RICE RESEARCH VERSUS RICE IMPORTS IN MALAYSIA: A DYNAMIC SPATIAL EQUILIBRIUM MODEL

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STATEMENT OF ORIGINALITY

I hereby certify that the substance of the material used in this study is my own research and has not been submitted or is not currently being submitted for any other degree. To the best of my knowledge, this thesis does not contain any material previously published unless due acknowledgement of the sources of the material is made in the text of the thesis.

(Deviga Vengedasalam) Date

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DEDICATION

To my husband, Karunagaran and my lovely kids, Arvend and Sreyaa

ABSTRACT

Rice is the main staple food, besides wheat, in many countries in the world. For the purpose of food security, many countries protect their rice industry through various mechanisms such as domestic subsidies, import/export tariffs, price ceilings and other mechanisms. Malaysia is one of the rice importing countries, which spends millions of Malaysian Ringgit from the public funds to protect the rice industry and at the same time invests in research and development (R&D) activities to increase rice production. However, in the past 30 years, the production of rice was still not sufficient to meet the domestic demand.

The purpose of the present study is to examine the impact of the reallocation of public funds from domestic subsidies to R&D expenditures. Furthermore, the present study also examines the impact of removing BERNAS, the sole importer, and removing all the trade barriers in the Malaysian rice industry. An econometrically estimated dynamic spatial equilibrium model was developed to analyse the impact of policy changes in the Malaysian rice industry.

The rice trade model in this study incorporated six regions of Malaysia, Thailand, Vietnam, Pakistan, Indonesia and the Rest of the World. In the present study, there are two main parts: econometrics and simulations. For each region, there were four stochastic equations; namely, consumption demand, stocks demand, area harvested and yield and the supply function was constructed as an identity comprising of area harvested, yield and the conversion rate of paddy to rice. The time series data used for the stochastic equations from the period of 1980 to 2009 were tested for stationarity using the Augmented Dickey Fuller test. The area harvested equation was estimated using ordinary least squares and the other stochastic equations were estimated using two-stage least squares. In the cases with autocorrelation, the equations were re-estimated using a first-order serial autocorrelation correction. The econometric results were consistent with *a priori* expectations and as represented in the equations the decision-making agents appeared to be well behaved according to theory.

An R&D expenditure variable was incorporated into the yield function for Malaysia. To select the most appropriate yield function including the R&D expenditure variable, eight alternatives of R&D lags of different lengths and shapes were tested. Two lag lengths, 16 and 35 years and three shapes: trapezoid, inverted "V" and gamma distributions were used and the most preferred model was the gamma distribution with δ=0.6 and λ=0.8 with a lag of 16 years. The R&D elasticities in the range of 0.10 to 0.13 were computed for the Malaysian rice industry and these were found to be consistent with the R&D literature. As there seemed to be no other estimates of R&D elasticities for Malaysian agriculture previously published, these estimates are seen as a contribution to knowledge about the effects of R&D expenditure in Malaysia.

The coefficients of all the exogenous variables from the econometric estimation were collapsed into the intercept and then these collapsed demand and supply equations were included in the spatial equilibrium model. The spatial equilibrium model was formulated using a primal-dual approach in a mathematical programming model. The model was simulated dynamically from 1982 to 2009 using the Lemke algorithm written in Visual Basic in Microsoft Excel. Both statistical and graphical methods were then used to validate the historical data with the simulation values. The simulated endogenous variables were found to replicate the historical values quite closely.

Four historically based policy simulations were developed to analyse policy changes in Malaysia. In the first two scenarios, 10 per cent and 25 per cent of the rice subsidy funds were reallocated to R&D expenditures. In the third scenario, the sole importer status of BERNAS was removed and replaced with import tariffs and in the fourth scenario the free trade environment was represented. The results from the simulations in scenario 2 showed that if the government had allocated 25 per cent of the subsidy funds into R&D expenditures in the 1980s, self-sufficiency in rice could have been achieved 25 years earlier. Furthermore, both the consumers and producers would be better off if these changes had taken place back in 1980s.

Findings that emerged from this study have some important policy implications for the Malaysian rice industry. The findings suggest that the government interventions, such as providing domestic subsidies to farmers to increase the production of rice and the use of a marketing board to control imports do not necessarily protect the industry. The findings indicate that if the government had chosen to eliminate domestic subsidies and the sole importer status, consumers would be better off even though the farmers' revenue would be affected in such a free trade environment. The findings in the present study also suggest that the income per farmer could increase by about double if the government invested 25 per cent of the subsidy funds into R&D expenditure. The key recommendation from this study is that the government should remove the domestic subsidies and other trade barriers and use the limited public funds for R&D related activities and both the consumers and producers will be better off than in the current situation.

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LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Meaning
AFTA	ASEAN Free Trade Area
AoA	Agreement on Agriculture
BERNAS	Padiberas National Berhad
Bumiputera	Malay term used in Malaysia for indigenous people
CEPT	Common Effective Preferential Scheme
FAO	Food and Agriculture Organization
GATT	General Agreement on Tariffs and Trade
GERD	Gross Expenditure on Research and Development
GMP	Guarantee Minimum Price
IFPRI	International Food Policy Research Institute
IRPA	Intensification of Research in Priority Areas
IRRI	International Rice Research Institute
MARDI	Malaysian Agricultural Research and Development Institute
MASTIC	Malaysian Science and Technology Information Centre
MOSTI	Ministry of Science, Technology and Innovation
MYR	Malaysian Ringgit
ROW	Rest of the World
WTO	World Trade Organization

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Chapter 1: Introduction

"*Meeting the food demands of a global population expected to increase to 9.1 billion by 2050, and improving incomes and livelihoods to enable access to food, will require major improvements in agricultural production systems.*" Food and Agriculture Organization of the United Nations (FAO 2009).

The agricultural sector provides livelihoods for many people, especially the rural population in developing countries. Improving the productivity of the sector is an important goal for most policymakers as arable land is limited. Thus, public and private sector investments in the agriculture sector are essential to develop new technologies. Agricultural investment includes government expenditures on agricultural infrastructure such as irrigation and drainage, training in agriculture and research and development. The agricultural research and development (R&D) policy is often related to other policies such as trade policy, pricing policy and subsidy policy. It is important to consider these policies when estimating the benefits of research.

Rice is the main staple food, besides wheat, for most of the population in the world, especially in Asia. However, most rice is consumed in the country in which it is produced, with only 7 per cent of total rice output being internationally traded in 2010 (FAO 2011). According to Calpe (2005) rice is regarded as a thin, distorted, segmented and volatile market.

Even with the implementation of the Agreement on Agriculture (AoA) under the World Trade Organization (WTO) in July 1995, the rice sector is still protected not only by exporting countries but also by the importing countries. The rice sector is subject to multiple types of trade-related protection measures including tariff and non-tariff barriers, export restrictions and domestic interventions such as the creation of monopolistic conditions via the use of state trading enterprises. It is not only developing countries that support their rice industries but also developed countries like the European Union (EU) and the United States (US). Each country's policy differs with the EU and US protecting the producers' income through direct budgetary transfers, India imposes export restrictions and importing countries like Malaysia impose ad-valorem import tariffs to protect the rice industry. Thus, rice is one of the most distorted commodities in the agricultural market (Calpe 2005; Durant-Morat and Wailes 2011; Sadoulet and de Janvry 1995).

Background to the Problem

The agricultural share of gross domestic product (GDP) in Malaysia has declined from 35 per cent in 1960 to less than eight per cent in 2011. In spite of this, the sector plays an important role in the country's economic growth as the major agricultural exports contributed about 11.3 per cent of total exports for the year 2011 with a value of MYR78,916 million.

Rice has always been a major staple food for most of the populace in Malaysia and this sector plays a significant part in food security. Production of rice has increased over time from 1,318,000 tonnes in 1980 to 1,590,000 tonnes in 2009; however, this increase was not sufficient to fulfil the demand requirements in Malaysia of 2,445,000 tonnes in 2009 due to the population growth at an average rate of 2.4 per cent annually (FAOSTAT 2010). As a result, Malaysia imports rice from other countries like Thailand, Vietnam and Pakistan, to supplement its domestic production. Since the 1980s, rice imports have been increasing at a cost of millions of ringgit to the Malaysian economy.

The financial crisis in late 1997 and global rice crisis in 2008 caused the imported agricultural commodities to become more expensive as the Malaysian currency depreciated. This situation led the policymakers to decide on increasing the production of staple foods especially rice, and to impose the necessity of a self-sufficiency level to ensure food security and reduce import dependency. The third national agricultural policy was implemented in December 1998. This has placed importance on food security by setting a target of a 90 per cent self-sufficiency level in rice by the year 2010.

However, the self-sufficiency level in rice has been revised under the 10th Malaysia Plan (2011-2015) with a new target set at 70 per cent. Current, domestic production is meeting 64 per cent of domestic consumption, still lower than the target.

The government has introduced various policies, subsidies and incentives in the rice industry to enhance the production of rice to meet the domestic requirements and reduce imports. In 2009, the government spent almost MYR1 billion in subsidies and incentive payments to encourage farmers to produce more rice. However, the increase in production has not been significant. The rice sector in Malaysia is regarded as a high cost production sector compared with other producing countries in the region. This is due to higher labour costs, agricultural inputs and more appealing alternatives from other crop sectors (Ahmad1998). Additionally, as a member of the World Trade Organization (WTO) and ASEAN Free Trade Agreement (AFTA), the government needs to reduce domestic support and allow the market to be competitive with other lower cost efficient producers in the region.

Instead of relying on trade protection and domestic interventions, the government could consider opening up more land for farming and investing in productivity improvement to increase rice production. Opening new land is not a viable option as rice has already occupied 9.6 per cent of the total agricultural land, and new land for rice comes at the expense of other crops. Adding to that, the cost of opening more land area is significant due to the need to install irrigation and drainage systems. Furthermore, in the most recent five-year plan, the 10th Malaysian Plan, the government indicated it had no intention of opening new land, while under the National Physical Plan 2005, they allocated eight granary areas to permanent rice cultivation with no conversion of land use allowed. However, these eight granaries are situated on the west coast of Malaysia where these areas are facing rapid urbanization and industrialization. There are pressures from farm owners to convert their land to industrial use to capture higher profits; however, land conversion is still under the Federal Government’s jurisdiction (Personal Communication 2011).

Thus, one of the few avenues for the government to reach its self-sufficiency level in rice production may be through increasing the productivity of rice within the limited land area. Productivity can be increased through seed improvement, better irrigation systems and most importantly through research and development (R&D) focused on yields. However, the recent R&D expenditure data obtained from the Ministry of Science, Technology and Innovation (2009), indicated that the expenditure on rice research was an average of MYR5.7 million per year from 2002 to 2008 which is only seven per cent of the total agricultural R&D.

Using historical data, the government allocates more money into subsidies and incentives than it does to rice research. The government has allocated MYR974 million to price subsidies for paddy, fertilizers and paddy seeds, MYR230 million for production incentives and increasing paddy yield, and MYR235 million to upgrade the drainage and irrigation system under the 2011/2012 national budget (Ministry of Finance Malaysia 2012). On the other hand, the government allocated only MYR529.7 million to agricultural R&D under the Ninth Malaysian Plan, 2006 - 2010 and only seven per cent of this total is for rice research.

Statement of Problem

The problem to be analysed in this thesis is what is the government's most effective allocation of funds between rice research and subsidies to increase productivity and farmers' welfare. On the one hand, the government spends a substantial amount on subsidies and incentives to protect farmers' income and on the other hand, a small amount of funding on rice research. Furthermore, the implementation of the AoA and AFTA agreements could affect the rice sector since it would no longer protected with subsidies and import restrictions and therefore the sector will have to compete with cost effective producing countries in the region..

The question to be answered is how much should the government spend on rice subsidies and how much should they invest in rice research? How long will it take the benefits of research to be realized by the farmers? What will be the option to reduce import dependency and face international competition? A parallel problem to this is to evaluate the existing policies such as price controls, sole importer status and quantitative restrictions and their impacts on trade flows.

Objectives of the Study

The main objective of this research is to evaluate the impact of the re-allocation of the public funds from rice subsidies to rice research and the benefits to producers, consumers and the overall economy.

The specific objectives of the study are to:

1. Develop an econometrically estimated dynamic simulation model to replicate the current situation.
2. Use the model to analyse the impact of redistribution of the subsidy funds to R&D activities.
3. Estimate the relative impact of the sole importer status on the Malaysian rice industry.
4. Evaluate the impact of trade liberalization in the rice industry.

Outline of this Thesis

This thesis is organized into a number of chapters. In Chapter 2, an overview of the Malaysian rice industry is discussed. This chapter has more detailed information on production, consumption and trade as well as the institutional organization of the rice industry in Malaysia. Government supports and R&D initiatives in the industry are also discussed in this chapter.

In Chapter 3 a review of literature is provided outlining the relevance of R&D expenditure to productivity. Some important government policies pertaining to trade and R&D are also discussed. Some alternative methods are evaluated in Chapter 4. In Chapter 5, the research methods and empirical model are discussed considering both the econometric and simulation methods along with data sources. Econometric estimation and model validation results are explained in Chapter 6. In this chapter, the econometrically simulated model is validated using graphical and statistical measures. In Chapter 7, alternative models of the R&D lag lengths and adoption path shapes are tested and R&D elasticities for the Malaysian rice industry are computed. Some policy simulations on subsidies and R&D are explained in detail in Chapter 7. Finally, the conclusions and recommendations for future studies are discussed in Chapter 8.

Chapter 2: The Rice Industry In Malaysia

Introduction

In this chapter, some details of the production, consumption and trade in the world and the Malaysian rice industry will be presented. The aim is to explain the motivation of the government interventions to protect the industry, not only in exporting but importing nations. In the following section, the government policies relating to the rice industry in Malaysia are explained in detail. Overall, research and development (R&D) expenditure will be discussed so as to understand Malaysia's involvement in R&D. General agricultural R&D investment and particularly rice research will be discussed in the subsequent sections. Finally, a summary of this chapter will be presented.

World Rice Production and Trade

Besides wheat, rice is the most consumed commodity for almost half of the world's population. Rice is regarded as a thinly traded agricultural commodity as 31 million tonnes or approximately 6.8 per cent of world rice was traded in 2009, despite the world production of 456 million tonnes (FAO 2011). The top three rice producing countries, China, India and Indonesia consumed most of the rice produced and Indonesia is an importer. Thailand, Vietnam and Pakistan emerged as the top three rice exporters in 2010.

A rice balance sheet is a tabulation of a country's demand and supply for rice at one time period and incorporates production plus imports plus opening stocks on the supply side and consumption plus exports plus closing stocks on the demand side. The changes in the rice consumed by the population and the per capita consumption can be derived from the balance sheet. In Table 2.1, a rice balance sheet for selected countries and the rest of the world in 2009 is illustrated. The countries selected for this study are Malaysia, Thailand, Vietnam and Pakistan (major exporters) and Indonesia (net importer) and rest of the world. This balance sheet will be used in the subsequent model construction and simulation.

Table 2.1 Rice balance sheet for selected countries and ROW, 2009

Item	Beginning stocks ('000 Mt)	Milled production ('000 Mt)	Imports ('000 Mt)	Total supply ('000 Mt)	Domestic consumption ('000 Mt)	Exports ('000 Mt)	Ending stocks ('000 Mt)	Total distribution ('000 Mt)	Ratio of production to domestic utilization (%)	Ratio of beginning stock to domestic utilization (%)
	(1)	(2)	(3)	(1)+(2)+(3)	(4)	(5)	(6)	(4)+(5)+(6)	[(2)/(4)]x100	[(1)/(4)]x100
Malaysia	730	1,620	907	3,257	2,550	1	706	3,257	63.53	28.63
Thailand	4,787	20,260	300	25,347	10,200	9,047	6,100	25,347	198.63	46.93
Vietnam	1,961	24,993	400	27,354	19,150	6,734	1,470	27,354	130.51	10.24
Pakistan	1,200	6,800	15	8,015	2,915	4,000	1,100	8,015	233.28	41.17
Indonesia	7,057	36,370	1,150	44,577	38,000	0	6,577	44,577	95.71	18.57
ROW	75,798	346,927	28,427	451,152	361,769	11,417	77,966	451,152	95.90	20.95
Total	91,533	436,970	31,199	559,702	434,584	31,199	93,919	559,702	100.55	21.06

Source: Derived from USDA (2011)

The self-sufficiency level is defined as the ratio of production to domestic consumption. From Table 2.1, notably, Pakistan has the highest ratio of self-sufficiency of 233 per cent compared with the major exporters, Thailand and Vietnam with 199 and 131 per cent respectively[1]. Malaysia has the lowest self-sufficiency level of 64 per cent in rice in the region and Indonesia the third largest producer was close to a 96 per cent level. The ROW had a deficit in rice and thus, it was considered a net importer.

The balance sheet for rice as given in Table 2.1 will be used in formulating the trade model for a period of 30 years from 1980 to 2009. The details of the modelling procedure will be explained in a later chapter. In the next section, the rice sector in Malaysia will be discussed.

Area Harvested, Production and Yield of Paddy in Malaysia

Rice farming plays an important role in the Malaysian agricultural sector after oil palm and rubber. Despite its contribution of merely two per cent to GDP, the industry is still the major source of income of the rural populations. Besides generating income, the rice sector is also considered the most important cultivation crop, as it is the main staple food for the majority of the population (Dano and Samonte, 2005).

Three major crops, namely oil palm, rubber and rice constitute 92.9 per cent of the use of total agricultural land. In 2010, the rice plantation area occupied about 678,000 hectares, 9.6 per cent of the total agricultural land while the major export crops, oil palm and rubber constituted 68 and 14 per cent of the total agricultural land respectively (Central Bank of Malaysia 2012). The area planted for paddy increased from the 1960s until 1975 but has since remained stagnant until now. One of the reasons could be the change in the structure of the economy as it moved from agriculture towards manufacturing and another reason could be the focus on the alternative profitable crops such as oil palm.

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[1] Although, Pakistan has a higher self-sufficiency level, its production is lower than Thailand and Vietnam. Unlike Thailand and Vietnam, rice is the second staple food for Pakistan consumers. Thus, Pakistan only consumes 42 percent of the total production while Vietnam and Thailand consume 76 and 52 percent respectively.

Interestingly, the paddy production had substantially increased from the 1960s to the 2000s with marginal increases in the paddy planted area. The reason behind this is clearly because of increases in the yield per hectare as shown in Table 2.2. Over the years, yield has improved through the introduction of high yield varieties, irrigation provided by the government, government supports through fertilizer subsidies and price supports like the paddy price subsidy and guaranteed minimum prices. Additionally, under the government's incentives under the 8th Malaysian Plan (2000-2005), the industry fully mechanized most of the farming operations which has also led to higher yields (Athukorala and Wai-Heng 2007).

The government has created eight granary areas so as to maintain rice production and to ensure at least a 70 per cent self-sufficiency level in rice. These eight granary areas situated in Peninsular Malaysia are designated as the main rice producing areas; namely Muda Agriculture Development Authority (MADA), Kemubu Agriculture Development Authority (KADA), IADP Kerian-Sg. Manik, IADP Pulau Pinang, IADP Seberang Perak, IADP KETARA, IADP Kemasin-Semarak and IADP Barat Laut Selangor as shown in Figure 2.1[2]. Notably, these eight granaries are also in the main irrigation scheme, which constitutes about 57 per cent of the total irrigated rice area. These eight granaries have been the permanent areas for rice cultivation and also have adopted new varieties and technologies resulting from the research and development (R&D). Alternative crops are not allowed to be cultivated in these areas but farmers outside the granaries are given options to choose their preferred crops.

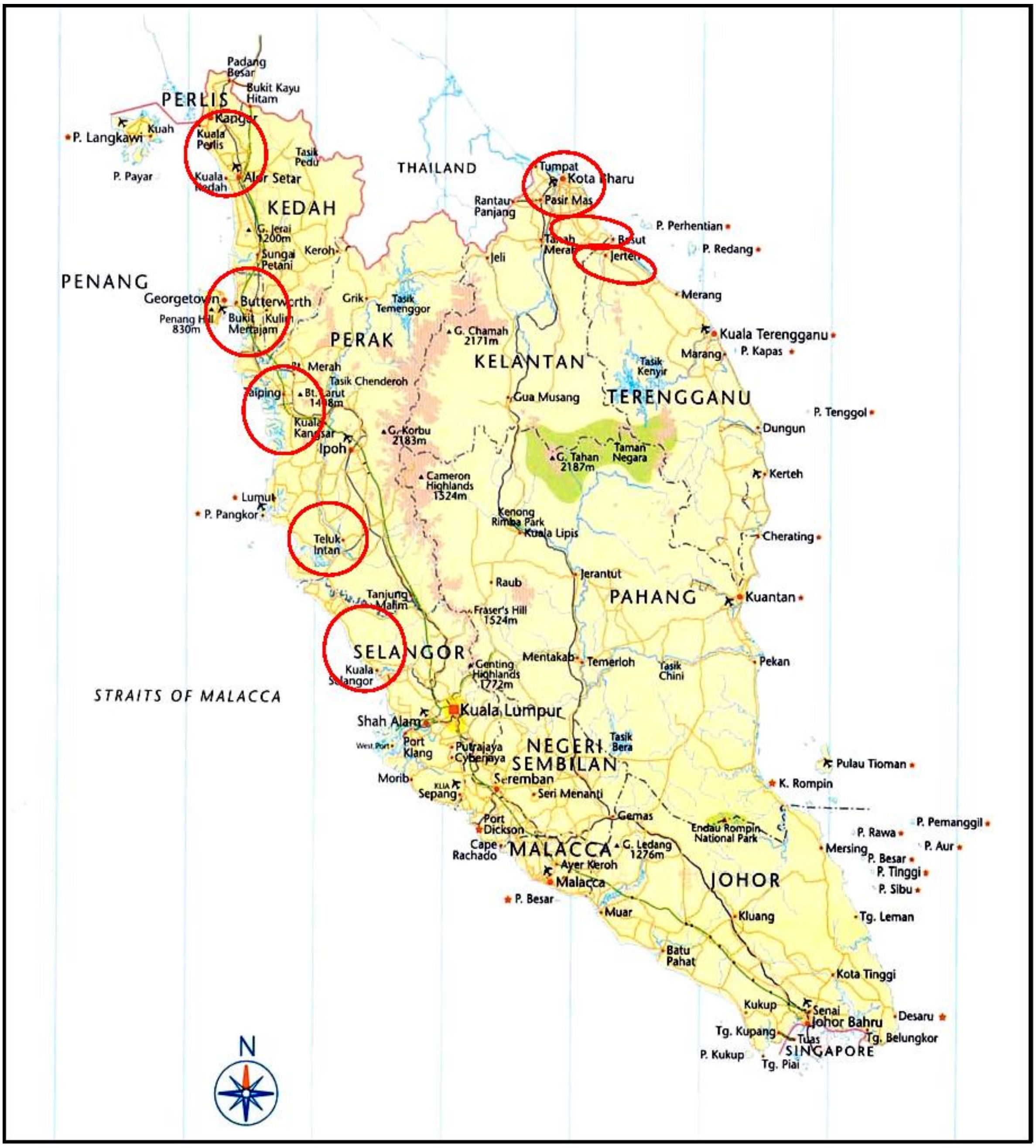
Government has continuously spent funds in upgrading the drainage and irrigation system. In 2011, the government allocated MYR235 million to further improve the irrigation and drainage system (Ministry of Finance Malaysia 2012). In the MADA irrigation system, the main granary area, the use of modern technology has improved water use efficiency and further reduced drainage wastage by using real-time management of water release from dams which are keyed to telemetric monitoring of weather and stream flow conditions (Pingali and Hossain1998). Thus, this irrigation development has encouraged double cropping of paddy and has increased the

[2]IADP stands for Integrated Agricultural Development Programme. Interestingly, all the granaries are located in the Peninsular Malaysia and further expanding these areas is not possible due to urbanization.

production of paddy. Almost half of the paddy land, about 322,000 hectares is capable of double cropping because of the extensive irrigation and drainage schemes, while the rest of the areas are rainfed. An annual rainfall of more than 2,500 mm also affects the paddy production in the most of the rainfed areas. Therefore, Malaysian paddy production depends heavily on irrigation as well as rainfall.

