities during the rice season, caused the increase in input use.

6.4 TFP Indexes

The TFP index was calculated by taking the ratio of the index of output to the total input index. Table 6.3 shows the growth rates of TFP per annum in the rice industry in Viet Nam over the study period.

Table 6.3

Average Annual Rate of Rice TFP Growth 1976-95 (%)

	Reg1	Reg2	Reg3	Reg4	Reg5	Reg6	Reg7	Reg8	VN
1976-81	-1.60	-1.90	-0.70	-0.88	0.60	0.36	0.14	0.14	-0.54
1981-87	1.10	0.40	3.40	0.37	1.00	1.80	0.73	3.90	1.71
1987-95	1.20	1.60	4.00	3.70	2.70	2.30	1.60	3.94	3.39
1976-95	0.23	0.03	2.90	1.31	1.43	2.15	1.39	2.66	1.65

Note:

R1 is Mountainous Area **R2** is Midland Area **R3** is Red River Delta **R4** is North Central Coast **R5** is Central Duyen Hai **R6** is South-West Viet Nam **R7** is North-East Viet Nam **R8** is Mekong Delta

Sources: Based on Appendix C, Tables C1-C8.

Temporal differences in TFP growth rate

When one considers the full study period, TFP increased over time in all regions (see Table 6.3). Nationally, TFP had shown an annual rate of increase of 1.65 per cent. However, in the sub-period 1976-81, the period before the first agricultural reform in Viet Nam, TFP declined at a rate of 0.54 per cent a year. In the succeeding two periods, on the other hand, significant growth in TFP occurred. In the second sub-period 1981-87, after the first agricultural reform, and the sub-period 1987-95, following the second agricultural reform, the TFP growth rates were 1.71 per cent and 3.39 per cent per year, respectively. The factors causing this growth are discussed later.

From Table 6.3, it can be seen that in the sub-period before the first agricultural reform, the TFP growth rate in almost all rice-producing regions was either very small or negative. For example, TFP declined in region 2 (Midland Area) by 1.9 per cent a year. Even the biggest rice-producing region in the north, the Red River Delta, experienced a negative TFP growth rate of 0.7 per cent per annum. The Mekong Delta had a positive rate of TFP growth with the small figure of 0.14 per cent a year.

In the sub-period from 1981 to 1987, all rice-producing regions in Viet Nam had positive average annual rates of TFP growth (see Table 6.3). This figure was the highest in the Red River Delta, at 2.9 per cent a year. In the Mekong Delta, it was 2.66 per cent a year.

The rates of TFP growth in all rice-producing regions increased during the second agricultural reform. The Red River Delta and the Mekong Delta experienced rates of TFP growth which were high, at 2.90 per cent and 2.66 per cent per annum, respectively.

Regional differences in TFP growth rate

It is shown above that indexes of TFP in all rice-producing regions in Viet Nam increased over the study period. However, there were differences in growth rates between regions.

The two main rice-producing regions (the Mekong and Red River Deltas) had the higher rates of growth in TFP. Region 1 (Mountainous Area) and region 2 (Midland Area) in the north had lower rates of TFP growth at 0.23 per cent and 0.03 per cent a year, respectively, whereas the other regions ranged from 1.31 per cent (North Central Coast) to 2.9 per cent per year (Red River Delta).

TFP growth rates were low in the Mountainous Area and Midland Area because while the input growth rate increased, output growth rate did not increase much and sometimes decreased. For example, in region 2, when annual growth rate of input increased at 0.49 per cent, the annual average growth rate of output increased at only 0.52 per cent per year.

In general, it can be said that the average annual growth rates in TFP of the northern regions were lower than those of the southern regions. One possible explanation for this is that, even though the annual growth rates of input use in the northern regions were similar to those of the south, the average annual growth rates of output in the southern regions were higher, so that the TFP growth rates were higher.