A more detailed analysis on the area planted, yield, production of paddy and rice for the granary areas and the total rice area from 1980-2009, with five years average growth rate is illustrated in Table 2.2. There was a decline in all the variables for the first period, 1980-1984, and then an increasing trend for the next ten years, 1985-1994, finally a short decline for another five years (1995-1999) before increasing again until 2010 (the exception being area planted). This trend reflects the policy changes under the five-year Malaysian Plans.

During the period 2005-09, the average growth rate in the area planted in the granary areas was 3.2 per cent compared with a negative growth rate of 0.02 per cent in total area. This can be explained as areas outside the granary areas could be used for other alternative crops. Notably, the yield showed higher growth rate of 6.3 per cent per year for the granary areas for the same period compared with growth of 1.74 per cent for the total area. The reason could be the increase in the research and development expenditure in the rice industry and granary areas are the most prompt in adopting new varieties and technologies.



Source : Vaghefi et al. (2011)

Figure 2.1 Eight granary areas in Malaysia

Table 2.2 Annual growth rate (%) of area planted, yield and production, 1980-2009

Year	Granary Areas			All Area		
	Area Planted	Yield	Production	Area Planted	Yield	Production
1980-1984	-3.60	-6.04	-9.34	-3.13	-3.31	-6.31
1985-1989	5.37	2.02	8.07	1.05	1.58	2.79
1990-1994	1.90	2.88	4.85	1.03	3.14	4.20
1995-1999	0.53	-0.74	-0.25	-0.15	-0.71	-0.84
2000-2004	-2.78	-1.24	1.04	-0.45	3.15	2.42
2005-2009	3.20	6.32	3.77	-0.02	1.74	1.98

Source: Derived from Department of Statistics Malaysia (2012).

Domestic Demand and Self-Sufficiency Level

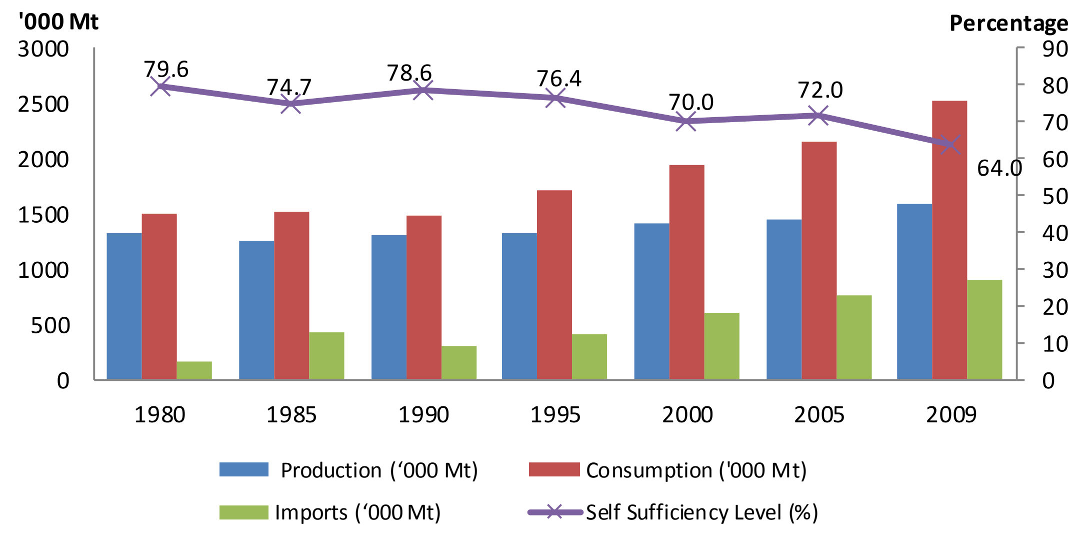
Despite an increase in consumption of rice over the years, per capita consumption of rice showed a declining trend for the time period of 1980-2009. The per capita consumption declined from 109 kg in 1980 to 92 kg in 2009, a drop of 14 per cent. The decrease in consumption is due to a change in consumption patterns, as consumers have tended to shift to alternative foods such as wheat when incomes rise. This was evident in the household expenditure survey in 2009 that showed that rice comprises about 1.9 per cent in the 2009/2010 survey compared with 2.3 per cent in 1993/1994 (Department of Agriculture Malaysia2011).

Domestic consumption continues to increase due to population growth at 2 per cent per year, however, domestic production has not increased much between 1980 and 2009 as illustrated in Figure 2.2. In 2009, the self-sufficiency level of rice production was 64 per cent of domestic demand.

Since independence there have been various government policies and strategies to ensure food security in the country. The government has emphasized the importance of the rice self- sufficiency level[3] in its five-year national plan as well as in the Third National Agricultural Policy (NAP3). Under the recent Tenth Malaysia Plan (2011-2015), the government's target for the self-sufficiency level in rice was 75 per cent

[3] The self-sufficiency level is based on the ratio of production to consumption (after subtracting exports and adding imports to production).

and this target may well be possible as the country has had a record of achieving at least 70 per cent since the 1980s except for a decline in 2009 as shown in Figure 2.2.



Source : FAOSTAT (2011), Paddy Statistics (various issues).

Figure 2.2 Rice production, consumption, self-sufficiency level and imports in Malaysia, 1980 - 2009

Imports

Since, domestic rice production is unable to meet the domestic need, Malaysia is a net importer with imports having increased from 167,000 tonnes in 1980 to 907,000 tonnes in 2009. As shown in Figure 2.2, imports are an important component of the total rice supply in Malaysia. Imports increased dramatically between 1995 and 2009 with a hike of125 per cent, and this situation caused increased concern among the policy makers as import bills also increased.

The major sources of imports for rice were Thailand, Vietnam and Pakistan. Almost 96 per cent of imported rice came from Thailand in the 1990s but this figure eventually declined to its lowest level of 27.7 per cent in 2010. Surprisingly, Vietnam, originally a net importer became the main exporter of rice to Malaysia, supplying 64 per cent of total imports of rice in 2010. In 2010, Malaysia's five top suppliers of rice were Vietnam, Thailand, Pakistan, China and India as shown in Figure 2.3.

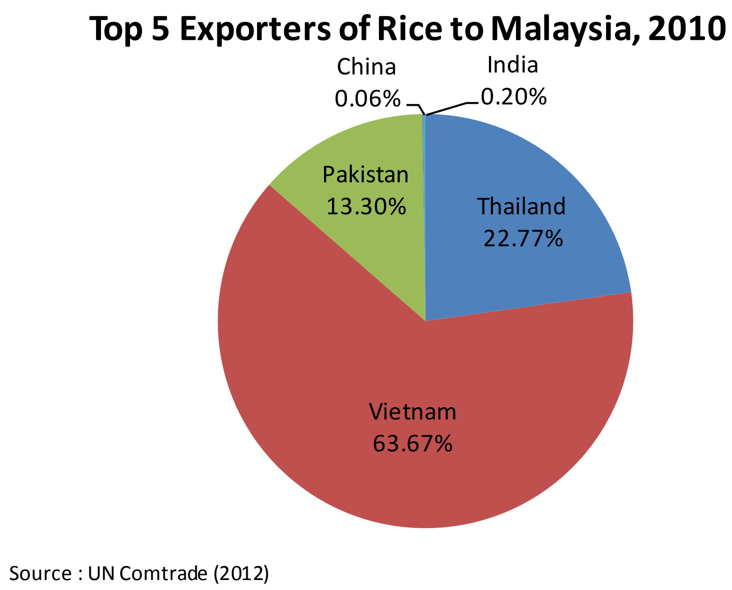


Figure 2.3 Top 5 exporters of rice to Malaysia

Institutional Organizations in the Malaysian Agricultural Sector

The institutional organizations in the Malaysian agricultural sector, particularly in the rice sector are well organized and coordinated. The Ministry of Agriculture and Agro-Based Industry which changed its name from the Ministry of Agriculture in 2004 is comprising of three departments, namely the Department of Agriculture (DOA), Department of Fisheries and Department of Veterinary Services; along with eight agencies which include Lembaga Pertubuhan Peladang (LPP), Fisheries Development Authority of Malaysia (LKIM), Agro Bank, Malaysian Agricultural Research and Development Institute (MARDI), Federal Agricultural Marketing Authority (FAMA), Muda Agricultural Development Authority (MADA), Kemubu Agricultural Development Authority (KADA) and Malaysian Pineapple Industry Board (MPIB).

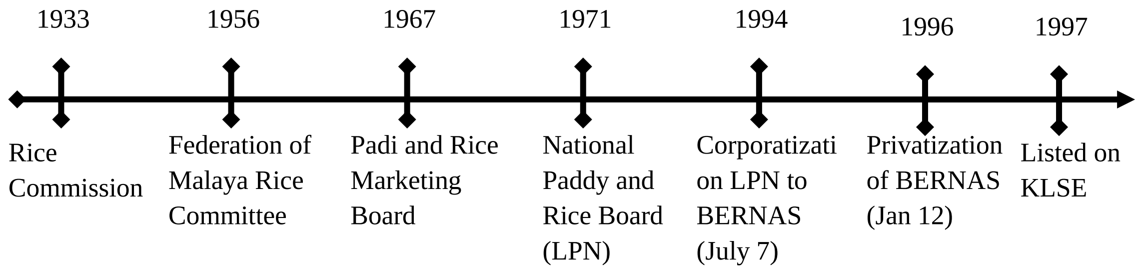
Under FAMA[4], the Paddy and Rice Marketing Board was established in 1967 to assist the paddy farmers in marketing functions and prevent exploitation by middlemen. This Board issued trading licenses to middleman and took direct control of buying, selling and milling (Ahmad1998). The National Paddy and Rice Authority or Lembaga Padi dan Beras Negara (LPN) was established in September 1971 under the

[4] FAMA was established for marketing agricultural produce.

LPN Act 1971 to take over the functions of the Paddy and Rice Marketing Board where one of the functions was to ensure price stability in the rice industry.

LPN had extensive controls in terms of price control and marketing channels. LPN controlled prices at the farm gate and the border level. It also issued licenses to wholesalers, retailers, importers, exporters and millers. Following the shortage in the world supply in early 1970s, the government granted an exclusive monopoly right to import and export rice to the LPN in 1976 (Ahmad1998). The LPN was also responsible for maintaining the stockpile of rice to stabilize any price fluctuations. Furthermore, the LPN also controlled the interstate movements of rice or paddy to prevent shortages. (Dano and Samonte 2005).

In 1994, the LPN was corporatized into Padiberas National Berhad (BERNAS) and later privatized on January 1996. In the following section, further roles of BERNAS in Malaysia's rice sector will be discussed. The various milestones of the authorities involved in the paddy and rice industry in Malaysia are given in Figure 2.4.



Source : PadiBeras National Berhad (2009)

Figure 2.4: Institutional developments in rice industry

Role of BERNAS in Rice Industry

Padiberas National Berhad known as BERNAS is the successor to the National Paddy and Rice Board (LPN) which has regulated the paddy and rice sector in Malaysia since its privatization in January 1996.BERNAS is involved in paddy procurement and rice processing, importation and exportation, distribution and marketing activities.

Hitherto, as reported by Padiberas National Berhad (2009), BERNAS has a market share of around 25 per cent of the paddy market and 45 per cent of the local rice demand. It also owns 32 rice mills as well as 50 purchasing centres, called "Skim Pusat Belian", which are located with the "*Bumiputera*"[5] millers who participate with BERNAS. Local farmers have choices between BERNAS millers (this includes the millers under the Bumiputera Rice Millers scheme) and private millers to sell their paddy. However, the BERNAS purchase about 800,000 tones, 34 per cent of the total paddy production from the local farmers. Locally produced and imported rice is distributed to licensed wholesalers and retailers (such as Save More Community stores) to control the price.

One of the most important roles of BERNAS is to ensure a sufficient supply of rice in the country. Currently, the self-sufficiency level in rice is around 75 per cent with the remaining 25 per cent imported by BERNAS, the sole importer, to meet the demand. The government has given BERNAS monopoly power to import and export rice until January 2011 and further extended this power for another 10 years until 2021. The government has given an import duty exemption to BERNAS under the privatization agreement. This allows BERNAS to supply imported rice slightly above the local rice prices. Besides maintaining quality standards of the rice, BERNAS is also obligated to ensure fair and stable prices on imported and locally produced rice. They also import high quality rice varieties such as basmati and fragrant rice to meet the requirements of a diverse society.

Under the privatization agreement with the government, BERNAS is obliged to maintain and manage the national stockpile of rice to ensure sufficient supply and to stabilize prices.[6] Due to the rice crisis in 2008, the government increased the size of the national stockpile to 292,000 tonnes from only 92,000 tonnes previously. This was designed to ensure food security for the populace as well as to control prices due to world price fluctuations.

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[5]*Bumiputera* is the Malay term used in Malaysia to address the indigenous people of the Malay Archipelago. Under the New Economic Policy (NEP) in 1970, the government designed policies in favour to the Bumiputeras to create opportunities in education, business and social development. This was to eradicate poverty and reduce the income disparity among other religions.

[6]Managing stockpile alone is not sufficient to stabilize prices. According to Gouel and Jean (2012), storage policies (buffer stocks) and trade policies act as complements to each other in stabilising the domestic price.

As a part of its obligations under the privatization agreement, the distribution of paddy price subsidies to the farmers is also regulated by BERNAS on behalf of the government. BERNAS also ensures that paddy buyers follow the Guaranteed Minimum Price (GMP) set by the government. Besides these obligations, BERNAS also acts as the buyer of last resort purchasing all paddy delivered if the farm gate price falls below the GMP. Under the Bumiputera Rice Millers scheme, BERNAS guarantees the Bumiputera millers'[7]a market share for their produce at predetermined price and quantity.

The roles of BERNAS in the Malaysian rice industry as shown in Figure 2.5 are significant and the effects on trade and production are yet to be examined. In this study, the role of BERNAS as the sole importer and its impact on rice trade will be examined.

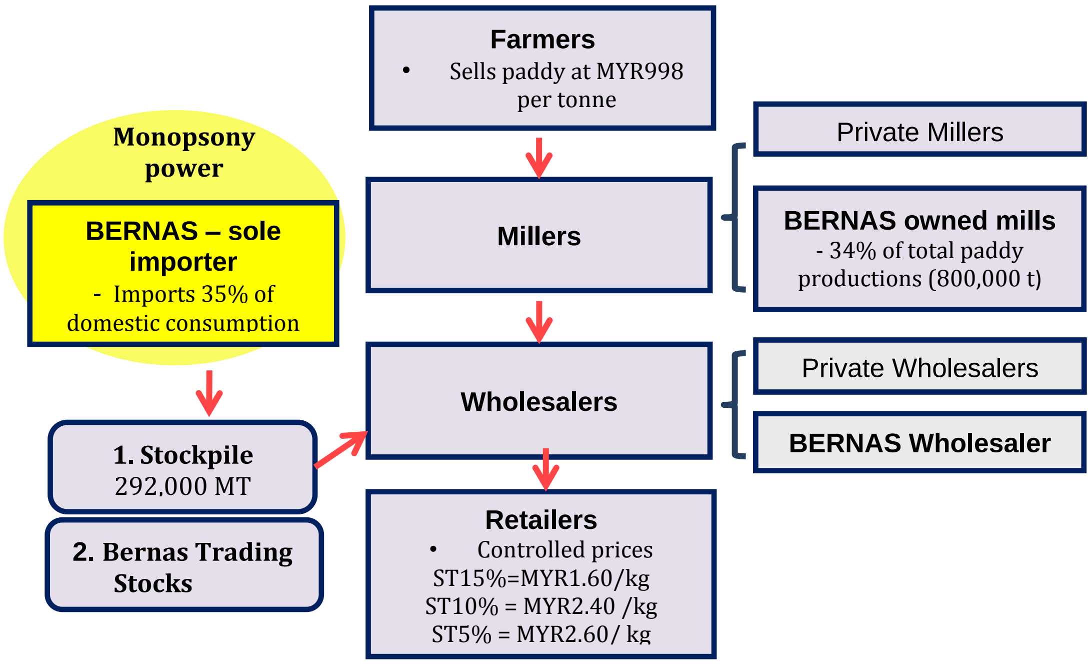


Figure 2.5 Roles of BERNAS in the Malaysian Paddy and Rice Industry

Domestic Support in the Rice Industry

The rice sector is not only highly subsidized but also highly regulated by the government in favour of the farmers at the expense of taxpayers. Rice is regarded as one of the most assisted crops since the guaranteed minimum price scheme was

[7]Bumiputera millers refer to the rice mills owned by the Bumiputeras who are the indigenous people of the Malay Archipelago.

introduced in 1949, well before independence (Athukorala and Wai-Heng 2007; Zubaidi 1992; Fletcher 1989; Rudner1994). As the poverty among paddy farmers is high in Malaysia, the government regards this as an important and sensitive political issue (Fatimah and Mohd Gazali 1990). Three primary objectives of the rice policy are to ensure food security, to raise the farmers' income and productivity; and to ensure food supply to consumers at reasonable costs (Tan 1987).

Besides self-sufficiency, the government policies for the rice industry also are focused on poverty reduction and sectoral growth (Ahmad 1998). For this purpose, the government has carried out a set of policy measures for the industry ever since independence in 1957. It has been targeted to increase the yields and raise the income level of farmers. In the next section, some of the important policy interventions that are relevant to this study will be discussed.

Subsidies and incentives

According to the Economic Report 2011/2012 (Ministry of Finance Malaysia2012), the government allocates MYR3.8 billion to the agriculture sector of which about 37.9 per cent goes to the rice sector. The allocations are MYR974 million for price subsidies for paddy, fertilizers and paddy seeds and another MYR230 million for production incentives and to upgrade the drainage and irrigation system and MYR235 million for usage of high quality seeds. However, the allocation in 2009 was higher than in 2011, because the government introduced new subsidies such as millers' subsidy and a consumer subsidy as a consequence of the fluctuations in the world price. The breakdown of the government allocation in 2009 to various types of subsidies and incentives is shown in Table 2.3.

Table 2.3 Subsidies and incentives in paddy production and rice industry, 2009[a]

Types of subsidies/incentives	Descriptions	Allocations (MYR mil.)
Subsidy for the paddy price	Farmers receive MYR 248.10 for each tonne of paddy sold.	448.00
Federal Government paddy fertilizer subsidy scheme	240kg/hectare mixed fertilizer (12 bags@ 20kg/bag) and 80kg/hectare for organic fertilizer (4 bags @ 20kg/bag)	275.06
Yield increase incentive	MYR 650 for each 1 tonne of increase in yield at the farm level compared with the previous year (base year).	40.00
Paddy production incentive[b]	Ploughing expenses at a maximum of MYR 100 per hectare and additional fertilizer of MYR 140 per hectare per season (maximum)	150.00
Additional fertilizer NPK	3 bags @ 50kg each bag/hectare	250.00
Subsidy for pesticide control	MYR200/hectare/season	173.00
Rice millers subsidy[c]	Peninsular Malaysia: MYR750/tonne Sabah & Sarawak: MYR600/tonne	250.00
Subsidy for rice in Sabah and Sarawak	Difference between wholesaler price and purchasing cost of rice import	150.00
Total		**1736.06**

Source : Ministry of Agriculture and Agro-Based Industry (2010).

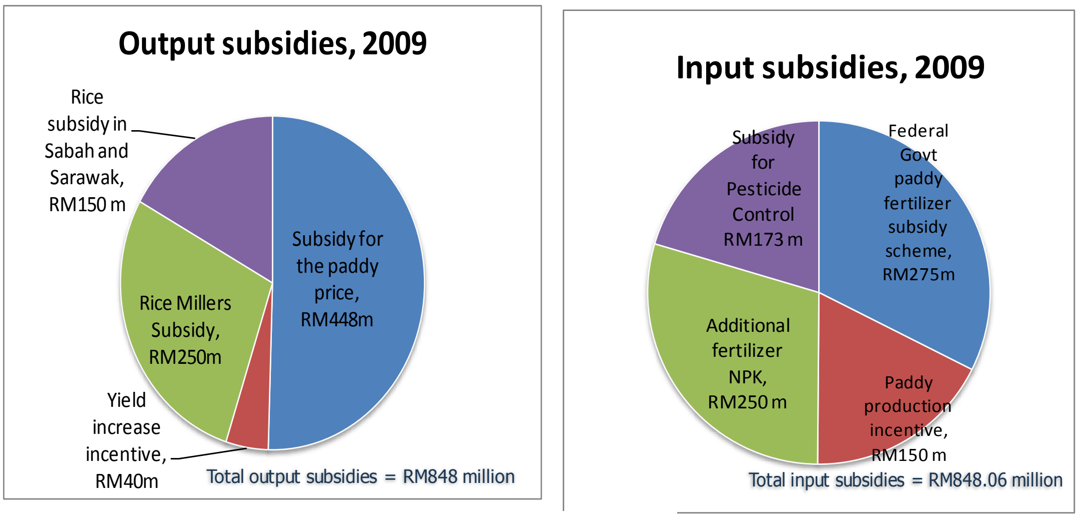
[a] Last updated on 27 August 2009
[b] Figure estimates based on area harvested and total expenses in year 2009.
[c] This subsidy started in 2008 during the rice crisis to encourage millers to produce ST15% broken rice. However, this scheme will be replaced by a consumer subsidy program called "Rice for the People Subsidy Programme"(SUBUR). The estimated cost for this program is approximately MYR93.9 million.

Fertilizer Subsidy. This program was one of the earliest policies in the rice sector introduced in the early 1950s to encourage farmers to use organic fertilizers to achieve higher production and thus increase their income. This program is mainly focused on the small farm holders to protect their income. Under this scheme, the farmers received free fertilizer of 240 kg of mixed fertilizer and 80 kg of organic fertilizer for each hectare planted. The government continues to support the scheme even though it was a temporary measure at the time of its implementation. The reason is associated with the continuous increase in the world fertilizer price, so the government still supports the scheme even though the import cost has risen as well as the government's total cost for the scheme (Ahmad 1998; Dano and Samonte 2005). In 2009, the allocation for this program was further increased by 8.2 per cent from the previous year, to MYR276.06 million.

Paddy Price Subsidy. As an income support program, this subsidy was first introduced in the early 1980s when farmers were given MYR33 for each tonne of paddy sold (MYR2 per picul) to any millers. This amount was a top-up to the farm gate price. This rate was subsequently revised to MYR165 per tonne in 1982 and finally in 1990 to the current level of MYR248.10 per tonne. Among the subsidies and incentives provided by the government, this subsidy program cost the most. From 1980 to 2009, the total cost for this program to the government was MYR13.38 billion which was paid to the farmers for the purpose of income support with an average of MYR448 million annually.

Incentive for Productivity Improvement. This program was implemented in 2005 to encourage the farmers to increase their productivity. The program was designed to increase the self-sufficiency level in rice to 90 per cent under the 9th Malaysian Plan. For every one tonne increase in the yield from the previous year, the farmers would receive MYR650. The minimum requirement to obtain this incentive is to produce at least one tonne increase in yield.

The other incentives such as the Rice Miller's Subsidy, Addition of NPK Fertilizer and an incentive to use certified seeds were introduced in 2008 to support farmers. To simplify, the subsidies are divided into output and input subsidies as illustrated in Figure 2.6



Source: Ministry of Agriculture and Agro-Based Industry (2010)

Figure 2.6 Output and input subsidies in 2009

Guaranteed Minimum Price (GMP)

The Guaranteed Minimum Price (GMP) was introduced in 1949, mainly to protect the income of paddy farmers. If the farmers are net buyers of food, then the GMP may raise the poverty level. The GMP is a price floor at which the government will act as the "buyer of the last resort" if the farm price falls below the GMP. At the initial stage, the GMP was MYR248 per tonne and then was revised over the years until the current level of MYR700 per tonne in 2011. However, the GMP was found to be not effective since the farm price has always been well above the GMP as shown in Figure 2.7. Therefore, the effect of the GMP has not been included in the model formulation.

Price controls

Besides the GMP, the government also imposed a price ceiling to prevent high prices for rice as it was seen as an essential good for most of the consumers in Malaysia. The government regulates the price for three categories of locally produced rice, Super Tempatan (ST) rice namely, ST5 (5 per cent broken rice), ST10 (10 per cent broken rice) and ST15 (15 per cent broken rice). However, recently the government has only controlled the price for the ST15 grade rice, which is consumed largely by the lower income population. The controlled retail price for the ST 15 rice is between MYR1.65 to MYR1.80 per kg according to zones.

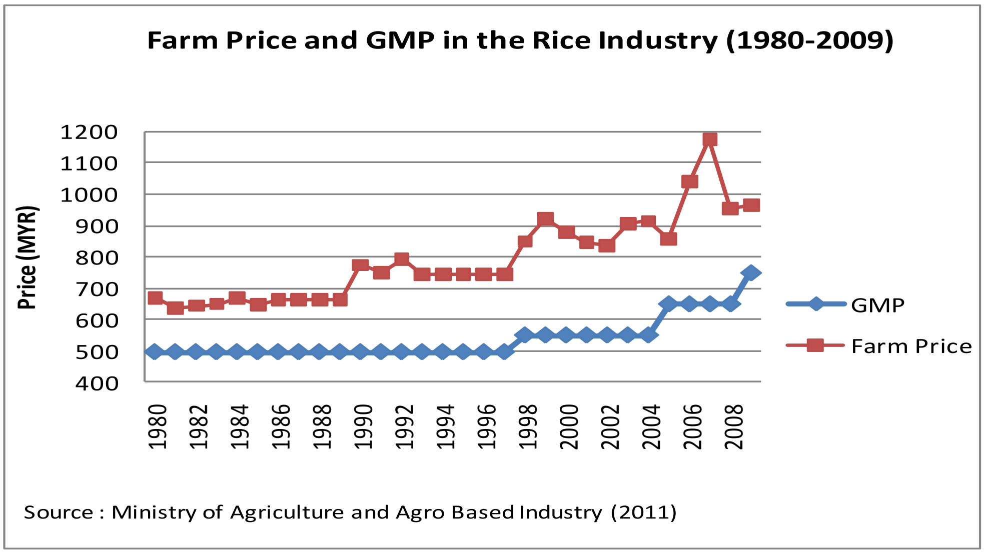


Figure 2.7 Difference between farm price and GMP in rice industry from 1980-2009

Soon after the world price spike in 2008, the government introduced a new subsidy, the Rice Miller's Subsidy, to encourage millers or producers to produce ST15 grade rice. Under this scheme, the government pays MYR750 and MYR600 for each tonne produced in Peninsular Malaysia and Sabah and Sarawak respectively. Since the consumption of ST15 rice is about 10 per cent of the total consumption, it was assumed that the effect of price control on the industry was not significant. Furthermore, in this study, it was assumed that rice is homogeneous due to the unavailability of data on different rice grades.

Buffer stocks

Malaysia is one of the countries that still practise the use of buffer stocks. A buffer stock is one of the measures used to stabilize the domestic price from fluctuations in the world price together with trade policies. Introduced by the government under British rule in 1949, the buffer stock was implemented to ensure sufficient rice supply during emergencies as well as to stabilize the price of rice. When the world price of rice rises, the domestic price for consumers is less affected as the government controls the price through the release of stocks. If the world price drops, the producer's price is protected as government imposes a price floor and holds back supply and moves it into stocks.

The government has suffered huge losses by maintaining the stockpile of 90,000-100,000 tonnes due to storage costs and spoilage. After the surge of world prices in 2008, the government instructed BERNAS to increase its stockpile by 217 per cent from 92,000 to 292,000 tonnes. This drastic step was taken to ensure a sufficient supply of rice for its populace for at least 45 days of consumption in case the world price remained high. Eventually, this has led to an increase in the overhead cost to BERNAS of maintaining the stockpile and has led to the release of rice from stocks to consumers at a lower price (which is independent of the world price).

Quantitative restriction

As discussed, the government has given BERNAS the exclusive right to import rice until2021. In other words, BERNAS has the monopsony power as the sole buyer of rice into the country. As a result, they can negotiate lower prices with their suppliers. As discussed earlier, in regard to the buffer stock and financing the cost of storage and spoilage costs, the government imposed an import quota on the importer, BERNAS. Under this policy, BERNAS was allowed to import rice based on the quota given by the government. The impact of import quotas will be analysed further in Chapter 7.

Trade Agreements

Multilateral agreement

The government has understood the importance of trade liberalization, including agricultural trade, as it has become a member of World Trade Organization (WTO) and the ASEAN Free Trade Area (AFTA). Under these agreements, Malaysia has an obligation to instigate the requirements as set out in the multilateral trade agreements between the member countries. In any multilateral agreement, agricultural requirements are often the most difficult to satisfy. More details on the agricultural agreement, particularly regarding rice, are provided in the next section.

WTO Agreement of Agriculture

Malaysia is a founding member of the WTO as it has been a member of the General Agreement on Tariffs and Trade (GATT) since 1957. Malaysia's accession into the WTO in 1995 and signing of the Uruguay Round Agreement had significant implications for the agricultural sector, especially on rice. Under the WTO Agreement on Agriculture (AoA), Malaysia has to comply with the agricultural negotiations which currently focus on market access commitments[8], reducing subsidies (domestic support) provided to farmers in the agricultural sector and elimination of export

[8]As Malaysia underwent tariffication (converts non-tariff barriers into tariffs), it has been eligible to use the Special Safeguard (SSG) which is a tariff mechanism that gives temporary protection against import surges and drops in world prices.

subsidies and export financing supports. The tariff reductions on the agricultural products by an average of 36 per cent over 5 years and 24 per cent over 10 years for developed and developing countries respectively were negotiated.

Despite these reductions, many developing countries still retain agricultural subsidies, especially on rice. Malaysia is not an exception to this case, as it has listed rice under the sensitive list[9]. As rice is the main staple food, and to protect domestic farmers, the majority of which are predominately ethnic Malay, the government provides subsidies to farmers. As with many other developing countries, Malaysia imposes a high tariff rate on rice imports, as high as 40 per cent among the member countries to protect its rice sector[10].

ASEAN Free Trade Agreement (AFTA)

Apart from being a member of the WTO, Malaysia is also a member of the Association of Southeast Asian Nations (ASEAN), which initiated the ASEAN Free Trade agreement (AFTA) to enhance the intra-ASEAN trade. Originally, the AFTA agreement was signed in January 1992 with six members namely; Malaysia, Singapore, Thailand, Philippines, Brunei and Indonesia. Currently, there are ten members including Vietnam, Laos, Myanmar and Cambodia. The main objective of the establishment of AFTA was to enhance the competitiveness of ASEAN regions as a globally competitive production base as well as to attract higher foreign direct investment to ASEAN countries. One of the measures was to eliminate trade and non-trade barriers among the member countries. Thus, the Common Effective Preferential Scheme (CEPT) was established in 1992 to implement this issue.

Under the AFTA, there are four categories of products listed namely: inclusion list, temporary inclusion list, sensitive and highly sensitive list; and general exception list. Malaysia had eliminated 3,368 tariff lines in 2007 and a further elimination of 2,291 tariff lines in 2010 under the CEPT scheme (Ministry of Trade and Industry 2010). However, rice was listed under the sensitive and highly sensitive list as the

[9]Under the CEPT-AFTA agreement, the member countries agreed to maintain tariffs on selected items in the sensitive or highly sensitive list.
[10]The 40 percent tariff is irrelevant while BERNAS has the import license.

government protects the industry for food security reasons. As obliged by the protocol of sensitive and highly sensitive product reductions in tariffs, Malaysia reduced the import duty for rice to 20 per cent in January 2011.

Currently, Malaysia's import duties are 20 per cent and 40 per cent for rice imports which are tariff bindings under the CEPT and WTO agreements respectively. However, BERNAS is bound by the provisions on state trading enterprises (STE) which are required to meet domestic demand and not to impose a mark-up above the tariff bindings. The existence of BERNAS as a sole importer may have trade-distorting effects as occurs with most of the state trading enterprises in other countries where they are effectively acting as non-tariff barriers to trade (McCorriston and MacLaren 2012). A state trading enterprise such as BERNAS could resolve the impacts of price fluctuations in the domestic market by other means. In effect, there are no tariffs in the Malaysian rice trade while BERNAS has a duty free import license. The actual impact of the tariff arrangements will only be felt when BERNAS's license expires in January 2021.

Research and Development

In this section, the overall trends in research and development (R&D) in Malaysia will be discussed and then a focus given to the agricultural sector and finally a focus on the rice industry.

Trends in Overall R&D expenditure

After an increasing trend in the gross expenditure on R&D (GERD) since 1996, there was a steep decline from MYR3.6 billion in 2006 to MYR1.7 billion in 2008 which account for a 52 per cent drop as shown in Figure 2.8. The R&D intensity – R&D gross expenditure relative to GDP – has also dropped from 0.64 per cent in 2006 to 0.24 per cent in 2008 as in Figure 2.7. The R&D intensity ratio in 2008 was close to what it was in 1996, which was 0.22[11].

[11]The data obtained from the National Survey of Research and Development 2008 is in nominal terms and does not account for inflation. However, the inflation rate in Malaysia was only about 4 percent per

Not surprisingly, Malaysia's research intensity ratio (GERD/GDP), which was as low as 0.24 per cent in 2008 has placed Malaysia near the bottom of the list for research intensity compared even to the least developed countries such as Ethiopia. According to MASTIC 2010, the GERD/GDP ratio may not have captured the true R&D expenditure, thus the international comparison in that particular year could be meaningless. In 2006, Malaysia was placed at the 47th place, which is closer to the lower income countries but according to World Bank classification, Malaysia is in an upper middle-income group. This showed that Malaysia still has a long way to go to achieve higher R&D expenditure and to be closer to China and India.

The private sector has always been a prominent contributor to the Malaysian GERD. However, in 2008, the GERD for the private sector dropped dramatically from MYR3.1 billion in 2006 to MYR535.5 million, which is reflected in the overall GERD as in Figure 2.8. Many private firms reduced their investment due to the global crisis in 2008 and this change in the longer-term increasing trend as well as a shift in the proportion of private sector R&D to total R&D expenditure are reflected in Figure 2.9.

Until 2006, the involvement of the private sector had increased over time. At the same time, the importance of the public sector dropped as shown in Figure 2.9. The private sector has had the biggest share in the R&D expenditure except in 2008 as illustrated in Figure 2.10. However, the share of the private sector has not been consistent over the last 16 years. The public sector accounted for 69.2 per cent of the GERD in 2008 in which the Government Research Institute (GRI) and the Institute of Higher Learning (IHL) had24.8 per cent and 44.4 per cent respectively.

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year and the GERD is still low in 2008 even if it is deflated by the GDP deflator base year of 1987, based on the World Development Indicator (WDI).

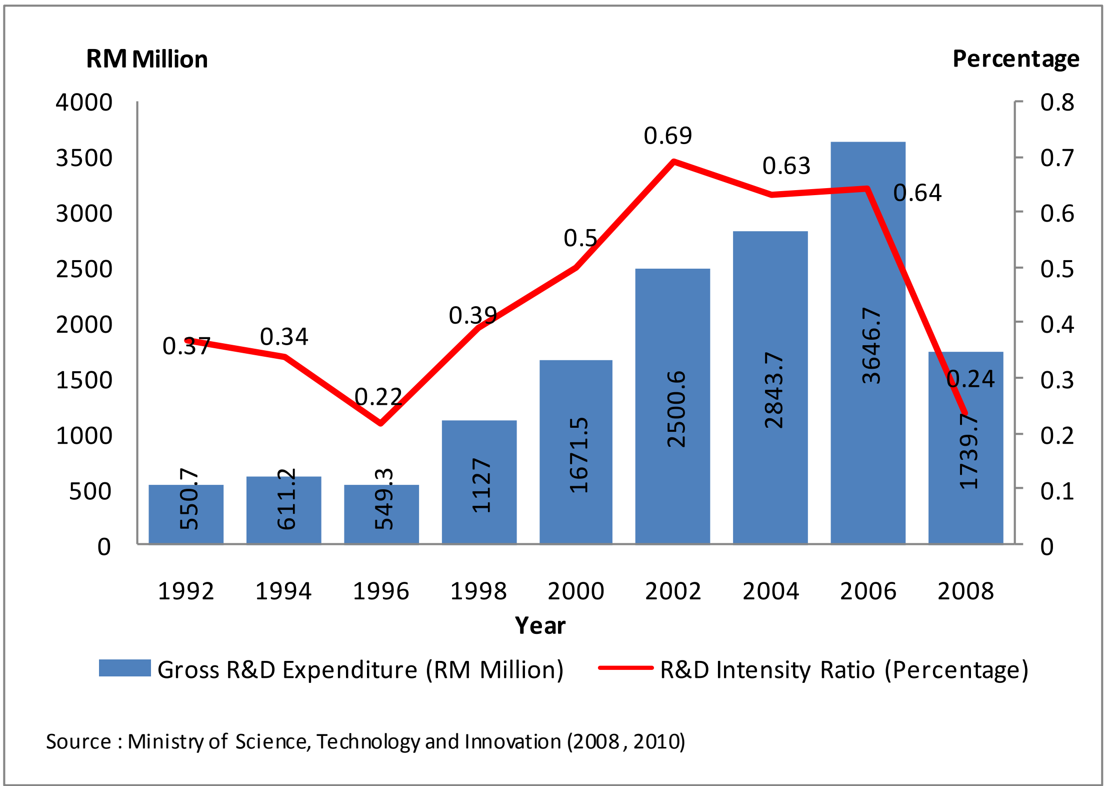


Figure 2.8 Gross expenditure on R&D and R&D intensity ratio, 1992-2008

In 2008, the R&D spending for both the public and private sectors were sourced from their own institution's funds which accounted for 67.2 per cent; foreign funds represented 0.1 per cent; federal and state government funds consisted of21.5 per cent and 1.3 per cent respectively and the balance of 9.9 per cent of funds was derived from the Intensification of Research in Priority Areas (IRPA) program[12]. However, 99.5 per cent of the funds for the private sector came from the institution's funds.

Research in Malaysia is classified according to five main fields of research. These are Engineering Science, Applied Science and Technology, Agricultural Science, Material Science and Information, Communication and Technology (ICT). Unlike previous years, in 2008, the R&D expenditure for Agricultural Science was the second top field of research expenditure accounting for MYR274.1 million with a share of 58 per cent compared with only 4.6 per cent in 2006. This showed that government has placed significant emphasis on agricultural R&D.

[12]IRPA grants were initiated in 1988 to encourage the researchers in both agricultural and non-agricultural research into the priority areas set by the government. The Institute of Higher Learning and government research institutes were eligible for IRPA grants in three important categories, namely applied research, strategic research and prioritized research.

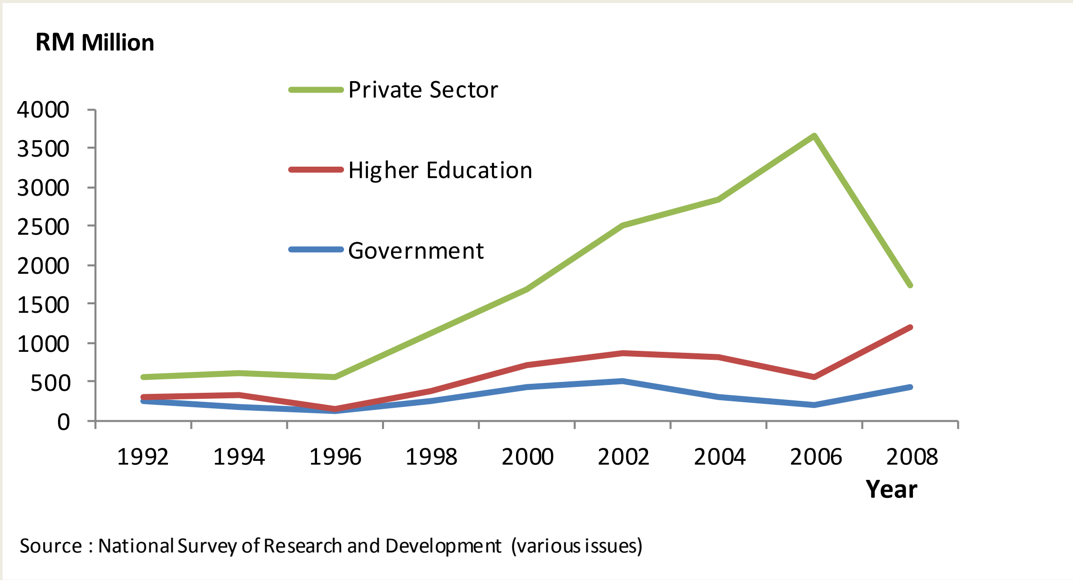


Figure 2.9 R&D Expenditure by Sectors, 1992 -2008

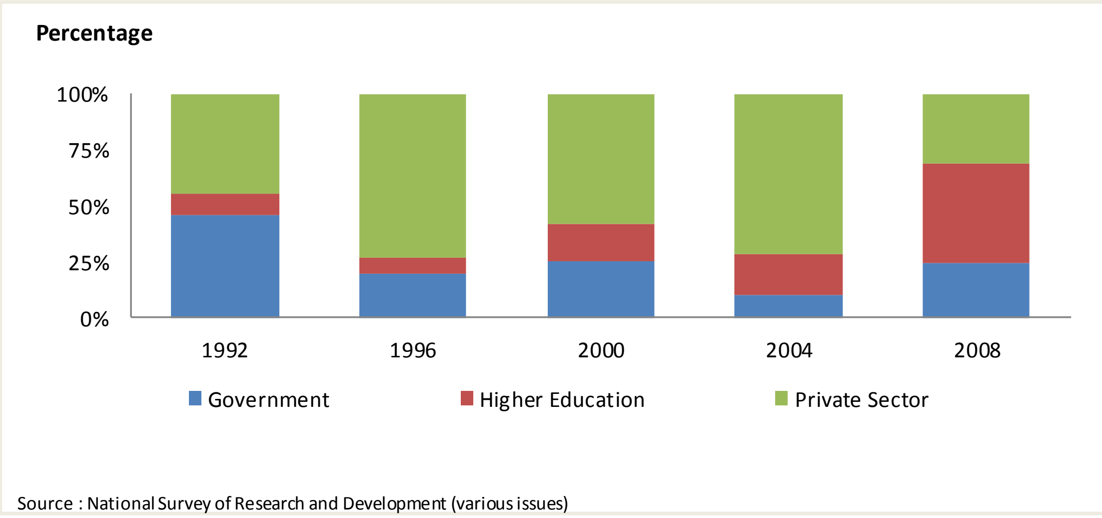


Figure 2.10 Share of R&D Expenditure by Sectors, 1992 -2008

Trends in agricultural R&D spending

In the previous section, the R&D investment in Malaysia was discussed. However, this section will be focused more on the agricultural sector. Before looking at the agricultural R&D spending in Malaysia, it is essential to understand the global perspective.