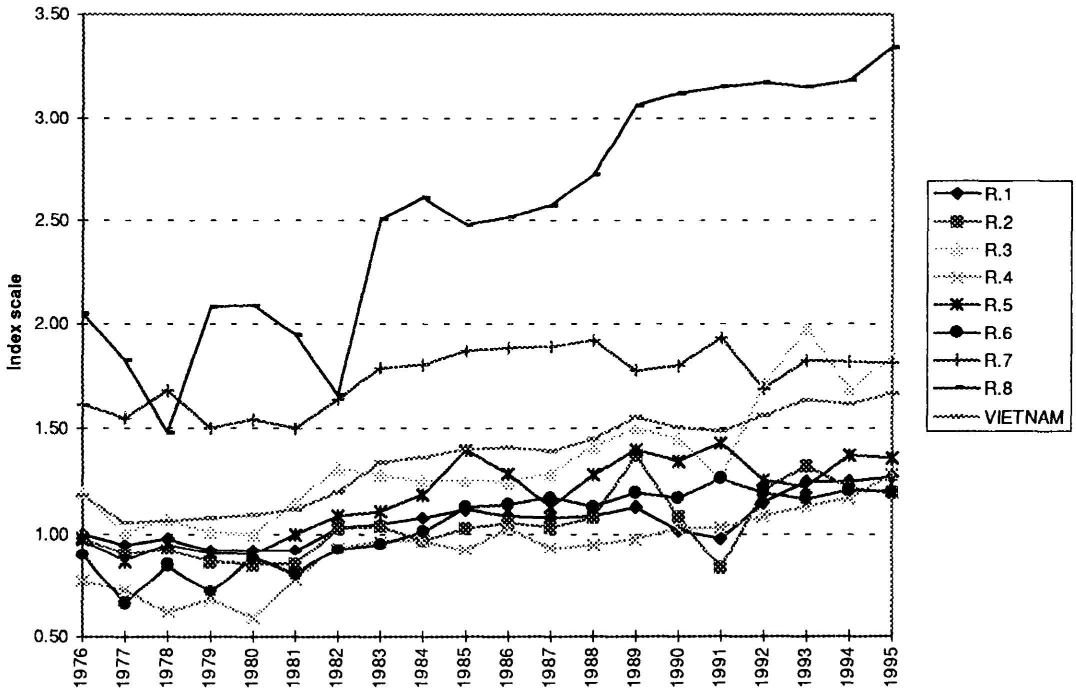
Regional differences in levels of TFP

From Figure 6.3 it can be seen that two groups of regions may be distinguished. The first group consists of region 8 (Mekong Delta) and region 7 (North-East Viet Nam), which begin with indexes of more than 1.5. The second group is comprised of the remaining regions, with starting indexes below 1.2.

The TFP level in region 8 shows considerable fluctuation in the first half of the study period and then gradually increases to 3.3 in 1995. On the other hand, region 7 shows relatively little fluctuation. The reasons for the fluctuation in this group are the fluctuations in both input and output growth.

Figure 6.3

TFP Indexes of 8 Regions in the Rice Industry in Viet Nam, 1976-95



Note:

R1 is Mountainous Area **R2** is Midland Area **R3** is Red River Delta **R4** is North Central Coast **R5** is Central Duyen Hai **R6** is South-West Viet Nam **R7** is North-East Viet Nam **R8** is Mekong Delta

Sources: Based on Appendix C, Tables C1-C8.

TFP levels for the remaining regions are similar to one another, with the striking exception of region 3 (Red River Delta) which shows a sharp rise in 1987-95. Before the first agricultural reform, the TFP levels in all regions of the second group were low, because of the generally low levels of output.

6.5 Contributions of TFP and Inputs to Growth of Rice Output

Table 6.4 shows the growth rate of output, total input, TFP and their relative contributions in growth of total inputs and TFP to growth of rice output in Viet Nam over the study period.