The global spending on public agricultural R&D has increased consistently to about 43 per cent of total R&D expenditure from USD16.6 billion in 1981 to USD23.9

billion in 2000 (Beintema and Elliott 2011; Alston et al. 2010)[13]. Notably, the shares of agricultural R&D in the developing countries are much higher than in developed countries. In Figure 2.11, the public agricultural R&D expenditure for some selected Asian countries is given (China and India, the main players in agricultural R&D; Vietnam, Indonesia, Pakistan and Malaysia) in 1994 and 2002 (years that data are available for all the selected countries).

In both years, 1994 and 2002, China and India accounted for more than three quarters of the public sector expenditure in agricultural R&D. Malaysia's agricultural R&D increased by 69 per cent from 1994 to 2002, but its share of public agricultural R&D among the countries, is comparatively low at 9.4 per cent because of the much larger contributions from India and China. In 2002, Malaysia was the highest in terms of share of agricultural R&D in agricultural value added with 4.9 per cent and followed by China and India with 1.24 and 1.23 per cent respectively.

Interestingly, Vietnam's share of public agricultural R&D almost tripled from USD17.2 million in 1994 to USD55.9 million in 2002. This showed that Vietnam has invested heavily in its agricultural sector. However, both Pakistan and Indonesia showed a declining trend in their R&D expenditure and eventually the share in the region has also dropped. Given the low levels of agricultural R&D investment in Malaysia, it is likely there are very large marginal revenues to growing the expenditure and large payoffs to making Malaysia more competitive with particularly China and India.

Agricultural research in Malaysia was initiated in the1900s; however, after 1986 under the 5th Malaysian Plan (1986-1990), the government established agricultural research as an important component in the national development planning. Since then, GERD has increased steadily over the years. Agricultural R&D expenditure in Malaysia increased between1981 to 2002 at an average growth rate of 5.65 per cent per year.

[13]The data for agricultural R&D were obtained from Agricultural Science and Technology Indicator (ASTI) dataset published in 2005 using purchasing power parity (PPP) dollars. The latest year available for international comparison is for the year 2000. ASTI has a complete database for agricultural research for middle and lower income countries.

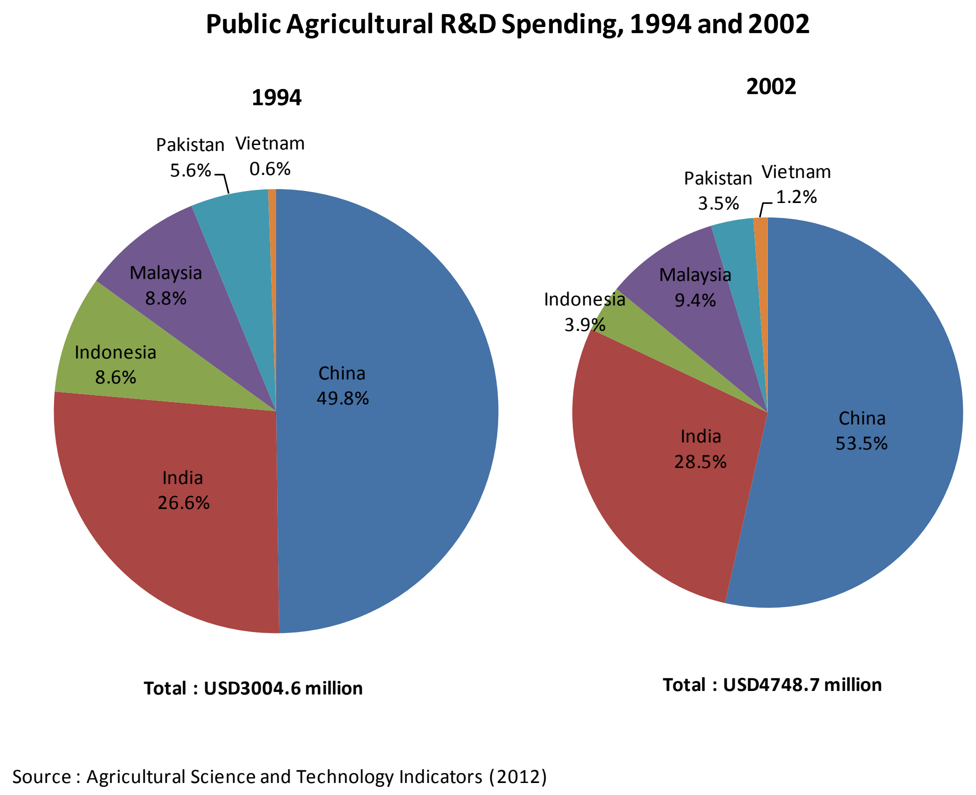


Figure 2.11 Public Agricultural R&D spending for selected countries, 1994 and 2002

Unlike total R&D expenditure, 95 per cent of the agricultural R&D expenditure is from the public sector and the contribution from the private sector has been limited. A study by Pray and Fugile (2001) on Asian countries found that private sector investments grew faster than public sector investments in China, India and Indonesia. However, this was not true for Malaysia. Based on the Agricultural Science and Technology Indicator (ASTI) dataset, the growth rate of the private agricultural R&D from 1996 to 2002 was 3.8 per cent per year while the public sector was 8.7 per cent.

In 2002, 60 per cent of total funds for R&D came from the federal government, 9 per cent were generated from the Intensification of Research in Priority Areas (IRPA) program and CESS revenues[14] levied on oil palm and rubber exports contributed another 25 per cent while foreign donors and other sources constituted 6 per cent (Stads et al. 2005).

[14]CESS revenue is the government revenue obtained from the levy or tax imposed on oil palm and rubber exports. The revenues are used for R&D purposes.

Agricultural research is generally conducted by public agencies, government research institutes and institutes of higher learning as well as the private sector. The Malaysian Agricultural Research and Development Institute (MARDI), is the main government agency to conduct agricultural R&D and it accounted for a quarter of the agricultural spending in 2002. The majority of research in MARDI is funded by the government and IRPA grants and also with limited funding provided by the private sector and international agencies (Stads et al. 2005). Besides MARDI, there are eight other government agencies and more than ten institutes of higher learning that conduct agricultural R&D.

Research on rice

Rice research is carried out mainly by the public institutions. R&D on rice has been conducted mainly in Malaysia's principal agricultural research agency, MARDI and higher learning institutions namely the University Putra Malaysia (previously known as Malaysian Agricultural University). In MARDI, a specific department called the Rice and Industrial Crops Research Centre specialized into carrying out rice research. MARDI has a collaboration with the International Rice Research Institute (IRRI) and signed a memorandum in 1991 to promote and accelerate research on rice and rice-based farming systems. In 2011, the personnel in both institutions had agreed to further the collaboration and work on various projects such as developing drought tolerant rice varieties and sustainable aerobic rice production (IRRI 2011)[15]. It is also apparent that Malaysia will have gained from rice industry research in other countries that is as a spillover from their research programs.

The main focus of rice R&D has been to increase production levels of local rice to meet the 75 per cent self-sufficiency level for rice. More focus has been given to areas like varietal development for higher yields and production of high quality rice. Some of the new high-yielding rice varieties are MR 232, MR 220, MR 219 and MR 211; and high quality rice varieties are MRQ 50 and MRQ 74. The majority of the rice varieties used in the field is from MARDI's own-breeds namely MR219 and MR220

[15]MARDI has access to the R&D carried out by IRRI as outlined in the memorandum, however, the disaggregate data for the R&D expenditure and the rice varieties used by farmers are not available, thus the impact of R&D from IRRI is assumed to be constant in this study.

(Personal Communication 2012). Besides these varieties, there are also herbicide resistant varieties and improved technologies such as rice storage and water saving. MARDI, as well as other departments such as Agricultural Biotechnology and Food Technology also carry out rice research.

Rice R&D expenditures represent only seven per cent of total agricultural R&D. In 2002, only MYR5.7 million was spent on rice research. The proportion of the rice R&D in total agricultural R&D was small during the time period of this study partly because rice research expenditures are shared by other crops research. Most of the other agricultural research, such as biotechnology, mechanization and strategic research also contribute to the rice research, but, due to the unavailability of disaggregated data, these expenditures are not counted in the rice research. Furthermore, disaggregating R&D expenditure into a single commodity is difficult since all the research facilities and equipment are shared among different departments (Alston et al. 1995). The figures obtained for rice R&D were based on the percentage given by the Ministry of Science, Technology and Innovation. The research data and selection of appropriate lag structures and length will be discussed in detail in Chapter 7 when more details of the modelling work are considered.

Concluding remarks

In this chapter, an overview of the Malaysian rice industry has been presented. The production, consumption and trade patterns were discussed to facilitate the design and development of a model structure. It is important to understand the institutional settings, so that a consistent evaluation can be undertaken. Some important policies pertaining to the rice industry were also pointed out so as to set a clear picture for the modelling framework. The import quotas and domestic subsidies will be included in the modelling framework.

Chapter 3: Agricultural R&D and Trade

Introduction

In this chapter, a review of the literature on the returns from research and development (R&D) and the impact on international trade is discussed. A broad perspective of R&D benefits and productivity growth in the agricultural sector will be explained in the first section. In the next section, the effect of research lags and distributions of benefits from research will be explained. Some market distortion policies and the impacts on trade and research benefits will also be evaluated in the next section.

Agricultural R&D expenditure and productivity

Agricultural productivity growth is essential for the overall economic growth for developing as well as developed countries. Measuring the agricultural productivity has been a major focus for agricultural economists and policy makers. A huge number of empirical works have explored the impacts of R&D on productivity growth in developed countries (for example, Thirtle and Bottomley 1989; Huffman and Evenson 1992; Chavas and Cox 1992, Mullen and Cox 1995) and developing countries (Fan 2000; Coelli and Rao 2005; Nin et al. 2003; Alene 2010; Fulginiti and Perrin 1998, Lusigi and Thirtle 1997).

Before examining the relationship between agricultural R&D and productivity growth, it is important to understand the meaning of productivity. By definition, productivity is measured by the quantity of output per unit of input used. According to Hall and Scobie (2006), though, higher productivity can also be caused by other sources; the main source of productivity growth is increments in the stock of knowledge. Since the stock of knowledge is difficult to quantify, the aggregated R&D expenditures have usually been used as a proxy. Intuitively, knowledge is derived from research, thus an increase in R&D expenditures is usually assumed to increase the stock of knowledge.

A seminal contribution by Griliches (1958) on the measures of return to investments in agricultural R&D gave impetus to hundreds of studies in this particular area. As the pioneer, Griliches (1958) used the cost-benefit approach and showed internal rates of return of 35 to 40 per cent in corn research and 20 per cent return in hybrid sorghum. He estimated the loss in the net economic surplus if the hybrid corn were to "disappear" and assumed that the supply curve would shift upwards as in the case of a perfectly elastic supply (long run) or alternatively shift to the left as in a perfectly inelastic supply (shorter run). He found that the estimated losses were somewhat greater in the case of using the perfectly inelastic supply of corn assumption and so used the more conservative perfectly elastic supply case.

Furthermore, Griliches (1964) was one of the first to use regression analysis and the Cobb-Douglas production function, and found that research expenditures had significant contributions to output and had similar rates of return as in his earlier studies in 1958. Following Griliches (1958, 1964), Peterson (1967) employed an index-number approach to measure the percentage decrease in the supply function and thus relaxed the supply elasticities assumptions of Griliches. He used both cost-benefit and production functions to analyse the rates of return to R&D in the poultry market and found a 20 to 30 per cent return from the investment. Much of the earlier work had focused on partial measures of productivity in terms of labour and land productivity. The econometric and non-econometric approaches used to evaluate the benefits of research will be discussed in detail in the next chapter.

Recent studies have also found significant contributions of agricultural R&D research to productivity growth (Thirtle and Bottomley 1989; Lusigi and Thirtle 1997; Mullen and Cox 1995; Mullen 2007; Hall and Scobie 2006; Sheng et al. 2011, Thirtle et al. 2008). Alene (2010) found that R&D was a profitable investment in African agriculture with a rate of return of 33 per cent per year while Mullen et al. (2008) found 15 to 20 per cent returns to investment in New Zealand and Australia.

From previous literature, it is obvious that the returns to agricultural R&D investment are significant and continue to increase over time as reported in Alston et al. (2000). They have compiled a list of 292 studies published from 1953 to 1997 and reported 1,886 estimates of rates of return to agricultural R&D. Since the average rates of return measure leads to some misinterpretation, the median was used in their compilation. The median return to investment estimates for research and extension were 48 per cent and 69.2 per cent respectively.

Apparently, only 21 per cent out of the 1,886 estimates of the rates of return to agricultural research fell within the conventional range of 40 to 60 per cent per year (Alston et al. 2000). Additionally, they found a wide spread of rates of return around the average and significant positive skewness in the distribution. To understand the variation in the measured rates of return, Alston et al. (2000, p. ix) listed various factors such as:

- Characteristics of the measures (e.g., ex-post or ex-ante, average or marginal, private or social, nominal or real).
- Characteristics of the analyst (e.g., differences in the method and approaches used by individuals or groups of researchers or differences in precision of the measures attributable to the person or group who generated the estimate or the differences between research conducted by different groups (university, government, research institute or private sector).
- Characteristics of the research being evaluated (e.g. type of technology, field of science, commodity class, time period, geographical location, institutional scope of research).
- Characteristics of the research evaluation (methodologies used to evaluate the rates of return, e.g. lag structure (gamma, trapezoid or inverted “V”, polynomial) or lag length (short lags or long lags) or market distortion and spillovers taken into consideration when evaluating the research).

Besides these characteristics, the size and distribution of the research benefits depended on the R&D induced supply shifts. In the next section, the induced supply shifts will be elaborated in more detail.

Supply shifts and research benefits

There has been debate on the functional forms and the nature of the supply shifts when evaluating R&D. In the market model, the supply curves were typically assumed to be linear or non-linear and the R&D induced supply shifts to be either parallel or non-parallel. In empirical work on evaluating research benefits, assumptions that have been used were nonlinear and pivotal supply shifts (Peterson 1967; Akino and Hayami 1975; Ayer and Schuh 1972; Wise 1984), linear and parallel shift (Griliches 1958, 1964; Hertford and Schmitz 1977; Rose 1980; Edwards and Freebairn 1984), linear and pivotal supply shift (Linder and Jarrett 1978; Rose 1980; Norton et al. 1987) and a proportional shift (Peterson 1967). Producers tend to obtain negative returns with a divergent pivotal shift when demand is inelastic (Duncan and Tisdell 1971). Voon and Edwards (1991) showed that the gross annual research benefits calculated for the non-linear supply curve with a pivotal shift differ from the linear supply curve.

However, Rose (1980, p.837) suggested that assuming a parallel shift for a supply curve is the most realistic strategy. He argued that for most innovations, the only available information will be the cost-reduction estimate for a single point on the supply curve, thus the knowledge pertaining to the shape of the supply curve or the position for single point estimates will not be available. It was suggested by Alston and Wohlgenant (1990) and agreed by Alston et al. (1995, p.64) that "under the assumption of a vertically parallel, research-induced supply shift, the functional forms of supply and demand are unimportant...". Furthermore, in Zhao et al. (1997), they found that if the proportional supply shift is assumed, significant errors in surplus changes are possible. Thus, parallel shift of the supply curve seems to be plausible, particularly when the innovation involves land-augmenting technology, as in Martin and Alston (1997). Hence, in this study, linear demand and supply functions and a parallel shift have been used.

Quality enhanced research

As discussed above, not only production improvement results from research, but also quality enhancement. Unlike productivity, the improvement in quality due to research shifts the demand curve outward (e.g. Unnevehr 1986; Lemieux and Wohlgenant 1989; Voon and Edward 1992). Unnevehr (1986) and Kim and Sumner (2005) have estimated the research benefits in rice grain quality improvement in Asian countries. Voon and Edwards (1992) assessed the research payoff for producers in Australian wheat with a one per cent point increase in the protein content. They found that 90 per cent of the net benefits accrued to the wheat producers. Other research pertaining to quality improvements have been based on the valuation of product characteristics (Dalton 2003; Ara 2003; Hurley and Kleibenstein 2005; Harris 1997). However, in this study, due to unavailability of disaggregate data on rice, it has been assumed that R&D activities are focused on quantity improvement.

Public and private investment in agriculture

Most of the agricultural research on productivity improvement has been carried out by the public sector until the Green Revolution and the Gene Revolution. Since then, participation of the private sector has started to increase. Moreover, in recent years, the private investment in agricultural research in developing countries has increased twofold compared with the public sector and the private expenditures account for almost half of the total R&D expenditures (Hareau 2006; Beintema and Elliot 2011; Alston et al. 2010). However, this scenario is not the same with the developing nations. In most developing countries, private sector underinvestment in agricultural R&D is due to a weaker definition of intellectual property rights on innovations (Alston et al. 1998; Pray 2001). Furthermore, there are weaker linkages between private-public sectors as there tends to be a lack of significant research programs in the private sector (Pray 2001).

Krishna and Qaim (2007) suggested that both the public and private sector benefits if technology transfers were properly designed and managed. They found that private-public technology transfer gives an added advantage to the private sector in which the agreement facilitates regulatory procedures and lessens the public calls for government price intervention. Moreover, Pingali and Traxler (2002) have proposed that the public sector should focus on the areas of underinvestment by the private sector such as self-pollinating crops (rice and wheat) to help the poor farmers. They also recommended the need for collaboration between public, private and multinational sectors.

Though most of the studies focused on the public R&D, only some have focused on the relationship between public and private R&D and the difference in the rates of return. Chavas and Cox (1992) estimated internal rates of return of 28 per cent and 17 per cent for public and private R&D respectively using a non-parametric approach for the period of 1950-1982. Yet, Huffman and Evenson (1992) for the same time period, reported a higher rate of 41 for public and 46 per cent for private R&D. Using an error correction model, Makki et al. (1999) estimated 27 per cent and 6 per cent returns to public and private R&D respectively. However, Thirtle et al. (2004) suggested that the relationship between public and private R&D is complementary rather than a substitute. In this study, both the public and private R&D was combined as total R&D and separate effects were not evaluated. In the next section, the potential outcomes from agricultural biotechnology will be reviewed.

Ex-ante studies on agricultural biotechnology

In assessing the impact of agricultural biotechnology, many researchers have used both ex-ante and ex-post evaluations. One of the ways, as suggested by Mamaril (2002), was to evaluate the potential impact pathways for rice biotechnology R&D output like *Bt* rice and to use this information in research prioritization and development of effective product deployment strategies. Huang et al. (2004) examined the cost and benefits of R&D of the genetically modified (GM) crops, cotton and rice, in China and found that the gains from the GM were substantial. However, they could not find any significant impact on global trade, despite higher productivity that had resulted from the R&D. In a recent study by Anderson and Nielsen (2004), it was pointed out that import bans on GM technology had a large adverse effect in Western Europe, on those who practised the import bans, but the global economic welfare from the new biotechnology was not influenced by the distorted policies.

In the case of transgenic rice[16], Annou et al. (2005) have found that an increase in production due to research leads to a decrease in price and expanded rice consumption that benefits consumers, while the producer welfare gains are small or negative. But the implication is limited in their studies as no trade regulations were assumed to be imposed on transgenic rice.

In this section, R&D and its impact on productivity and producer and consumer benefits have been reviewed. However, the size and distribution of benefits from R&D depend upon the lag effects of R&D, taking into consideration the gestation lags and how long the R&D continues to affect production. In the next section, the importance of lag length and shapes when evaluating research benefits will be discussed.

Research lags and structures

As explained in the earlier part of this chapter, agricultural productivity was assumed to be measured based on the stock of knowledge, which was modelled as a function of a distributed lag of past research expenditures. In an econometric estimation, productivity was regressed against the weighted average of past research expenditures. But questions emerged in estimating weighted research expenditures: how long will it take the research to affect the production? Then, how long will it last, 10 years, 15 years or forever? What would be the shape of the lag, polynomial or exponential? Despite a huge number of studies conducted to determine the returns to agricultural research, choosing an appropriate lag profile and the length of past research expenditures still remain questions among researchers.

Some researchers have used finite lags, while others have opted for infinite lags. Even though the stock of knowledge derived from the research depreciates over time, but to some extent, the effects of research will still persist (Alston et al. 2008). For practical reasons, many studies used finite lags to formulate the relationship with aggregated R&D expenditures. Alston et al. (2000) compiled a comprehensive meta-analysis of 1,886 observations from 292 publications. They found that 28 per cent of the

[16] Transgenic rice is a type of rice that has been genetically modified.

estimates were from studies with research lag lengths in the range of 11 years to 20 years.

It was common for researchers to limit the lag length up to 20 years in the 1980s but as more time series data became available, researchers used lag lengths up to 35 years (Mullen and Cox 1995; Huffman and Evenson 2006; Thirtle et al. 2008; Sheng et al. 2011; Alston et al. 2010). The study by Alston et al. (2008) tested for longer lags of 35 and 50 years for the U.S. agricultural research. In a recent study by Sheng et al. (2011), 16 and 35 years for R&D lags were used and found that the 35-year lag periods captured the effects of past R&D expenditures in the Australian broadacre agriculture better than the 16-year lags. However, in developing countries, the available time series data are usually not sufficient for testing longer lags. As an example, in Africa, Alene (2010) used only a 16-year lag and Schimmelpfenning et al. (2000) employed a lag of nine years between R&D expenditures and productivity. The reason these studies have used shorter lags in African studies was also due to the generally adaptive nature of the R&D.

Besides lag length, the R&D lag shape also affects the rates of return. Various types of lag shapes, designed to represent the stock of knowledge, have been used by many researchers. According to Alston et al. (2000), there were 5 types of lag shapes that have been used, namely, inverted-V, polynomial (second-order), polynomial (higher-order), trapezoid and free-form. They found that the most common types used were inverted-V or known as de Leeuw (Evenson 1967; Mullen and Cox 1995; Kim and Summer 2005), trapezoid (Huffman and Evenson 1989, 1992, 2006; Mullen and Cox 1995; Sheng et al. 2011) and lower order polynomial lags (Davis 1980, Knutson and Tweetan 1979; White and Havlicek 1982; Hastings 1981; Thirtle et al. 2008; Alene 2010). Studies by Alston et al. (1998), Alston et al. (2010), Schimmelpfenning et al. (2000), Sheng et al. (2011) and Bervejillo et al. (2011) had used gamma lag models which have more advantages compared with other shapes. Even in some studies, the geometric distribution, which was commonly used in industrial R&D, has been employed (Shank and Zheng 2006; Alston et al. 2010; Sheng et al. 2011). Also, free-form lag shapes have been used by some researchers to determine the impacts of research (Chavas and Cox 1992; Pardey and Craig 1989).

Based on Alston et al. (2000) and their meta-analysis, in the 1950sto the 1970s, most studies used the inverted-V shape or de Leeuw shape and from the 1970s, there has been a movement in the R&D lag shape to trapezoid and polynomial (second order). However, Thirtle et al. (2008) found that the beta distribution was most preferred compared with the most common lag shape, namely the trapezoid and polynomial, since both did not fit the data well, though both yielded significant elasticities.

It is essential to choose an appropriate length and shape for the lag profile so as to estimate the rates of return to R&D. Restrictions imposed on the lag length and lag shape could lead to direction and magnitude biases in the rates of return (Alston et al. 2008). Furthermore, the rates of return to public R&D are sensitive to lag shape and length (Thirtle et al. 2008) and could lead to under or over estimates of returns. According to Alston et al. (2000), in econometric studies, most studies with shorter lags (within some forms of lag) are likely to have larger average rates of return. Lag shapes also have an important role in determining the rates of return, where the polynomial and free-form lags lead to lower rates of return compared with the common lags, trapezoid and inverted-V. Thus, in this study the inverted-V, trapezoid and gamma distributions will be employed and lag lengths of 16 and 35 years used due to the time span of available data. More detail on the R&D lags will be given in Chapter 7.

Market Distortion Policies and Benefits from Research

The agricultural sector is often a highly distorted sector with various government interventions both in the developed and developing countries. Price distortions in the agricultural sector are debated among various interest groups such as producers, consumers, governments, international competitors and environmentalist (Sadoulet and de Janvry 1995). In this section, the impact of various forms of market distortions in evaluating research benefits will be considered. As discussed in Chapter 2, Malaysia practises many of the distortionary policies. Thus, it is important to review some of the related studies.

Measuring the size and distribution of research benefits assuming a free market when in fact, there are restrictions could lead to over or under-estimates of rates of return. It is essential to investigate the benefits of research under market distortions including price controls, tariffs, subsidies and taxes. Furthermore, examining whether the country is small or large, exporting or importing could significantly impact the distribution of research benefits.

According to Alston et al. (1988), there is a strong relationship between distorted and undistorted research benefits. Alston and Martin (1995) also agreed with this statement, as they found that the research benefits that accrue in a distorted market were equal to the benefits in the undistorted market less the deadweight losses from the distortion. One of the earlier studies on the distribution of research benefits under market distortions, Alston et al. (1988) explored the benefits of research under a range of distorted policies (quotas, target prices and production subsidies) and a range of market conditions and compared the results with results in the absence of those policies. They concluded some important implications were:

- The distribution of benefits among producers, consumers and government change in all of the forms of intervention, from cost-reducing research, compared with free trade
- Depending upon the different types of market intervention, the world benefits may be increased, unchanged or decreased
- Besides the form of interventions, the status of the country, whether importing or exporting, small or large, affected the distribution of the benefits.

However, there seems to be no general rule to measure the size and distribution of research benefits under various market distortions. Alston et al. (1995) suggested that the price distortion effects on research benefits should be investigated based on the individual case of the country.

In additional to Alston et al. (1988) and their graphical analysis of the effects of market distortion policies on research benefits, Oehmke (1988) has used algebraic analysis to explain that if the intervention policies were not properly measured, it could cause the internal rates of return from research to be seriously biased. However, Voon and Edwards (1991) re-examined Oehmke’s results with a simple geometric approach and their results suggested that an output subsidy in a small importing region and a target price in a large exporting nation led to minor reductions in the rate of returns from research.

Many studies have used the model of agricultural research with market distortions to determine the distribution of research benefits (Hayami and Ruttan 1970; Mellor and Johnston 1984). Murphy et al. (1993) explained that theoretically the gains from research for a product with the aid of export subsidies could induce a negative rate of return. They claimed that R&D induced export expansion, thus led to higher export subsidies. As the taxpayers' burden rises, this could result in negative gross annual research benefits. Another theoretical paper by de Gorter et al. (1992) postulated that if the research and subsidy policies were treated as complementary, the society could be better off with underinvestment in research and overinvestment in subsidies. Several other studies on theoretical aspects of the problem also found that government intervention could induce negative rates of return from agricultural R&D (e.g. Chambers and Lopez 1993; Martin and Alston 1994).

Some of the theoretical studies on the distribution of research benefits under various market distortions were supported by empirical evidence (e.g. Norton et al. 1987; Fox et al.1992; Ortiz 1998; de Gorter and Norton 1990). Among these, Zachariah et al. (1989) pointed out that in the Canadian broiler market, using data from 1968 to 1984, the distribution of research benefits among producers and consumers was more affected by the mechanism used to determine the market price rather than the market distortions in the product market. Similarly, Haque et al. (1989) investigated the effect of distortionary policies on the size and distribution of benefits in the federally funded laying-hen research in Canada. They found that price distortions had a major impact on the distributions but only minor effects on the rates of return. Similar results were obtained for dairy cattle research in Canada (Fox et al. 1992).

In a recent empirical study by Ahmed et al. (2010) in Syria on barley fertilization, it was proposed that policy distortions, trade restrictions and procurement pricing had artificially increased the net benefits. Additionally, with free trade, the research benefits accrued to the producers since the imports were substituted with increased domestic production. This result was consistent with the theoretical observations by Alston et al. (1988).

There were some studies that relate the protectionism policies with technical efficiency and which hypothesized that protectionism is a source of technical inefficiency (e.g. Leibenstein 1966; Martin and Page 1983). Lachaal (1994) agreed with the hypothesis and suggested that the government subsidy, a form of protectionism policy in the U.S. dairy industry was the source of technical inefficiency. Despite a lack of empirical studies, Fulginiti and Perrin (1993) explored the link between agricultural productivity and price distortions. Using the same input variable as in Hayami and Ruttan (1970) and data from 1960 to 1984 for 18 less developed countries, they concluded that if these countries eliminated the price distorting policies, the average productivity would have increased by 25 per cent.

Furthermore, some studies emphasized the importance and role of political economy to determining the size and distribution of research benefits. Gardner (1988) postulated that in a political economy model, the price distortions and research investment policies were jointly endogenous. Further, studies on this include de Gorter and Zilberman (1990), Rausser and Forster (1990), de Gorter et al. (1992), Alston and Pardey (1993). However, Alston et al. (1995) noted that the market and research policies were often jointly determined to maximize the welfare function and this was likely to impact evaluating policies rather than the research benefits.

Besides market distortionary policies, it is essential to evaluate research benefits under imperfectly competitive markets. In the next section, how the research benefits differ under imperfect markets will be explained.

Imperfectly competitive markets

To avoid complexity, most agricultural policy analyses use the assumption that markets are perfectly competitive (Freebairn et al. 1982; Holloway 1989). However, this assumption may create counter effects on net welfare and public costs if the interactions between market power and government interventions are not taken into account (Voon 1994; Sexton and Sexton 1996; Russo et al. 2011). Voon (1996) agreed with Sexton and Sexton (1996) that the total research benefits were greater in a perfectly competitive market than in a monopolistic market.

Some research had also shown that under imperfect markets especially with the existence of monopoly power, welfare benefits can be increased through escalation in private sector investments (Qaim and Traxler 2005; Oehmke and Wolf 2004; Falck-Zepeda et al. 2000).

According to Russo et al. (2011), an appropriately designed set of support policies, including a price floor and deficiency payments, with the presence of downstream market intermediaries (oligopoly or oligopsony) could improve the net welfare. Therefore, it is important to evaluate the benefits of research under the current market situation in Malaysia with the existence of BERNAS. In this study, the market distortions will be incorporated in evaluating the research benefits.

Role of trade in R&D benefits

There are links between productivity, R&D investment and trade. Research enhanced productivity can clearly lead to higher production. This could lead to lower trade costs, either expanded exports or reduced imports. In industrial R&D, the most recent theoretical papers by Atkeson and Burstein (2010) and Constantini and Melitz (2008) explored how trade liberalization can increase future productivity gains through increasing rates of return to firm’s investment in R&D. It was also assumed that the country that carries out the research is able to export or import at a lower cost without influencing the world price (Akino and Hayami 1975).

One of the earlier studies in agriculture to evaluate the rates of return in an open economy was Akino and Hayami (1975). They analysed the returns to rice breeding research in Japan under an open economy scenario. Besides evaluating the benefits from research from one country's perspective (Martin and Havlicek1977; Akino and Hayami 1975; Sarris and Schmitz 1981), Edwards and Freebairn (1984) assessed the level and distribution of research benefits to the rest of the world in tradeable commodities. They proposed that the importing countries gained more since the research results in cost reductions in the own country as well as the rest of the world. However, there were some limitations in this paper as they assumed free trade and zero transfer costs.

Murphy et al. (1993) suggested that in a free trade environment, returns to research will always be positive and greater in the rest of the world than in the individual countries. Similarly, Demont and Tollens (2004) showed that in the European sugar sector, 50 per cent of the research benefits accrued to the rest of the world compared with only 26 per cent to EU-12 growers. However, Frisvold et al. (2003) employed a world agricultural trade model to estimate the distribution of welfare impacts of genetic improvements of major crops in the US and their results showed that the distribution of benefits were 44-60 per cent to the US and for other developed countries and developing countries were 24-34 per cent and 16-22 per cent respectively. Findings from Prasada et al. (2010) quantified the producer gain as higher when the competitiveness in the international market rises. This showed that the distributions of research benefits differ by the countries and crops.

When countries are involved in international trade there are spillovers of the R&D benefits from one country to another region through the traded commodities which have embodied the new technology or know-how (Alston et al. 1995; Grossman and Helpman 1991). Therefore, calculating the research benefits not only for an individual country but for the world there is a need to capture the spillover effects (Alston et al. 1995). In order to capture the international spillover effects of research benefits, it is essential to develop a global economic model (Alston 2002).

In most countries, governments spend substantial amounts on public R&D investments to improve agricultural productivity. At the same time, they provide subsidies to protect the farmers' income, and increase the production. Subsidies, including output and input subsidies (fertilizer, credit and irrigation) are considered as trade distortions in the view of trade agreements. Though, in the early green revolution periods, subsidies were given to farmers to adopt new technologies, in most countries, investments in agricultural R&D have now emerged as an important tool for generating agricultural growth (Fan et al. 2008). The question arises as to whether the government should spend more on agricultural subsidies or invest more in agricultural R&D. Most of the previous studies focused on the rates of return for R&D and productivity growth with market distortions, but not many have analysed the possibilities of switching limited public funds between subsidies and R&D. An effort will be made to analyse this gap in this study.

Concluding Remarks

In this chapter, a review of the agricultural research literature and the impact of R&D on productivity have been discussed. The different types of research lag structures were explained to give a better understanding of the modelling needed in this study. The literature on the impact of agricultural R&D on trade showed that imports and exports of a particular commodity were affected by research conducted in both the importing and exporting countries. It is also important to analyse the impact of research under various market distortions. Not many studies make the link between subsidies and returns to research, as well as the substitutions that can take place. These issues and the impacts on international trade will be addressed in this study. In the next chapter, the existing models in evaluating research and trade will be reviewed. The rationale for selecting the appropriate model for this study will be discussed in the next chapter.

Chapter 4: Theoretical Framework and Alternative Models

Introduction

In the previous chapter, some of the theory relating research benefits and trade distortions in the agricultural sector were discussed. An assessment of agricultural trade and R&D modelling will be presented in this chapter.

This chapter is divided into two major sections. The first section is focused on the modelling approaches used in evaluating the impact of agricultural R&D. In this section, the methods will be explained briefly and followed by an assessment of these models. In the second part of this chapter, the trade models will be considered, particularly the existing world rice trade models. At the end of this chapter, an assessment is made and a justification given of the model selection for use in this study.

Measuring Research Benefits

Various methods for evaluating the contribution of research to productivity growth have been developed and used by many researchers. These methods include: econometric techniques (Colman 1983; Capalbo and Vo 1988); economic surplus methods (Griliches 1985; Peterson 1967; Edwards and Freebairn 1984); mathematical programming procedures (Chavas and Cox 1992); and growth accounting techniques (Antle and Capalbo 1988).

In this section, different modelling approaches to measuring research benefits are discussed. There are two broad categories of ex-post evaluations: a) economic surplus methods; and b) production function methods.

Economic surplus approach

The economic surplus approach is one of the most common methods used to evaluate the economic welfare benefits and costs from R&D investments. The earlier empirical works by Griliches (1958), Peterson (1967), Hertfort and Schmitz (1977) and Schmitz and Seckler (1970) used the economic surplus concept in calculating the rates of return from research. However, the economic surplus concept had been critiqued in many studies including in Wise (1975) and Norton and Davis (1981). Alston et al. (1995), had grouped the criticisms of surplus analysis into six types including: a) normativeness; b) measurement errors; c) partial welfare analysis; d) externalities and free riders; e) transaction costs and incomplete risk markets; and f) policy irrelevant. Despite these criticisms employed in this surplus model, Alston et al. (1995 p. 40) suggested that this model is the best available method to assess research returns.

In an economic surplus approach, the total annual welfare gains from investing in R&D are measured by changes in consumers' and producers' surpluses. This can be illustrated in Figure 4.1, a stylized demand and supply diagram.

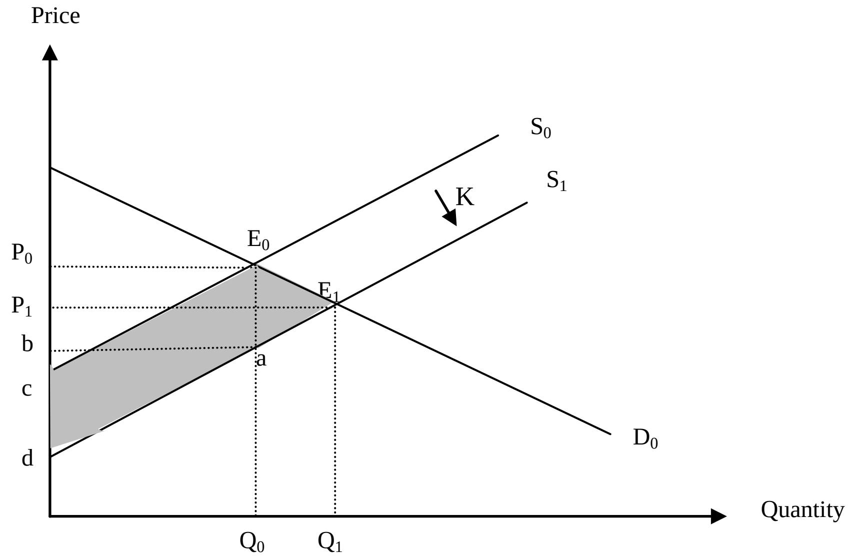


Figure 4.1 Stylized economic surplus measures

At initial equilibrium, E_0, the price and quantity are P_0 and Q_0. The demand and supply curves, D_0 and S_0, are assumed to be linear. It is also assumed that the R&D investments will increase production in two possible ways: a) higher productivity with the existing processes; or b) a new lower cost production process. This eventually will shift the supply curve downwards from S_0 to S_1. In this basic model, it is assumed that the shift of the supply curve is parallel[17]. That is, R&D will cause higher production and the producers sell the product at lower prices. So, at the new equilibrium level, E_1, the price drops from P_0 to P_1 and the quantity increases from Q_0 to Q_1. Based on this diagram, the change in consumers' surplus (ΔCS) and producers' surplus (ΔPS) can be calculated using the following formulae (Alston et al. 1995):

(4.1) $\Delta CS = P_0E_0E_1P_1 = P_0Q_0K(1 - 0.5Z\eta)$

(4.2) $\Delta PS = P_1E_1ab = P_0Q_0(K - Z)(1 + 0.5Z\eta)$

Where Z is the relative reduction in price due to research and η is the absolute value of the price elasticity of demand[18]. The vertical distance of the supply shift from S_0 to S_1 , *K*, is the percentage shift in the supply curve. The size of *K* can be measured as a horizontal shift (Hertford and Schmitz 1977) or a vertical shift (Rose 1980; Linder and Jarrett 1978; Alston et al. 1995) or proportional change in quantity (Peterson 1967).The value of *K* can also be estimated using an econometric approach. The percentage changes in the consumer and producer surplus depend on the magnitude of the elasticities of demand and supply curves[19]. Once the changes in the CS and PS are computed, the gross gains or losses (shaded area in Figure 4.1) can be computed as:

(4.3) Gross Gains/Losses = $\Delta CS + \Delta PS = cE_0E_1d = P_0Q_0K(1+0.5\, Z\eta)$

The formulas used in Equations 4.1–4.3 are based on linear demand and supply curves. The basic model above has been extended by Schmitz and Seckler (1970) to incorporate the value of labour, followed by Ayer and Schuh (1972) who included the previous year's price in the case of cotton supply. Similarly, Akino and Hayami (1975) employed the economic surplus approach in Japanese rice breeding research to estimate the benefits of research under market distortions. Norton and Davis (1981)

[17] Following Linder and Jarrett (1978) and Ross (1980), there are number of types of supply shifts. Supply shifts could be parallel, proportional, pivotal or divergent. In chapter 3, the supply shifts and associated assumptions were discussed.

[18]Following Alston et al. (1995), the Z is defined as $Z=K\varepsilon/(\varepsilon+\eta) = -(P_1-P_0)/P_0$, where ε is the price elasticity of supply.

[19]Griliches (1958) assumed a perfectly elastic and a perfectly inelastic supply curve. With a research induced supply shift (*K*), the price falls, which reflects a decline in the producers' surplus. However, gains and losses to producers depend entirely on the elasticities of the supply and demand curves.

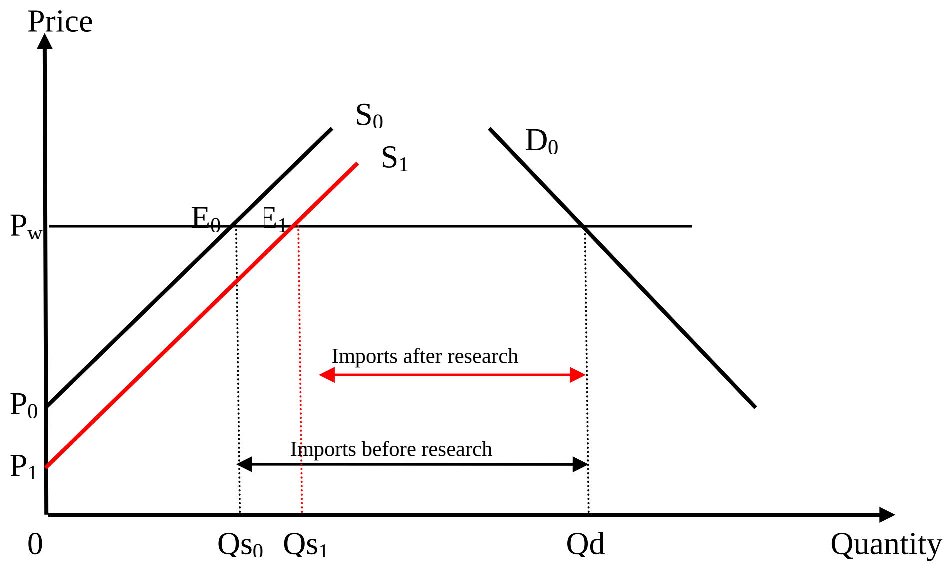
have reviewed numerous studies that have employed the most common methods to evaluate the benefits of research.

Alston et al. (1988) examined the effects of a quota, target price and production subsidy on the size and distribution of research benefits. The level of distortions can cause the calculated rates of return to be over or underestimated if the distortions are not properly accounted. Calculating the distribution of research benefits to consumers and producers depends upon the level of trade and whether a small or a large economy. In the next section, the research benefits in the case of a small open economy will be discussed.

Research benefits in a small open economy

Improvement in technical knowledge that results from rice research can boost the yield and this can be reflected in higher production and thus, increased supply of rice. This in return can increase the social welfare. The returns to such rice research can be measured in terms of economic surpluses that result from the supply curve shift. However, the size of the research benefits is also subject to the effects of trade, whether or not it is an open or closed economy and an importer or exporter nation. Based on a small-country assumption, the trading regions do not significantly influence the international prices (Alston et al. 1995).

In Figure 4.2, the market demand and supply curves are D_0 and S_0 respectively and at the world price of P_w, the quantity consumed and quantity produced are Q_{d0} and Q_{s0} respectively. The difference between Q_{d0} and $Q_{s0}$is the trade volume. Technical knowledge from the research will shift the supply curve to the right from S_0 to S_1, thus production increases to Qs_1 and imports decrease. In the case of a small country, there will be no effect in the world price, thus the economic surpluses go to the producers by the area of $P_0E_0E_1P_{1.}$



Source: Derived from Alston et al. (1995)

Figure 4.2 Impacts of research in a small-open economy

Cost -Benefit Approach

Most of the ex-ante studies use cost-benefit methods to compare among alternative projects. As explained in the earlier section on the economic surplus concepts, the cost-benefit approach uses these concepts to measure the consumer and producer surplus changes as outlined in Figure 4.1.

Since the effects of research expenditures evolve over time, the changes in consumer and producer surplus are distributed and discounted over time. Therefore, it is essential to calculate the net benefits with the research cost incorporated rather than just computing gross benefits as in equation (4.3) (see e.g. Alston et al. 1995; Norton et al. 1987; Davis et al. 1987). The cost-benefit ratio, net present value and internal rate of return can be computed to compare projects that have different time patterns of costs and benefits.

According to Alston et al. (1995), the potential advantage of using the implicit consumer surplus analysis is that it eliminates the need to obtain elasticity estimates since the polar cases of demand or supply elasticities are posed in the analysis by assumption. However, the cost-benefit approach has some drawbacks. The price effects at the regional and the international levels as well as the distributional consequences due to research are ignored.

Econometric Approach

The major alternative methods for evaluating returns to research are econometric and nonparametric approaches. Econometric approaches have been used to measure directly the relationship between agricultural production (or and productivity) and past research investments. Both these methods have been widely used in agricultural research studies and these models have been used to measure the agricultural productivity with past investment in research.

The main difference between parametric and nonparametric approaches is that in the case of parametric methods, an explicit functional form that relates inputs to outputs is used while in the nonparametric methods, the use of a specific functional form can be avoided (Alston et al. 1995). Most of the previous studies have used parametric methods to calculate the internal rates of return from public investments (Nagy and Furtan 1978; Haque et al. 1989, Thirtle et al. 2008). Parametric approaches can be either primal (production or productivity functions) or dual (cost or profit functions).