Table 6.4

Growth Rate of Output, Total Input, TFP and the Relative Contributions of Growth of Total Inputs and TFP to Growth of Rice Output in Viet Nam, 1976-95 (%)

	Growth rates			Relative contribution to output growth	
	Output	Total inputs	TFP	Total inputs (%)	TFP (%)
1976-81	0.48	1.02	-0.54	+	-
1981-87	2.32	0.62	1.71	26.70	73.30
1987-95	4.12	0.74	3.39	17.80	82.20
1976-95	2.32	0.65	1.65	28.00	72.00

Note:

R1 is Mountainous Area **R2** is Midland Area **R3** is Red River Delta **R4** is North Central Coast **R5** is Central Duyen Hai **R6** is South-West Viet Nam **R7** is North-East Viet Nam **R8** is Mekong Delta

Sources: Based on Appendix C, Tables C9-C16.

It can be seen from Table 6.4 that the share of TFP in total rice output growth in Viet Nam increased with time. Between 1976 and 1981, output grew due to increased use of inputs rather than improved productivity. Output growth for the sub-period 1981-87 was 2.32 per cent per year with TFP contributing 73.3 per cent of the growth. Between 1987 and 1995, output growth was 4.12 per cent a year with TFP growth accounting for 82.2 per cent of this. Over the study period, TFP growth contributed 72 per cent to output growth, while total input growth contributed 28 per cent. TFP fell substantially in the first sub-period (1976-81), largely due to reduced output associated with a recession in agricultural production at that time.

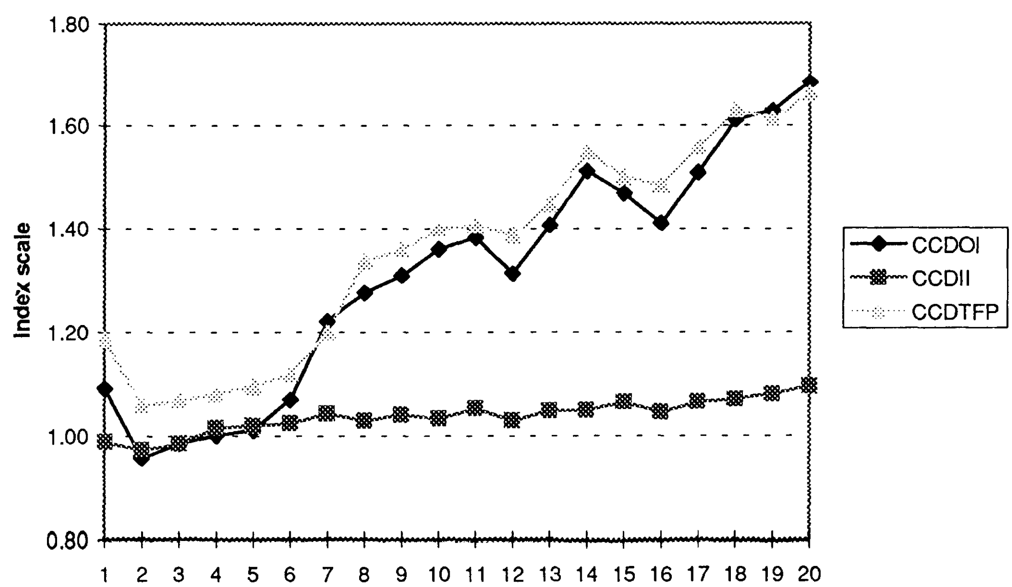
The output, input and TFP indexes are graphed in Figure 6.4.

The differences in sources of rice growth among regions could also be explained by decomposing the growth in output in each region into that due to growth in inputs and that due to growth in TFP (see tables and figures for all regions in Appendix C).

From these tables, it can be seen that the contribution of total input growth to rice growth varies from 15 per cent in region 8 (Mekong Delta) to 94 per cent in region 2 (Midland Area). The differences in input quantities used can be seen in Appendix A. In terms of regional differences in TFP contribution, it can be seen that TFP contribution varies from 6 per cent in region 2 (Midland Area) to 78.4 per cent in region 3 (Red River Delta). TFP growth in the rice industry in Viet Nam could be mainly explained by technological changes, institutional reforms and effects of efficiency improvement.