Production function approach

Following Norton and Davis (1981), the general form of the production function is:

$$(4.4) \quad Q = A\prod_{i=1}^{m} X_i^{\beta i} \prod_{j=0}^{\pi} R_{t-j}^{\alpha_{t-j}} e^{v}$$

Where

Q - Value of agricultural output

X - Conventional inputs for the *i-th* product

A - Shift factor

R_{t-j} - Research expenditures and extension in the *t-j*th year

β_i - Production coefficient for the *i*-th conventional input

α_{t-j} - Partial production coefficient of research in *t-j*th year.

ν - random error term

In the production function approach, past research expenditures (R_{t-j}) have been included as arguments (e.g. Griliches 1963, Bredahl and Peterson 1976 and Evenson 1967) and jointly estimated with conventional inputs as part of the output response.

Similarly, Wise (1986) set out a generalized framework using production functions and explained how the rates of return on additional R&D could be computed. He calculated the marginal rates of return from the production function with additional research expenditure at year zero (t = 0). He also showed that previous studies had overestimated the internal rates of return. In equation 4.4, the lagged research expenditures depend upon the lag lengths and shapes[20].

Productivity functions

By definition, a productivity index is the relationship between inputs and outputs. Basically, there are partial factor productivities (output per unit of a particular input) and total factor productivity or TFP (output relative to an index of inputs). Numerous studies have applied the total factor productivity measure to estimate the relationship between productivity and past research expenditures (Mullen and Cox 1995; Sheng et al. 2011; Chavas and Cox 1992; Lusigi and Thirtle 1997; Thirtle and Bottomley 1989). Following Mullen and Cox (1995), the form of the TFP model is:

(4.5) $TFP_t = f(RES_{t-i}, EDU_t, TOT_t, WEA_t)$

Where

RES_{t-i} - Real research expenditure lagged *i* years

EDU_t - Education levels

TOT_t - Terms of trade

WEA_t - Changes in climate e.g. rainfall

Sheng et al. (2011) employed a similar approach to estimate the return to public investments in R&D in the Australian broadacre agriculture. Alene (2010) studied the effects of R&D expenditures using the Malmquist index and found an annual average rate of return of 33 per cent.

[20] Different lag lengths and shapes were explained in detail in Chapter 3.

Direct estimation

Besides primal and dual estimation, direct estimation of the supply function is another alternative approach that has been used. A regression analysis is used to estimate the supply function for a commodity (e.g. rice, wheat, etc.) as a function of a group of independent variables. The lagged research expenditure variables are added into the supply function to measure the benefits of research. The supply function with and without the research variable is then estimated using time-series data.

The supply function is represented as in Equation (4.6)

(4.6) $Q_t = f(P_t, W_t, X_t, R_{t-i}, Z_t)$

Where Q_t is the quantity produced of a particular commodity, P_t is the expected output price, W_t is the weather variable, X_t is a vector of input prices, R_{t-i} represents lagged research expenditures and Z_t is a vector of other supply-shifter variables.

The direct estimation approach used in a single equation supply response model allows for the dynamics of supply response, particularly in relation to price and research. Thus, the direct estimation approach may be more desirable than the production function approach (Alston et al. 1995).

Equilibrium Modelling Approaches

The equilibrium models are also widely used in agricultural economics research. Generally, equilibrium models can be classified as general and partial equilibrium models. The partial equilibrium models cover only some of the sectors in the whole economy, whereas the former models focus on the whole economy. In this section, both the general and partial equilibrium models that have been used in the previous literature will be briefly reviewed.

General equilibrium models

General equilibrium, industry-wide mathematical programming models have been used as an alternative to the production function approach to evaluate the benefits of research. Klein et al. (1994) employed the Canadian Regional Agricultural Model (CRAM) (Webber et al. 1986) to evaluate the economic payoffs from the beef research in Canada from 1968-1984. They compared the internal rates of return from beef research using mathematical programming with the previous estimates from an econometric approach and found that the rates of return from the latter approach were higher.

Most of the general equilibrium model studies have used the Global Trade Analysis Project (GTAP) modelling framework with multi-region and multi-sector computable general equilibrium (CGE) models with the assumptions of perfect competition and constant returns to scale. Building CGE models requires hundreds of equations and parameters, thus this modelling approach requires more substantial empirical knowledge and makes use of large and complex data sets. It is possible to use CGE (computable general equilibrium) models for the analysis of R&D, and they have been used in the past, but it is not a preferred model for this study because of the data requirements and the need to focus on rice at an industry level rather than an economy wide level.

Huang et al. (2004) employed the GTAP framework to evaluate the impact of the agricultural biotechnology in China on production, trade and welfare and found that welfare gains outweighed the cost of public research expenditure. Wailes et al. (2005) evaluated the potential impact of genetically modified paddy rice and genetically modified milled rice in China and Bangladesh. In all the five scenarios, global welfare was expected to increase as a result of the adoption of genetically modified varieties.

A similar study, based on the GTAP framework, with a recursive dynamic computable general equilibrium (CGE) model was used by Felloni et al. (2003) to investigate the impact of trade policy on the biotechnology gains needed to ensure self-sufficiency in China. They suggested that the imposition of tariffs or domestic supports would result in welfare losses. Hareau (2006) used a general equilibrium model to evaluate the potential welfare effects and regional distribution of these effects with three rice varieties depending on different rice environments: namely; favourable (steam-borer resistant rice); unfavourable (drought-tolerant rice); and any environment (herbicide-resistant rice). His results suggested that all the three technologies increased the world output and reduced the price of rice. He also found that the joint efforts between public and private sectors in rice research could lead to increases in the probability of success.

Nielsen et al. (2001) have adapted the CGE model to incorporate genetically modified organisms by segregating the markets into two: genetically modified and non-genetically modified markets. They suggested that there were large welfare gains for the developing countries since the productivity benefits outweigh the cost of the genetically modified seeds.

Aside from the GTAP framework, some studies have employed an alternative general equilibrium framework, namely Modelling International Relations under Applied General Equilibrium (MIRAGE) (Bouet et al. 2005; Fontagne et al. 2005; Bchir et al. 2002). This framework is a dynamic recursive model in which the model is solved for one period and the results of all the variables will be used as the initial values for the next period. Unlike GTAP, this model incorporates imperfectly competitive market sand product differentiation[21].

Partial equilibrium models

Partial equilibrium models have been used in many ex-ante studies to analyse the distribution of potential benefits among producers, consumers and innovators. Hareau (2002) used a partial equilibrium model and partial budgeting simulation techniques to estimate the potential benefits of adopting genetically modified rice and potatoes in Uruguay. The author concluded that the change in economic surplus was positive but

[21]Most of the trade models have used an assumption of perfectly competitive markets and homogenous products (products that cannot be differentiated by the buyers). However, in this model, the products were differentiated by varieties and qualities. With these differences, the suppliers may be able to charge different prices and thus, imperfectly competitive markets are allowed to exist.

the seed price, fixed by the monopolist could reduce the economic surplus generated by the introduction of new technology.

In another ex-ante study, Napsintuwong and Traxler (2009) evaluated the benefits from the adoption of genetically modified papaya in Thailand using the Dynamic Research Evaluation for Management (DREAM) model. Using open and closed market scenarios, the authors suggested that the producers' benefit more in the open market whereas consumer benefits are higher in the closed market. In the closed market, price drops due to the technology adoption that lower the total benefit and eventually, this reduces the producers' benefit.

Lapan and Moschini (2004) developed a two-country partial equilibrium model to analyse the impacts of genetically modified products on innovation and trade. In their model, the innovators held the proprietary rights and farmers were the adopters while the consumers were assumed to think that the genetically modified food was inferior in quality to traditional food. They found that the genetically modified innovation could make some groups worse off even though it had the potential to improve efficiency.

Equilibrium displacement models

In recent years, equilibrium displacement models (EDM) have been widely used in research and promotion literature. This model, originally developed by Muth (1964), is often used to evaluate welfare effects. The EDM methodology is built with a standard set of structural equations for supply and demand[22]. The exogenous shifts due to the research are modelled as shifts in the supply or demand equations from the initial equilibrium. As the system equilibrium displacement is caused by exogenous shifts, the changes in prices and quantities in all the markets can be estimated. Similar to the earlier economic surplus methods, the selection of the functional forms for the demand and supply curves and the type of shifts, either parallel or pivotal, are important determinants of the results. Zhao (1999) pointed out that significant errors

[22]The algebraic equations to solve the Muth (1964) model are explained in detail in Alston et al. (1995, p.258).

are possible if the wrong functional forms are chosen if a pivotal shift is assumed, whereas it is not such a problem if a parallel shift is assumed.

Falck-Zepeda et al. (2000) used the EDM model with stochastic simulations to estimate the surplus distribution among different economic agents. Apart from the normal assumptions, the authors included an intellectual property rights concept and imperfect competition with decreasing returns to scale to measure the welfare surpluses. They estimated an increase in the world surplus of $240.3 million for 1996 from the introduction of *Bt* cotton in the US where 59 per cent of the share went to the US farmers, followed by 21 per cent to the gene developers and 9, 6 and 5 per cent to the US consumers, the rest of the world and germplasm suppliers respectively.

Another study by Zhao et al. (2000) employed the EDM model, which was extended horizontally and vertically, to measure the welfare effects and the surplus distributions from research and promotion in the Australian beef industry. They found that farmers prefer on-farm research to off-farm research. Mounter et al. (2008) used a similar approach for the Australian sheep and wool industries.

One of the limitations of the EDM model is its inability to account for the dynamic responses of changes in the supply and demand. Despite being a static model, the EDM model is based on the assumption that the elasticities of supply and demand with respect to the exogenous variables are known and constant and frequently not derived econometrically.

Spatial equilibrium models

The spatial equilibrium model has been widely used in many studies, particularly in trade analyses of the agricultural sector. This model was originally developed by Enke (1951) and then Samuelson (1952) and later refined by Takayama and Judge (1964). The Takayama and Judge model (1971) used the assumption of a perfectly competitive market and homogeneous products although non-competitive forms were developed at a later stage.

Edwards and Freebairn (1984) employed a non-spatial equilibrium model to assess the benefits of research in tradeable commodities[23]. A set of linear supply and demand equations was assumed for country A and the rest of the world as follows:

(4.7) $Q_{dA} = a - bP$ *Demand for country A*

(4.8) $Q_{sA} = \alpha + \beta P$ *Supply of country A*

(4.9) $Q_{dROW} = c - dP$ *Demand for ROW*

(4.10) $Q_{sROW} = \gamma + \eta P$ *Supply of ROW*

(4.11) *At Equilibrium :* $Q = Q_{dA} + Q_{dROW} = Q_{sA} + Q_{sROW}$

Where P and Q are the price and quantity, and Q_{da} and Q_{sa} are the quantities demanded and supplied in Country A, Q_{dROW} and Q_{sROW} are the quantities demanded and supplied for the rest of the world, and a, α, c and γ are the intercepts and b, β, d and η are the slopes. Equations (4.7) to (4.11) were solved simultaneously to determine the equilibrium prices and quantities. This is a basic form of the spatial equilibrium model for two regions without transportation costs. The model was further extended to measure the effects of research.

Supply shifts due to research were measured as a vertical shift of the supply curve by changes in *k* and *h* in equations (4.8a) and (4.10a). If a rotational change were to be used then changes in β and ηwould be required.[24]

(4.8a) $Q_{sA} = \alpha + \beta P$

(4.10a) $Q_{sROW} = \gamma + \eta P$

Inverting these equations gives:

(4.8b) $P' = -(\alpha/\beta) + k + (1/\beta)\, Q_{sA}$

(4.10b) $P' = -(\gamma/\eta) + h + (1/\eta)\, Q_{sROW}$

[23]The model of Edwards and Freebairn (1984) is classified as non-spatial equilibrium model because there are no transport costs incorporated. However, the model provides a platform for the development of spatial equilibrium models where the effects of transport costs can be included.

[24] A rotational shift about the intercept is a shift that involves a change in the slope while the intercept is held constant. Note that with *k* and *h* representing cost changes in the quantity dependent form of the equation the shift should be (k/β) and (h/η).

where, k and h are the cost reductions for country A and the rest of the world respectively and the prime superscript represents the equations with research. To determine the quantities and price with research, equations (4.7), (4.8a), (4.9), (4.10a) and (4.11) were solved simultaneously. From these quantities and price, the changes in the consumer and producer surplus for country A and the rest of the world were computed.

Unlike other studies such as Akino and Hayami (1975) and Ramalho de Castro and Schuh (1977), the Edwards and Freebairn (1984) study can be considered as one of the earlier papers that evaluated the benefits of research for individual countries and for the rest of the world. Similarly, Mills (1998) employed the quadratic programming spatial equilibrium model to analyse the potential impact of maize research in Kenya. He found significant movements in the prices and quantities under two different scenarios: with- and without- research.

Numerous studies have employed the spatial equilibrium model to investigate the agricultural trade policies in different markets: rice (Chen et al. 2011; Acosta and Kagatsume 2003; Mosavi and Esmaeili 2012), sugar (Nolte et al. 2010), wheat (Gomez and Devadoss 2004); dairy (Abbassi et al. 2008); tomato (Guajardo and Elizondo 2003) and apple (Devadoss et al. 2009).

Though the spatial equilibrium models are most commonly used in trade and transportation analysis, this model is also suitable to employ for evaluating research benefits. The size and distribution of research benefits not only can be determined at the national level but also at the international level using the spatial equilibrium model.

Existing World Rice Market Models

There are some existing global rice market models that have been developed and used in many studies. It is essential to review these models to verify the difference between the previous studies and current work. The review may also provide some insights into the construction of the model in this study. The quantitative models for global markets have been used to analyse both short- and long-term policy impacts. Even though most of the models are partial equilibrium models, which focus on particular commodities and countries, they often also take exogenous variables such as exchange rates, interest rates and income into account. The main existing world rice models are the IMPACT, AGLINK, FAPRI AGRM and RICEFLOW. In this section, these will be briefly explained along with some of the model's drawbacks.

The IMPACT model is a partial equilibrium model developed and maintained by the International Food Policy Research Institute (IFPRI). This model is designed for the analysis of alternative futures for the global food demand, supply, and trade and food security. It covers 30 commodities, including rice, and 115 countries and it is structured as a link between the countries and the rest of the world through trade. The IMPACT model has been widely used in many studies including Rosegrant et al. (2001), Rosegrant and Ringler (2000), San and Rosegrant (1998), Huang et al. (1999) and Evenson et al. (1999).

Unlike the IMPACT model, the AGLINK model covers only the OECD members and some of the selected non-member countries. However, for the rice trade model, the major rice importers and exporters as well as the OECD members, are included (Wailes 2005). This model is a recursive dynamic model and used in the quantitative analysis of agricultural policies.

Besides these models, another model that was constructed by a consortium of US universities and the Food and Agricultural Policy Research Institute (FAPRI) is an econometric recursive dynamic model, which is focused on a multiple modelling system for policy analysis and short- and long-term projections. However, this model differs from than the AGLINK model, as it is a set of commodity models with country sub-models (Wailes 2005).

IMPACT, AGLINK and FAPRI are models that cover a wide range of commodities including rice, wheat, corn and others. A specific model that emphasizes the world rice market is the Arkansas Global Rice Model (AGRM). This model is a multi-region statistical simulation with an econometric framework that is used by the University of Arkansas. FAPRI uses the AGRM framework as the international rice model in its baseline model (Wailes 2005). The AGRM model consists of 40 countries and all the equations are estimated using econometric techniques. This model is dynamic in nature; however, it is a non-spatial trade model.

In addition to the AGRM framework, there is the RICEFLOW model that is a spatial equilibrium model for the global rice market. Though the RICEFLOW model is a static model, it is more disaggregated by rice type and quality compared with the other existing models. Furthermore, this model allows for the examination of trade policy issues like tariffs, quotas, regional trade agreements and others (Wailes 2005). However, the major drawback of this model is that it is static, so the dynamic adjustments cannot be captured.

Summary of Agricultural Models

Trade models differ in terms of being dynamic or static, partial or general equilibrium, single or multiple commodities, and one or more regions. The global models that have been used for rice research are summarized in Table 4.1.

The compilation of studies pertaining to the rice market involves numerous scenarios and most of these studies are focused on trade liberalization. However, the list of studies given in Table 4.1 is not exhaustive. From Table 4.1, it is obvious that most of the studies used existing trade models and made some modifications to fit into their own individual studies.

Drawbacks of methods

Choosing an appropriate method is a difficult task since each method has some advantages and some disadvantages. As stipulated in Alston et al. (1995 p. 43), the economic surplus models are subject to six types of criticism. The economic surplus approach ignores the price effects and spillover effects as well as the distribution effects.

Table 4.1 Summary of agricultural models

Study	Model Used	Static/ Dynamic	Partial/General Equilibrium	Regional Coverage	Products
Minot and Goleti (2000)	Vietnam Agricultural Spatial Equilibrium Model (VASEM)	Static	Partial Equilibrium	Vietnam	Rice, maize, sweet potatoes and cassava
Sayaka et al. (2007)	Multi-Market Model	Static	Partial Equilibrium	Indonesia	Rice, food items and agricultural inputs
Mosavi et al. (2012)	Iranian Rice Spatial Equilibrium Model	Static	Partial Equilibrium	Iran- 6 Regions	Rice
Acosta and Kagatsume (2003)	Spatial Price Equilibrium	Static	Partial Equilibrium	ASEAN (5 Regions)	Rice
Chen et al. (2011)	Spatial Price Equilibrium	Static	Partial Equilibrium	World	Rice
Durant-Morat and Wailes (2011)	RICEFLOW	Static	Partial equilibrium	World (27 regions	9 rice commodities
Conforti (2002)	AGLINK	Dynamic	Partial Equilibrium	OECD Members	2 rice commodities – Japonica and Indica
Rosegrant and Meijer (2007)	IMPACT	Static	Partial Equilibrium	World (36 countries)	Rice and other 16 Commodities
Dimaranan et al. (2007)	GTAP	Dynamic	General Equilibrium	23 Countries	Paddy Rice and other commodities
Hareau et al. (2004)	GTAP	Dynamic	General Equilibrium	9 countries including ROW	GM Rice
Vanzetti (2006)	ATPSM	Static	Partial Equilibrium	Vietnam	Rice and 2 other commodities
Cheng et al. (1991)	Mathematical Programming	Static	General Equilibrium	US	Rice and non-rice

Source: Author's compilation

The econometric methods require huge aggregated data sets to be developed and analysed and often focused on a single commodity, where technological spillover across to other sectors within the country as well as internationally are not captured. Thus, the interpretation of the results from these methods could mislead policy makers or funding agencies. Moreover, using the econometric approach makes it difficult to quantify whether the supply shift is due to R&D or could be other contributing factors such as improvement in education or due to more experienced farm operators (Klein et al. 1994). In a mathematical programming approach, the reliability of the estimates is questionable. There is generally a lack of statistical testing in this method. In the growth accounting model, strong assumptions about the technology are usually imposed. In the next section, the most appropriate model will be selected for this study and be justified.

Justification of model selection

Some justifications are needed to support the selection of an appropriate model to analyse the rice policies in Malaysia. The first characteristic on which to base selection is should it be a general equilibrium or a partial equilibrium model. General equilibrium models, particularly computable general equilibrium models (CGE) involve hundreds of equations and parameters and need large datasets, which are usually difficult to obtain for individual countries. Furthermore, the CGE model is often criticized for lack in term of econometric specifications (McKritrick 1998; Jorgenson 1984). Despite these drawbacks, Hertel et al. (2004) pointed out that it is possible for the combination of econometric work and CGE based models to produce more reliable results. A partial equilibrium model would be most appropriate taking into account of the data limitations in the case of the Malaysian rice industry.

The second characteristic to consider is whether the model should be a static or dynamic model. As shown in Table 4.1, most of the studies have employed static models, though these models can be used to evaluate the welfare impacts of agricultural policies at one time period, the dynamic adjustments cannot be captured. A dynamic model in this case has the strong advantage of being able to take into account the effect of investments such as R&D. As was discussed earlier, productivity depends upon the lagged R&D investments and these lags may have effects for up to 50 years (Alston et al. 2000; Mullen and Cox 1995; Sheng et al. 2011; Thirtle et al. 2008). A dynamic model would seem to be more appropriate for this study since there is a need to analyse the impact of public investments in R&D on the rice industry.

A third characteristic is to determine whether a non-spatial or a spatial model should be used. A non-spatial model is where the direction of trade for each commodity is usually fixed and the transportation costs are generally assumed to be zero (in a multi-region model). On the other hand, a spatial model has positive transportation costs and the trade flows are not fixed in direction. In the context of this study, trade flows and their directions are an important issue and may change direction or cease with policy changes. Also, policy impacts are more precisely transmitted when transportation costs are included.

Based on the discussion above, the model selected for this study will be a partial equilibrium model in nature, dynamic and spatial (multi-region). Once these characteristics are selected, another decision needs to be made as to whether to choose an existing model or to develop a new model. Most of the existing models have some drawbacks. The RICEFLOW model would be appropriate since it is a partial equilibrium model and is spatial but is not dynamic. Another disadvantage is that the parameters in the existing models are generally fixed and not econometrically estimated. In this study, it is important to estimate the yield function with the R&D investments, thus econometric estimation is necessary. Therefore, the use of an econometrically estimated dynamic spatial equilibrium model is to be preferred for this study. The econometric estimation and development of the dynamic spatial equilibrium model will be explained in detail in next chapter.

Concluding remarks

An assessment of methods used in evaluating R&D investments and trade policies was presented in this chapter. The first part of the chapter was focused on the R&D methods of analysis, including economic surplus models and econometric models. The research benefits in a small importing nation consistent with Malaysia’s rice industry were also discussed. Another part in this chapter was focused on the nature of trade models. General and partial equilibrium models were discussed and a summary of the models used in rice research was presented in this chapter. There are two significant differences in the methodology used, as most of the studies of R&D impacts are concerned with the rates of return from research investments and the welfare impacts. On the other hand, in the trade studies, most are focused on the trade liberalization and the welfare impacts of this liberalization. Few studies look into the impact of R&D investments on trade distortions and welfare impacts. This study will analyse the impact of R&D investments on productivity, and the effects under distorted markets. For this purpose, an econometrically estimated dynamic spatial price equilibrium model was selected as the most appropriate model. This choice was based on the characteristics of the model, such as a partial equilibrium model, being dynamic, multi-region and a full spatial specification with the opportunity for trade flow reversals and prices linked through price arbitrage conditions. In the next chapter, a more detailed model specification will be discussed.