Figure 6.4

Output, Input and TFP Indexes for the Rice Industry in Viet Nam, 1976-95



6.6 Discussion

6.6.1 Impact of agricultural reforms on rice productivity in Viet Nam

The various agricultural reform measures undertaken in Viet Nam since 1981 have affected growth in productivity in the rice industry in several ways. For example, the shift from the co-operative to the household responsibility system provided incentives to adopt new technologies and improve efficiency. The market reforms which raised the profitability of rice production by increasing the relative price of outputs to inputs and reduced the transaction costs of marketing can also similarly affect productivity by encouraging producers to increase output by working harder. The greater resources of the provincial governments relative to central governments as provincial-level enterprises, which allowed them to engage in international trade in rice products and inputs, may have increased public investment in the industry, particularly in the southern rice-producing regions where rice exports grew dramatically. This public investment in irrigation, market infrastructure and agricultural research both directly and indirectly increased rice productivity. Though the first agricultural reform was successful in boosting production, there were barriers to efficiency improvement that inhibited further growth. In 1988, many of these impediments were effectively removed when additional reforms liberalised the rice industry. Output markets were privatised, input supplies became more decentralised, and individuals were given greater decision-making power for household resource allocation and crop choice. In addition, households were given long-term leases on their land with the right to inter-generational transfers, which increased incentives for long-term investments to raise productivity.

6.6.2 Differences in rice productivity across regions

The contrast in patterns of output growth between north and south is interesting. Growth of output in southern rice-producing regions has been higher than that in northern rice-producing regions.

Our results show regional rice-productivity differences for both the northern and the southern areas. For example, the northern farmers were 1.1 per cent more productive, and, in the south, farmers were 1.9 per cent more productive per year on average. The differences in rice productivity between northern and southern regions could be attributed to different land-use and allocation patterns, greater adoption of modern rice technology by southern farmers and a stronger private enterprise economy in the south prior to 1976.

There could be two reasons for higher rice productivity in the southern regions during the study period. Southern farmers had inputs and equipment left over from before the reunification period, and centralisation and collectivisation efforts were not made in earnest until almost the end of the 1970s.

Collectivisation in the south was different from that in the north because land reform had been completed in the north before 1975 while a private enterprise economy had flourished in the south until 1975. In 1976 the fourth National Convention of the Communist Party adopted Resolution 4, which urged all party leaders in the regions of southern Viet Nam to move gradually toward collectivisation, with the goal of completing most rice regions by 1980. However, farmers in the Mekong Delta resisted collectivisation. Even by 1986, less than 6 per cent of Mekong Delta farmers belonged to an agricultural co-operative (GSO, 1995).

Rice production in the south, unlike the north, continued on a family-farm basis except in those few areas that were collectivised. Farmers continued to be the primary decision makers for all input and technology decisions on their assigned land.

6.6.3 Other factors contributing to rice productivity growth

While the study has shown the tremendous productivity impact of agricultural reforms, we ought to emphasise that agricultural reforms alone did not lead to sustained growth in rice output during the study period. There were differences in the irrigation system and water control between the north and south. The southern rice-producing regions, especially the Mekong Delta, had a greater potential for expanding irrigation, and a consequence of the growth of irrigated area in the south was the higher rate of growth in productivity because of better water control.

However, other factors also contributed to the productivity growth in rice production in Viet Nam. These include the abolition of subsidised rice sales to government employees, an end to the monetisation of rice with the decline of inflation, the advent of positive real interest rates, and currency devaluation that increased rice competitiveness in international markets.

6.7 Conclusion

This chapter has contained a discussion of the results of the study. Differences have been noted in terms of input growth rate, output growth rate and TFP growth rate as well as differences in levels of input indexes, output indexes and TFP indexes, over time and across regions of the rice industry in Viet Nam over the study period from 1976 to 1995.

It was found that the annual growth rate of inputs and outputs increased over time. However, output growth was higher than input growth, so that the TFP growth increased over time. Contribution of TFP growth to rice output growth rate was higher than that of input growth. The trends and patterns of growth in rice output and productivity could be attributed to an increase in the use of inputs, technological change and agricultural reforms.

CHAPTER 7

SUMMARY, POLICY IMPLICATIONS AND CONCLUSION

7.1 Summary of the Study

Remarkable progress has been achieved in the growth of agriculture in Viet Nam following a series of institutional reforms adopted since the early 1980s when the country shifted from a centrally planned to a market economy. This series of institutional and policy reforms, along with other factors, led to an acceleration of growth in rice production at a rate of 3.4 per cent per annum (GSO, 1996) during the period from 1976 to 1992. After being a net rice importer for nearly 30 years, Viet Nam re-emerged as the third top rice exporter by 1989. The present study was focused on this phenomenon of growing rice output. The objectives of the study were to analyse productivity changes in the rice industry in Viet Nam over the period 1976 to 1995, to gain more understanding about the trends and patterns of growth in rice production and productivity, and to explain how changes in the use of inputs, technological change and agricultural reforms have affected productivity in rice production through their effects on the incentive structure and technological potential.

To attain the research goal, it was hypothesised firstly that there had been no differences in TFP in rice production over the period from 1976 to 1995. The second hypothesis was that there had been no differences in TFP in rice production between the regions over the study period. Thirdly, it was hypothesised that the rate of TFP growth in pre- and post-agricultural reform periods had been equal.

The Multilateral-Tornqvist-Index Numbers were chosen to specify quantity and price indexes of output, inputs and TFP indexes. Index numbers were then used to measure price, quantity and TFP changes over time and across regions (see Chapter 4).

Data were required on quantities and prices of rice output and inputs. There were five inputs included in the study: seed, chemical fertilisers, pesticide, human labour and animal services. The single output was rice. All output and inputs were measured in averages per hectare (see Chapter 5). The data were obtained from various secondary sources. Twenty years of time-series data for eight regions were aggregated for estimation of index numbers. Data were also divided into three sub-periods to test the hypotheses. All the results of analysis can be seen in Chapter 6 and Appendices.

The findings of the study are summarised below:

1. There were increases in TFP in rice production in Viet Nam over the study period.
2. There were differences in TFP in rice production between the regions in the rice industry in Viet Nam.
3. The contribution of TFP growth to output growth in rice production over the study period was higher than the contribution of input use.
4. The periods of agricultural reform coincided with periods of relatively high rates of growth in rice productivity in Viet Nam over the study period.

7.2 Some Policy Implications

The findings from this study do not allow a specific policy conclusion. Nevertheless, the findings have contributed to a better understanding of rice productivity growth in Viet Nam during the period from 1976 to 1995, and some driving forces behind this growth.

While the policies since 1987 should continue to increase incentives to produce and export rice, the large boost in exports they initially provided is not likely to recur. The Vietnamese role in international rice trade in the 1990s will likely be more dependent on marginal changes in output and consumption, tied more to general economic performance and further rationalisation of economic activity, than on changes in economic structure.

Policy reforms have been fundamental to recent gains in both rice output and exports, and additional growth will depend in part on the direction and extent of further reforms. Rice output in the 1990s could be further boosted if measures are adopted to overcome remaining impediments to production and marketing efficiency. In the past, domestic policy reforms led to improved production through increased fertiliser use, greater use of modern high-yielding variety seeds, and more investment in irrigation. As a result, yield growth outpaced area expansion in the last decade of the study period, a trend likely to continue as land availability and multiple-cropping potential decline. However, additional use of modern high-yielding varieties can produce only marginal gains in output unless there is significant investment in water management, soil conservation and research, to overcome problems such as soil salinity, acidity and erosion.