Chapter 5: The Model Specification

Introduction

In the previous chapter, various issues related to justification for the selections of a particular model were discussed. There are two parts in this chapter: the econometric model and the spatial equilibrium model. In the first section, the behavioural equations used in this study will be explained. The parameters derived from the behavioural equations will then be used in the formulation of the spatial equilibrium model. The use of quadratic programming and the Kuhn-Tucker conditions that apply to the spatial equilibrium model will also be discussed in this chapter. This is then followed by a discussion of modifications to the spatial equilibrium model to fit the objectives of this study.

Econometric Model

The rice model used in this study includes stochastic domestic demand and supply functions for six countries or regions, namely Malaysia, Thailand, Vietnam, Pakistan, Indonesia and the rest of the world. In Malaysia, the domestic price is set by government policy, since rice is the main staple food. The prices for other countries are, in part, determined by the policy instruments implemented in those countries. However, to simplify the analysis, it was assumed that no policy interventions were changed in those countries and the prices were effectively determined by demand and supply.

The functional form of the behavioural models is linear in the parameters and the demand and supply functions are estimated in the quantity dependent form and solved simultaneously. Since there are endogenous prices and simultaneous equations, instrumental variable regression methods were employed in this study. The consumption demand, stocks demand and yield equations were estimated using two-stage least squares (2SLS). In the next section, a general model for the behavioural equations is outlined and followed by a detailed explanation of each of the equations.

General model of behavioural equations

In this section, a general model of the behavioural equations and identities is described and then how they fit into the spatial equilibrium model is outlined. The spatial equilibrium model is used to analyse trade policy issues. Therefore, it is essential for the model and the data for each country and the world as a whole to be consistent with a commodity balance sheet as in Equation (5.1). For a typical region *i*, the standard balance sheet is (region subscripts are omitted):

(5.1) $D_t + X_t + SD_t \quad = \quad S_t + M_t + SD_{t-1}$

Thus, to satisfy the balance sheet above, the system of equations for the typical region *i* at time *t*, is as follows:

(5.2)	$\boldsymbol{D_t} = f(\boldsymbol{P_t}, PW_t, GDP_t)$	*Consumption Demand*
(5.3)	$\boldsymbol{SD_t} = f(\boldsymbol{S_t}, SD_{t-1}, P_t)$	*Stock Demand*
(5.4)	$\boldsymbol{A_t}, = f(A_{t-1}, P_{t-1},)$	*Area Harvested*
(5.5)	$\boldsymbol{Y_t} = f(R_t, FC_t, T)$	*Yield*
(5.6)	$\boldsymbol{S_t} = A_t * Y_t$	*Supply Identity*

Where:

$\boldsymbol{D_t}$	=	Consumption of rice (tonne)
X_t	=	Exports (tonnes)
$\boldsymbol{SD_t}$	=	Closing stock in period *t* (tonnes)
$\boldsymbol{S_t}$	=	Milled production of rice (tonnes)
SD_{t-1}	=	Opening stock in period *t* or closing stock in period *t*-1 (tonnes)
M_t	=	Imports (tonnes)
$\boldsymbol{P_t}$	=	Price of rice (in local currency)
PW_t	=	Price of wheat (in local currency)
GDP_t	=	Gross domestic product (in local currency)
$\boldsymbol{A_t}$	=	Area harvested of rice (ha)
A_{t-1}	=	Lagged area harvested in period *t*-1 (ha)
P_{t-1}	=	Lagged price in period *t*-1 (in local currency)
$\boldsymbol{Y_t}$	=	Yield (tonnes/ha)
R_t	=	Rainfall (mm)

FC_t	=	Fertilizer consumption (tonnes)
T	=	Time trend

The bold variables are the endogenous variables[25]. The rationale for each of the equations is discussed in more detail in the next section.

Consumption demand estimation

It is assumed in this study that rice consumption is a function of its own price, the price of wheat, consumers' income and other pre-determined variables. Wheat was assumed to be a close substitute for rice consumption. The prices of rice and wheat were calculated as the unit values of imports for Malaysia, Indonesia and the ROW and unit values of exports for Thailand, Vietnam and Pakistan. Gross domestic product was used as a proxy for the consumers' income. The demand function for country *i*, D_i, was specified as;

(5.7) $$D_i = \alpha_{1i} + \alpha_{2i} P_i + \alpha_{3i} PW_i + \alpha_{4i} GDP_i + \alpha_{5i} z_i + \mu_i$$

where P_i denotes the price of rice, GDP_i is the current income in local currency and PW_i is the price of wheat and z is other predetermined variables such as population. Based on the theory of demand, it is hypothesized that the quantity demanded is negatively related to the price of rice and positively related to the price of a substitute (wheat in this case).However, the coefficient on income can be positive or negative depending on the consumption pattern in the country. If the coefficient is positive, then rice is a normal good but if it is negative, rice is then regarded as an inferior good. Relative prices and income are used as exogenous variables and assumed to be homogeneous of degree one to ensure that money illusion is precluded from the model (Sadoulet and de Janvry 1995).

Stocks demand estimation

For the spatial equilibrium model, the stocks demand can be considered as an additional region (MacAulay 1978), where the dependent variable is the closing stock

[25]The data sources for all the variables are explained in Appendix A.

which is assumed to depend on supply, beginning stocks and domestic price. The reasons for holding stocks are considered to be for transaction and speculative purposes. Therefore, these motives are used in the stocks demand equation in which the current price of rice is used to represent the speculative motive and the current production and lagged closing stocks (beginning stocks) are used to represent the transactions motive. The stock demand for country *i*, SD_i, is expressed in Equation (5.8).

$$(5.8) \quad SD_i = \beta_{1i} + \beta_{2i} P_i + \beta_{3i} S_i + \beta_{4i} SD_i(-1) + \beta_{5i} z_i + v_i$$

where S_i is the rice production and $SD_i(-1)$ represents the one-period lagged stocks demand and z_i is a set of predetermined variables such as dummy variables. It is theoretically expected that the production and lagged stocks demand coefficients will be positive to reflect the transactions motive and a negative sign on the current price coefficient.

Supply estimation

In this study, a Nerlovian supply response model is adopted in order to estimate the supply function. An indirect supply model can be formulated in terms of equations for area harvested and yield (Sadoulet and de Janvry 1995). The total production, S_i, in country *i* is endogenously determined as total area harvested (A_i) multiplied by yield per hectare (Y_i).

The area harvested equation in country *i* is modelled as a function of the lagged area harvested ($A_i(-1)$), lagged price of rice ($P_i(-1)$) and predetermined variables (z_i,)such as prices of other substitute crops, a weather index and subsidies. Lagged area harvested and lagged price are used as proxies for the farmers' expectations in deciding on the area to plant to paddy in the current period. A time trend (T) is included in the equation to capture technological change and other trending factors.

$$(5.9) \quad A_i = \gamma_{1i} + \gamma_{2i} A(-1)_i + \gamma_{3i} P(-1)_i + \gamma_{4i} T_i + \gamma_{5i} z_i + \mu_i$$

The lagged area harvested and lagged price are expected to have positive signs and the prices of other substitute crops are expected to have negative signs. For the yield estimation, rainfall data were used for Malaysia and Thailand since data for other countries in the study were not available. The yield equation was estimated as a function of fertilizer consumption per hectare (FC_i) and a time trend (T) and predetermined variables (z_i) such as rainfall data.

(5.10) $Y_i = \phi_{1i} + \phi_{2i} FC_i + \phi_{3i} R_i + \phi_{4i} z_i + \mu_i$

Based on theory, it is expected that the current price of rice and fertilizer consumption per hectare will be positively related to yield. A time trend was used to reflect technological progress (Kaufmann and Snell 1997; McCarl et al. 2008) and the rice yield was expected to increase in respect to technological advances such as the adoption of new varieties and the application of fertilizer and irrigation (Huang and Khanna 2010).

The supply function for rice is thus an identity where the two behavioural equations (5.9) and (5.10) are multiplied together. Thus, the supply response can be expressed as:

(5.11) $S_i = A_i * Y_i$.

The behavioural equations from (5.7) to (5.11) above are not fixed and differ from one country to another depending on the behaviour of the economic agents in that country.

The dynamic behavioural equations were estimated for a 30-year time period from 1980 to 2009. The time series data were subject to stationarity tests and thus, all the variables were tested using the Augmented-Dickey Fuller (ADF) test. The Durbin-Watson test was also used to detect any autocorrelation problems.

The collapsed intercepts and price coefficients for the demand and supply equations from the estimated results are then fitted into the spatial equilibrium model.[26]The next section explains the structure of the spatial equilibrium model.

Spatial Equilibrium Model

Spatial equilibrium models have been widely used in many studies, particularly trade analyses in the agricultural sector. The model was originally developed by Enke (1951) and then Samuelson (1952) and later refined by Takayama and Judge (1964). The spatial equilibrium model has considerable advantages over various other trade models as it can be dynamic, spatially connected, a solution is known to exist and furthermore the model can be developed in a primal-dual form so that the equilibrium of prices and quantities can both be determined as endogenous variables. This provides a means of including policy interventions that can impact on both prices and quantities together or separately in the same model.

Graphical approach

In this section, a generalized spatial equilibrium model is presented, using two regions and a single product in a perfectly competitive market. Based on the use of excess demand and excess supply functions for each of two regions, many problems in determining the equilibrium prices in spatially separated markets can be represented (Takayama and Judge 1971; MacAulay 1992). Linear demand and supply functions in each region are given as D_1, S_1, D_2 and S_2 and excess demand and supply as ED_1, ES_1, ED_2 and ES_2 as illustrated in Figure 5.1. Assuming zero transport cost, trade will take place when there is a difference between the price equilibria of the two sets of demand and supply functions.

[26]A collapsed intercept is calculated by adding together the estimated intercept and the exogenous variables multiplied by their coefficients for each time period.

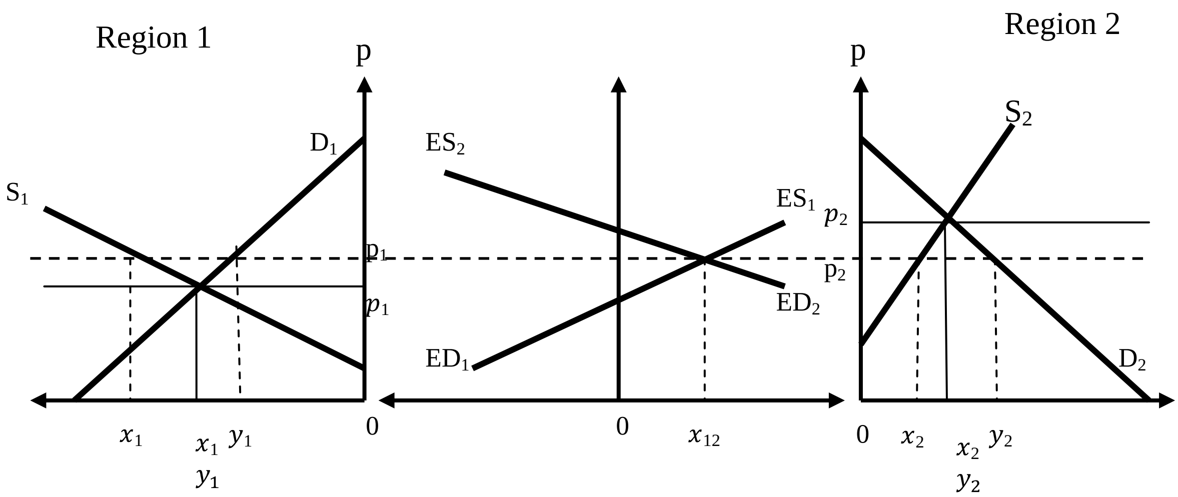


Figure 5.1 Spatial equilibrium without transfer costs

The equilibrium prices after trade takes place are shown as p_1 and p_2. The trade between the two regions occurs until the difference in the prices between regions is zero. The trade from region 1 (excess supply) to region 2 (excess demand) is indicated as x_{12} and the volume shipped is equal to $x_1 - y_1$ or $y_2 - x_2$.

Figure 5.1 can be modified by introducing a fixed per unit transportation cost of shipment from region 1 to region 2 as illustrated in Figure 5.2. The equilibrium prices, and demand and supply before trade takes place are given as p_1, x_1 and y_1 for region 1 and p_2, x_2 and y_2 for region 2. Trade occurs between the two regions so that the arbitrage conditions[27] hold.

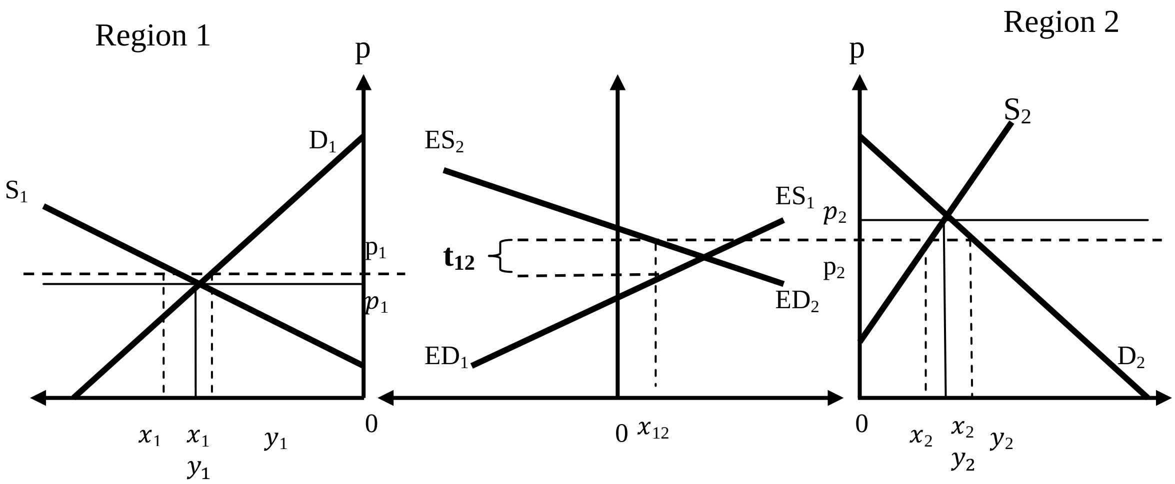


Figure 5.2 Spatial equilibrium with transfer costs of t_{12}

[27] The arbitrage condition requires that the price in region 1 is equal to or less than the price in region 2 plus the transportation cost. This is assumed to represent the price relationship in a competitive spatial equilibrium.

Assuming a positive transportation cost from region 1 to region 2, indicated as t_{12}, then competitive price arbitrage is assumed to take place until the difference in the prices between the two regions is equal to the transportation cost (more generally a transfer cost).

Net quasi welfare objective function

The net welfare objective function was used as an early approach to the spatial equilibrium model that developed by Samuelson (1952). This objective function is illustrated in Figure 5.3.

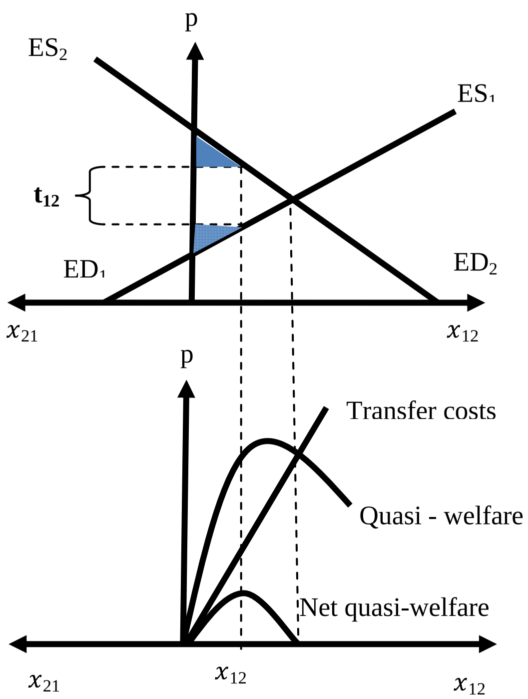


Figure 5.3Net quasi-welfare solution for the spatial equilibrium model

The net quasi-welfare objective function is shown in the lower part of Figure 5.3. The function is derived as the area under the excess demand curve less the area above the excess supply curve and less the area representing total transport costs (t_{12}). The total of the shaded areas in the upper part of Figure 5.3 is plotted as the changes in the trade volume to give the net quasi-welfare in the lower part of Figure 5.3.

Net social revenue function

The net social revenue objective function is used in this study instead of the net welfare objective function as originally developed by Samuelson (1952). The net revenue objective function is more appropriate in this study as it permits development of a primal-dual model so as to be able to readily incorporate various policy mechanisms into the models. Figure 5.4 illustrates the net social revenue solution for a spatial equilibrium model and also provides an indication of the mathematical approach to the solution of spatial equilibrium models.

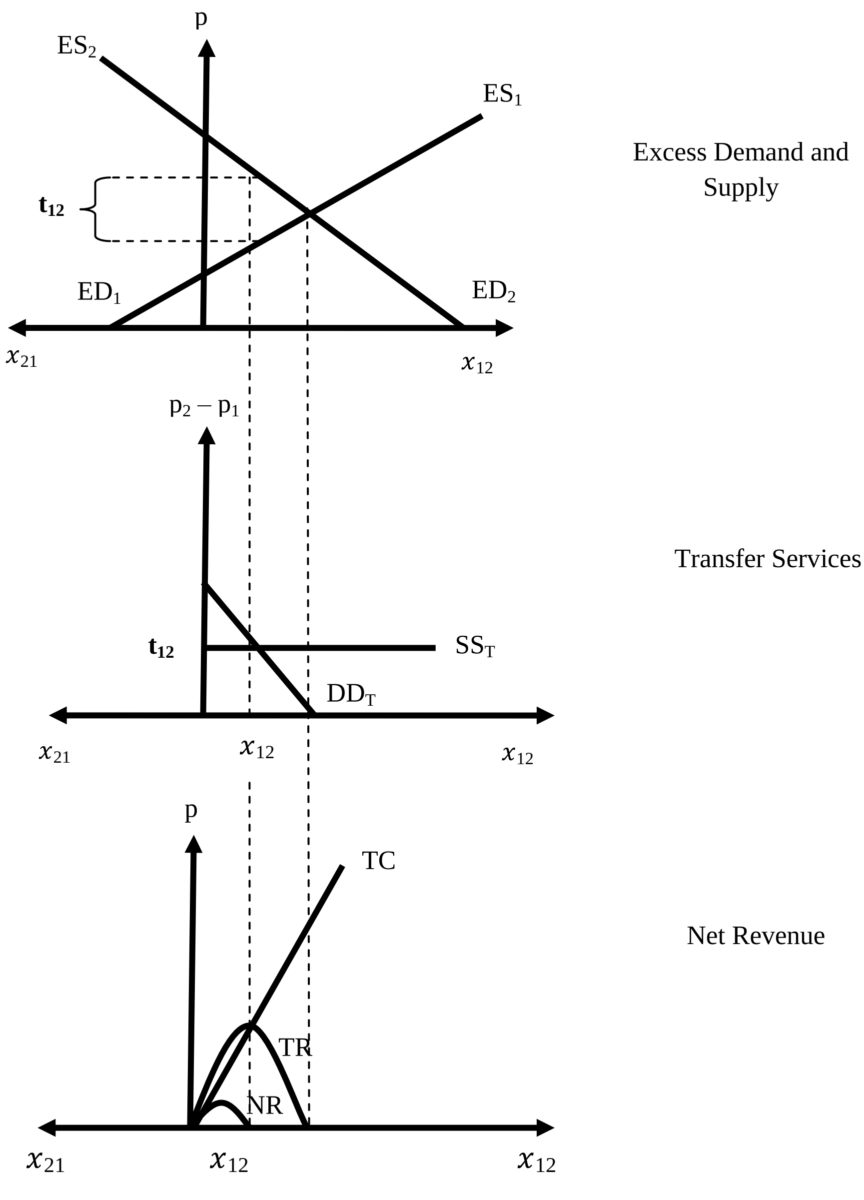


Figure 5.4 Net social revenue solutions for the spatial equilibrium model.

The demand for transport services, DD_T, is obtained from the vertical difference between the excess demand and excess supply as shown in Figure 5.4. The supply of transport services, SS_T is assumed to be perfectly elastic and horizontal at the level of a fixed per unit transport cost as shown in the middle part of Figure 5.4.

The net social revenue objective function can be seen in the lower part of Figure 5.4. This illustrates the framework for the mathematical programming in the next section. Since the demand function is assumed to be linear, the total revenue function will be a quadratic function and it is obtained from the money value of transfer services at each volume shipped. The total cost of shipment is linear and is obtained by multiplying the average cost by the trade volume. Thus, the difference between the revenue and cost functions is the quadratic function of the net revenue, which is the objective function to be maximized. However, the solution is constrained by the arbitrage conditions for a competitive market so that any profits from shipping the goods are bid to zero so that the net revenue at the competitive solution is also zero.

The spatial equilibrium model using the net social revenue objective function is a primal-dual formulation. In the primal-dual formulation, the primal model is subtracted from the dual model and both model's constraints are included (MacAulay, 1992).

Welfare Formulation: Mathematical approach

In the modelling of the spatial equilibrium, there are two possible domains: price and quantity. The difference between both of the domains depends on the initial point in developing the model whether the supply and demand functions are in the price form or quantity form. However, these two forms are equivalent to each other (Takayama and Judge 1971)[28].

[28]The numerical example in Takayama and Judge (1971, p. 142) was used in the mathematical programming formulation as a check on the use of the quadratic programming software and the price and quantity formulations both had the same results.

As discussed earlier, the net social revenue objective function is more general in character and it includes both price and quantity variables (also known as a primal-dual model) (MacAulay 1992).

In this study, the price form of the model is selected since in this formulation, the inclusion of import quotas[29] into the model is possible. In the price form, the demand and supply functions are defined in terms of quantity units and the quantity is the dependent variable. In this form, the quantities are replaced with the indirect supply and demand functions as in Equations (5.12) and (5.13) which are the inverted Marshallian supply and demand functions. The demand and supply functions for a region *i* are defined as:

(5.12) Demand function: $y_i = \alpha_i - \beta_i p_i$

(5.13) Supply function: $x_i = \theta_i + \gamma_i p^i$

where y_i and x_i are quantities demanded and supplied in the i^{th} region and p_i and p^i are the demand and supply prices respectively. α_i and θ_i are the intercepts and β_i and γ_i are the slope coefficients.