In addition, a lack of well-developed markets for inputs, outputs and labour inhibits efficient production. For instance, though domestic agricultural output markets operate relatively freely, state companies continue to control a large share of the wholesale trade in agricultural inputs, and the government still provides subsidised inputs, cheap credit and tax breaks to the state agricultural sector at the expense of private farmers. State control of credit and currency has limited the capital available to traders and rice processors, thus hindering their ability to purchase rice and other commodities. Further reform of the price and marketing structure for traded agricultural inputs and outputs, and liberalisation of the credit system, provide the necessary incentives for the farmers to further boost production.

Investment in agricultural research has been very low. Viet Nam continues to obtain modern high-yielding cultivars from IRRI, from rice research programs in other Asian countries, and from its own breeding program. Both primary and adaptive research for cultivar development and for crop and land management are required in order to increase rice output.

A key issue in the outlook for the Vietnamese rice industry in the 1990s is the relationship between rice export and domestic consumption, i.e., the degree to which rice exports are competing with national food availability. Despite exportable surpluses of rice, regional shortages which could become increasingly severe exist within the country.

In addition to its impact on productivity, income growth is important to the rice industry through its role in consumption decisions. Vietnamese per capita rice consumption is already high, at more than 300 kg/capita/year. As a result, one would expect strong income growth to lead to diet diversification into items such as wheat and animal products, rather than to increased rice consumption.

The last requirement is that, since it is not possible to decompose the sources of productivity growth among the various reform measures, technological progress and market development exogenous to the reform without more and better quality data than are now available, data need to be improved. The country must invest in developing appropriate data for monitoring and analysing productivity growth in order to provide information for policy changes and investment necessary to sustain productivity growth in agriculture, including rice production.

7.3 Limitations of the Study

The analysis covers the period from 1976 to 1995. It starts in 1976 after the unification of North and South Viet Nam because available official data on agriculture prior to 1976 pertain only to North Viet Nam, so that we could not compare for a longer time rice productivity between regions and obtain more data for the study.

The usefulness of the study would undoubtedly have been greater if data on inputs such as capital and irrigation in each region could have been identified and included. Another limitation of the study, also relating to the data, is that real input and output price data were not available. As we emphasised in Chapter 5, implicit prices had to be calculated.

One more limitation of the study is the use of unreliable data. The data collected from the districts on output and harvested areas of rice are themselves subject to doubt. Likewise, data on chemical fertilisers and pesticides were simply the record of sales by GSO. Since a negative fertiliser response is in practice unlikely, there is ample room to suspect that either the sales data did not measure the actual application of fertilisers and pesticides in the field, or the data themselves were erroneous. The data on seed have a similar weakness. Being measured as the total annual sales by GSO, the data did not account for the availability of seed from other sources at the local level. The use of annual sales alone, therefore, probably underestimates the actual use of the improved varieties on farms. All these weaknesses of data have imposed some limitations on the usefulness of this study in drawing concrete policy conclusions.

7.4 Directions for Further Research

Obviously the present study is not without limitations and the analysis could be improved in some ways. First, rice is grown in all eight regions in Viet Nam. There are differences in features of these agro-ecological regions such as elevation, rainfall, temperature, soil and sunshine. Therefore, in order to examine productivity in rice production more thoroughly, it would be more precise to consider these agro-ecological regions separately.

A more detailed study should consider variables such as the irrigation areas under rice cultivation. These have not been considered in this study because of the lack of data. If data were available for these variables, there might be a more precise picture of the productivity and in particular, differences in TFP between regions of the rice industry in Viet Nam.

A number of studies have had a multi-crop focus (Mehra, 1981; Nguyen, 1985). They incorporate a variety of crops in various regions and examine the overall productivity. Because of the greater importance of rice compared to the other crops in Viet Nam, this study examined only the productivity of rice production. However, if sufficient consistent data on other food crops could be found, a more complete picture of productivity in agriculture in Viet Nam would be possible.

Finally, there are several ways to examine productivity in agricultural production. The method of analysis in the present study was the use of multilateral-Tornqvist (CCD) index numbers. Data were required for this method on quantities and prices of inputs and output. Moreover, price data were required as market prices. The measurement of technical progress allows Malmquist Indexes of TFP to be distinguished from technical change measures, without resort to price.