The set of demand and supply functions for *n* regions can be written in the matrix form as below.

$$(5.14)\quad y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \vdots \\ \vdots \\ \alpha_n \end{bmatrix} - \begin{bmatrix} \beta_1 & & & & \\ & \beta_2 & & & \\ & & \ddots & & \\ & & & \ddots & \\ & & & & \beta_n \end{bmatrix} \begin{bmatrix} p_1 \\ p_2 \\ \vdots \\ \vdots \\ p_n \end{bmatrix}$$

$$(5.15)\quad x = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} \theta_1 \\ \theta_2 \\ \vdots \\ \vdots \\ \theta_n \end{bmatrix} + \begin{bmatrix} \gamma_1 & & & & \\ & \gamma_2 & & & \\ & & \ddots & & \\ & & & \ddots & \\ & & & & \gamma_n \end{bmatrix} \begin{bmatrix} p^1 \\ p^2 \\ \vdots \\ \vdots \\ p^n \end{bmatrix}$$

[29]Inclusion of import quotas can only be done in the price formulation as the intercept in the right hand side must be in terms of quantity units as the quota is also defined in quantity terms

Equations (5.14) and (5.15) can be rewritten in a compact form as:

(5.16) $y = \alpha - \mathrm{B} p_y$

(5.17) $x = \theta + \Gamma p_x$

where y and x are the quantities demanded and supplied for n regions and α and θ are (n x 1) vectors of the intercepts of demand and supply functions respectively. B and Γ are (n x n) matrices of the demand and supply slope coefficients respectively.

To ensure the characteristics of a competitive spatial equilibrium are represented, there is a set of constraints that need to be satisfied. Following Takayama and Judge (1971) and Martin (1981), the four types of constraints are:

1. *The supply and demand functions must hold*. In other words, the optimum consumption and optimum production conditions as shown in the Equations (5.18) and (5.19) must satisfy.

   (5.18) Optimum consumption: $y_1 \leq \alpha_1 - \beta_{11} p_1$

   (5.19) Optimum production: $x_1 \leq \theta_1 + \gamma_{11} p^1$

2. *The supply and demand quantities and the traded quantities must balance*. It is assumed that in each region, for example region *i*, the total shipments into region *i* from all other regions, must be greater than or equal to the total consumption (y_i). Equation (5.18) stipulates that when the optimal market demand price is zero, the inflows of shipments from all other regions are greater than or equal to the optimum consumption. The outflow of shipments from region *i*, must be less than or equal to the total supply (x_i) in region *i*. Equations (5.20) and (5.21) appear as constraints in the spatial equilibrium model, thus

   (5.20) Demand quantity balance: $y_i \leq \sum_{j=1}^{n} x_{ji}$

   (5.21)Supply quantity balance: $x_i \geq \sum_{j=1}^{n} x_{ij}$

3. *The price arbitrage conditions must hold*. Optimal flows from region *i* to region *j* are only possible if the price difference between the supply price in region *j*(p^j)and the demand price in region *i* (p_i) is less than or equal to the transportation costs(t_{ji}). This price arbitrage condition is shown in Equation (5.22)[30].

(5.22) Price arbitrage condition: $p_i - p^j \leq t_{ji}$

4. *All the variables, prices and quantities, must be non-negative*. Therefore, the other condition in a spatial equilibrium model is:

(5.23) Non-negativity condition: $y_i, x_i, y_j, x_j, p_i, p^j, x_{ij} \geq 0$

As in Figure 5.2, the area under the demand curve and above the equilibrium price is the total consumer surplus and the area above the supply curve but under the price line is the total producer surplus. Thus, the quasi-welfare function for region *i* with the concave quadratic function is as follow:

$$(5.24) \quad IW(p_i, p^i) = \int_{\hat{p}i}^{\rho_i - w_i} (\alpha_i - \beta_i p_i) dp_i - \int_{\hat{p}^i}^{\rho^i + v_i} (\theta_i + \gamma_i p^i) dp^i$$

Where w and v are slack variables and $\hat{p}i$ and $\hat{p}^i$ are the pre-trade equilibrium demand and supply prices respectively.

The quadratic indirect welfare function (IW) for all the *n* regions is the summation of the individual regions as given in Equation (5.25):

$$(5.25) \quad IW(p_y, p_x) = \sum_{i=1}^{n} IW(p_i, p^i) = \sum_{i=1}^{n} (\int_{\hat{p}i}^{\rho_i - w_i} (\alpha_i - \beta_i p_i) dp_i - \int_{\hat{p}^i}^{\rho^i + v_i} (\theta_i + \gamma_i p^i) dp^i$$

[30]According to Takayama and Judge (1971, p. 111), when the optimal consumption and optimal supply for a region is greater than zero, then the non-negative market demand price (ρ_i) is equal to regional demand price (p_i) and the non-negative market supply price (ρ^j) is equal to the regional supply price (p^j).

The commodity indirect welfare equation for *n* regions can be written by integrating the supply and demand functions in equation (5.16) and (5.17) respectively.

$$IW(p_y, p_x) = K + \alpha'(\rho_y - w) - 0.5(\rho_y - w)'\mathrm{B}(\rho_y - w) - \theta'(\rho_x + v) - 0.5(\rho_x + v)'\Gamma(\rho_x + v) \quad (5.26)$$

where K is a constant and $K = \sum_{i=1} K_i$ (summation of all the constants).

For an equilibrium solution, a set of constraints is necessary. As discussed in the earlier part, inequality constraints are imposed as stipulated in Equations (5.18) to (5.23), and the prices and quantities are also non-negative. Thus, it is essential to apply the Kuhn-Tucker conditions in order to maximise the objective function.

The Kuhn-Tucker conditions are the necessary conditions needed to be satisfied to obtain an optimal solution for a non-linear programming problem as in the equations below (Lee et al. 1992)[31]:

Maximize:

(5.27) $y = f(x_1, x_2, x_3, ..., x_n)$ objective function

subject to:

(5.28) $g_i(x_1, x_2, x_3, ..., x_m) \le r_i$ constraints (i = 1, 2, …., m)

and

(5.29) $x_j \ge 0$ non-negativity constraints (j =1, 2, ….,n)

The Kuhn-Tucker conditions can be derived by forming the Lagrangian function as in Equation (5.30).

$$L(x_j, \lambda) = f(x_1, x_2, x_3, ..., x_n) - \sum_{i=1}^{m} \lambda_i [g_i(x_1, x_2, x_3, ..., x_m) - r_i] \quad (5.30)$$

where λ is the Lagrange multiplier and *m* is the number of constraints. The Kuhn-Tucker conditions for the above equation are:

[31] The Kuhn-Tucker conditions are also known as the Karush-Kuhn-Tucker conditions in some publications. William Karush proved the theorem in his Master's thesis but did not receive much attention then, however, it was independently published 12 years later by Kuhn and Tucker (1951).

(5.30 a) $\frac{\delta L}{\delta x_j} \leq 0$ $(\frac{\delta L}{\delta x_j}) * x_j = 0$

(5.30 b) $\frac{\delta L}{\delta \lambda_i} \geq 0$ $(\frac{\delta L}{\delta \lambda_i}) * \lambda_i = 0$

Unlike in equality constrained problems, where the first-order conditions derived from a Lagrangian function must be zero, in the Kuhn-Tucker conditions, there is an additional feature known as the complementary slackness conditions as in the second part of Equations (5.38 a) and (5.38 b). For each choice variable, either the marginal condition holds as equality or the choice variable must take a zero value or both relationships may hold as equalities at the optimal solution. Similarly, for the Lagrange multiplier (λ), at the optimal solution, either the marginal condition or the multiplier is zero. The concept of this non-linear programming problem will be used to formulate the spatial equilibrium model.

The spatial equilibrium model in the price domain with maximization of the equation (5.26), subject to the constraints in Equations (5.18) to (5.23) is expressed in the Lagrangian function and with the Kuhn-Tucker conditions defined as follows:(5.31)

$$L(\rho_y, \rho_x, \xi_x) = K + \alpha'(\rho_y - w) - 0.5(\rho_y - w)'\mathrm{B}(\rho_y - w) - \theta'(\rho_x + v) -$$
$$0.5(\rho_x + v)'\Gamma(\rho_x + v) + \xi_x^{'}(\mathrm{T} - G_y^{'}P_y + G_x^{'}P_x)$$

Kuhn-Tucker Conditions:

a) $\frac{\delta L}{\delta \rho_y} = \alpha - \mathrm{B}(\bar{\rho}_y - w) - G_y\bar{\xi}_x \leq 0$ and $(\frac{\delta L}{\delta \rho_y})'\bar{\rho}_y = 0$

b) $\frac{\delta L}{\delta \rho_x} = -\theta + \Gamma(\bar{\rho}_x + v) - G_x\bar{\xi}_x \leq 0$ and $(\frac{\delta L}{\delta \rho_x})'\bar{\rho}_x = 0$

c) $\frac{\delta L}{\delta \xi_x} = \mathrm{T} - G_y^{'}\bar{\rho}_y + G_x^{'}\bar{\rho}_x \geq 0$ and $(\frac{\delta L}{\delta \xi_x})'\bar{\xi}_x = 0$

d) $\rho_y, \rho_x, y, x, \xi_x \geq 0$

where $\xi_x^{'}$ is a (n^2x1) vector of Lagrangian multipliers.

Condition (a) is the optimal consumption and there is no excess demand condition, whereas (b) stipulates the optimal production and there is excess supply. The price arbitrage and non-negativity conditions are explained in the conditions (c) and (d) respectively. The second parts of each of the Kuhn-Tucker conditions are the complementary slackness conditions.

Net Social Revenue Approach

As an alternative to the original formulation of the spatial equilibrium model as a welfare maximization problem Takayama and Judge (1971) formulated a net social revenue problem. The net revenue objective function is used in this study instead of the net quasi-welfare objective function, since in the former function, the demand and supply functions do not satisfy the integrability conditions. According to Takayama and Judge (1971), if a solution exists for the net revenue maximization problem, then that solution also satisfies the spatial price equilibrium conditions for the net social welfare function[32].

The spatial equilibrium model was programmed using the Marshallian demand and supply functions where the parameters were obtained from the econometric analysis. The net social monetary gain objective function or net revenue objective function consists of total revenue, ($y^{'}P_y$) less total production costs ($x^{'}P_x$) and total transportation costs ($T'X$). The function is defined as:

(5.32) Net social revenue: $NSR = y^{'}P_y - x^{'}P_x - T'X$

The objective function in Equation (5.33) is obtained by substituting Equations (5.16) and (5.17) into Equation (5.31) and in the matrix form is:

[32]This non-integrable case occurs when a system of supply and demand functions exists but the matrix of slope coefficients is not symmetric and therefore does not satisfy the integrability conditions (see Takayama and Judge, 1971 p. 38).

(5.33) $$NSR = \left[\begin{bmatrix} \alpha \\ -\theta \\ -T \\ -\alpha \\ -\theta \end{bmatrix} - \begin{bmatrix} \mathrm{B} & 0 & G_y & -\mathrm{B} & 0 \\ 0 & \Gamma & G_y & 0 & \Gamma \\ -G_y^{'} & -G_x^{'} & 0 & 0 & 0 \\ -\mathrm{B} & 0 & 0 & \mathrm{B} & 0 \\ 0 & \Gamma & 0 & 0 & \Gamma \end{bmatrix} \begin{bmatrix} \rho_y \\ \rho_x \\ X \\ w \\ v \end{bmatrix}\right]' \begin{bmatrix} \rho_y \\ \rho_x \\ X \\ w \\ v \end{bmatrix}$$

In the price form of the spatial equilibrium model, the solution can be obtained when the objective function, as in Equation (5.33), is maximized subject to a set of constraints as expressed in Equations (5.34) and (5.35).

(5.34) $$NSR = \begin{bmatrix} \alpha \\ -\theta \\ -T \\ -\alpha \\ -\theta \end{bmatrix} - \begin{bmatrix} \mathrm{B} & 0 & G_y & -\mathrm{B} & 0 \\ 0 & \Gamma & G_y & 0 & \Gamma \\ -G_y^{'} & -G_x^{'} & 0 & 0 & 0 \\ -\mathrm{B} & 0 & 0 & \mathrm{B} & 0 \\ 0 & \Gamma & 0 & 0 & \Gamma \end{bmatrix} \begin{bmatrix} \rho_y \\ \rho_x \\ X \\ w \\ v \end{bmatrix} \leq 0$$

(5.35) $$\rho_y, \rho_x, x, y, X \geq 0$$

Where *w* and *v* are slack variables and G_y and G_x are (*n x n*^{2}) matrices designed so as to sum the shipments into a region and out of a region respectively and are in the form of a matrix as in equations (5.36) and (5.37) respectively.

(5.36) $$G_y = \begin{bmatrix} 1 & & & & 1 & & & & 1 & & & \\ & 1 & & & & 1 & & \cdots & & 1 & & \\ & & \ddots & & & & \ddots & & & & \ddots & \\ & & & 1 & & & & 1 & & & & 1 \end{bmatrix}$$

(*n x n*^{2})

(5.37) $$G_x = \begin{bmatrix} -1 & -1 & \cdots & -1 & & & & & & & & \\ & & & & -1 & -1 & \cdots & -1 & & & & \\ & & & & & & & & \ddots & & & \\ & & & & & & & & -1 & -1 & \cdots & 1 \end{bmatrix}$$

(*n x n*^{2})

The net social revenue problem as in Equation (5.33) and subject to the constraints in Equations (5.34) to (5.35) is expressed in Lagrangian function form with the associated Kuhn-Tucker conditions defined as follows:

(5.38) $L(\rho_y, \rho_x, \lambda) = y'\rho_y - x'\rho_x - T'X + \lambda(\mathrm{T} - G_y^{'}\rho_y + G_x^{'}\rho_x)$

Kuhn-Tucker Conditions:

a) $\frac{\delta L}{\delta \rho_y} = y - \lambda G_y \leq 0$ and $(\frac{\delta L}{\delta \rho_y})'\bar{\rho}_y = 0$

b) $\frac{\delta L}{\delta \rho_x} = -x + \lambda G_x \leq 0$ and $(\frac{\delta L}{\delta \rho_x})'\bar{\rho}_x = 0$

c) $\frac{\delta L}{\delta \lambda} = \mathrm{T} - G_y\rho_y + G_x\rho_x \geq 0$ and $(\frac{\delta L}{\delta \lambda})'\lambda = 0$

d) $\rho_y, \rho_x, y, x, \lambda_x \geq 0$

The maximum value of the objective function must be zero in the net social revenue function since it is in a primal-dual formulation.

In the next section, the extensions to the standard spatial equilibrium model will be discussed.

Extensions of the Spatial Equilibrium Model

Since the formulation of the standard spatial price equilibrium model by Takayama and Judge (1971, 1964), many authors have made significant extensions to include various policies using different mathematical approaches. The extension work done in previous studies include price supports in term of price ceilings and price floors (Thore 1986), exchange rates (MacAulay 1992; Bjarnason et al. 1969; Elliot 1972), ad valorem tariffs, fixed per unit taxes or subsidies, rigid prices and imperfect competitive market behaviours. Only the relevant extensions used in this study will be discussed in detail in the next section.

Exchange Rates

To deal with the inclusion of exchange rates, there are two ways suggested by MacAulay (1992) and Bjarnason et al. (1969). One approach is to convert the local prices in different countries to a common currency, for example into US Dollars and then estimate the demand and supply functions (Bjarnason et al. 1969). This approach cannot capture the impact of exchange rates on the equilibrium prices and quantities. The method proposed by MacAulay (1992) is to estimate the demand and supply equations in their local currencies and then the exchange rate is used to convert all the local currencies into a common currency (such as US dollars). The exchange rate is also included in the price arbitrage equations in the spatial equilibrium model. This approach seems to be more practical. From Equation (5.22), the inclusion of exchange rates in the price arbitrage condition is as follows:

(5.39) $er_{ik} * p_i - er_{jk} * p^j \leq t_{ji}$

Where er_{ik} and er_{jk} are the exchange rates to convert the currencies in regions *i* and *j* to a common currency, *k*. The transfer cost from region *j* to region *i* is in the common currency, *k*. For example, assume in a two-country case: Malaysia and Thailand. Both the local currencies, Malaysian Ringgit (MYR) and Thailand Baht (THB) are converted into US Dollars (USD). The arbitrage condition will be:

$$er_{(MYR/USD)} * p_{(MYR)} - er_{(THB/USD)} * p^{(THB)} \leq t_{ji(USD)}$$

In this study, there are five countries all with different exchange rates and the price arbitrage condition will be as stipulated in Equation (5.39).

Domestic Subsidies

In Chapter 2, the domestic subsidies given to farmers and consumers in the Malaysian rice industry were discussed. It is important to include the subsidies into the formulation of the spatial equilibrium model to obtain more realistic solutions. The per unit domestic subsidy is calculated based on the total value of both the output and input subsidies and divided by the production to obtain an approximate estimate of an output equivalent subsidy. In the spatial equilibrium model, the domestic subsidy (s_{ii}) is included in the price arbitrage condition as a negative transfer cost as in Equation (5.40), since the own-region transfer cost (t_{ii}) is usually specified as zero.

(5.40) $p_i - p^i \leq t_{ii} - s_{ii}$

Import Quotas

An import quota is a direct method of restricting the quantities imported into a region. In Malaysia's case, although no official import quotas have been imposed, there is a limitation imposed by BERNAS to the importation of rice as it is a monopsony buyer of rice into the country.[33]. This limitation may cause distortions to the international price system (Takayama and Judge 1971). Thus, it is essential to include import quotas in the spatial equilibrium model. Following Takayama and Judge (1971, p.205), the mathematical model for the price formulation with the inclusion of import quotas can be written with an extension to Equation (5.26).

Maximize:

(5.41) $\alpha'(\rho_y - w) - 0.5(\rho_y - w)'\mathrm{B}(\rho_y - w) - \theta'(\rho_x + v) - 0.5(\rho_x + v)'\Gamma(\rho_x + v) - q'\rho_q$

subject to:

(5.42) $[G_y^{'}\ G_x^{'}\ G_q^{'}]\begin{bmatrix}\rho_y \\ \rho_x \\ \rho_q\end{bmatrix} \leq T$

and

(5.43) $(\rho_y'\ \rho_x'\ \rho_q' w' v') \geq 0'$.

Where q' represents a vector of total import quotas and ρ_q is the shadow price of the import quotas imposed by the country. If the country *i* imposes total import quotas, and the shadow price of the import quotas is greater than or equal to zero ($\rho_q \geq 0$)

[33]The imposition of an implicit import quota by BERNAS (as a state trading entity) is very common particularly as the WTO rules on this issue are somewhat more lenient than for specific import restrictions.

and the trade flow between region *i* and *j* is greater than zero ($x_{ij} > 0$), then Equation (5.44), must hold as an equality:

(5.44) $$\rho_i - \rho^j - \rho_\theta \le t_{ji}\ .$$

Equation (5.44) will be used in the programming formulation of the spatial equilibrium model together with other policy interventions.

Ad Valorem Tariffs

The inclusion of ad valorem tariffs in spatial equilibrium models has been discussed in detail in Takayama and Judge (1971) and further explanations in MacAulay (1992). Despite the fact that ad valorem tariffs are not in effect in the Malaysian rice industry since BERNAS has an import license, it is important to simulate the possible effects if BERNAS's import license expires in 2021. Once the import license is removed, then ad valorem tariffs of 20 per cent for the ASEAN countries a 40 per cent ad valorem tariff for the Rest of the World (ROW) will be effective. These tariffs under CEPT and WTO are tariff bindings and tariffs below these bindings will be allowed. This impact will be one of the policy scenarios to be analysed in this study.

Using the notation from MacAulay (1992), the ad valorem tariffs, τ_{ij} can be imposed on the domestic demand price with different tariff rates for different trade flows, as shown in the Equation (5.45).

(5.45) $$[R_\tau G_y' \quad G_x'] \begin{bmatrix} \rho_y \\ \rho_x \end{bmatrix} \le T$$

where R_τ is an $(n^2 \ x \ n^2)$ converter matrix which allows tariffs to be imposed on the demand or supply price and in the form of:

$$R_\tau = \begin{bmatrix} \psi_{11} & & & & & \\ & \ddots & & & & \\ & & \psi_{1n} & & & \\ & & & \psi_{n1} & & \\ & & & & \ddots & \\ & & & & & \psi_{nn} \end{bmatrix}_{(n^2 \, x \, n^2)}$$

Where ψ_{ij} is $1/(1 + \tau_{ij})$, and where τ_{ij} is the tariff rate imposed on the imports from region *i* to region *j*[34]. Devadoss et al. (2009) used a similar approach to incorporate ad valorem tariffs into the spatial equilibrium model. In this study, the values of Ψ_{ij} are 0.83 for imports from Thailand and Vietnam and 0.71 from Pakistan and the ROW. It was assumed that the tariff rates applied by other countries were constant in this study.

Computation Algorithms and Spatial Equilibrium Model

Different computation algorithms have been used in the solution of spatial equilibrium models in previous studies, including the variational inequality method (Nagurney and Zhao 1991; Nagurney 1993; Florian and Los 1982), linear complementary methods (Takayama and Uri 1983; Yang and Labys 1985; Freisz et al. 1984) and mixed complementarity programming (Rutherford 1995; Nolte 2008; Mosavi and Esmaeili 2012). However, there is no general algorithm that will solve all the optimization problems, though many techniques to solve non-linear programming models exist (Lee et al. 1992).

Simultaneous Equation Approach of the Spatial Equilibrium Model

In this section, the formulation of the spatial equilibrium model using the simultaneous-equation approach by Lee and Seaver (1971) will be discussed. According to Lee and Seaver (1971, p. 63):

[34] The ψ_{ij} in the own-region is equal to one. For example in a three-region case, $\psi_{11} = \psi_{22} = \psi_{33} = 1$

"It should be emphasized that a positive analysis of spatial equilibrium should estimate the demand and supply functions simultaneously within the model in order to produce quantitative statements describing the existing competitive markets and to predict the future course of economic variables."

Assume that there are *n* spatially separated regions and a single commodity. The supply and demand functions for region *i* are as follows:

(5.46) $y_i = f(p_i, z_k)$ Demand function

(5.47) $x_i = f(p^i, z_k)$ Supply function

where p_i and p^i are the demand and supply prices in i^{th} region respectively and z's are the predetermined variables such as income, weather, price of substitutes and others[35].

The spatial equilibrium model allows for the interregional trade, given the x_{ij} as the trade flows from region *i* to region *j*. The demand and supply quantity balances are:

(5.48) $y_i = \sum_{j=1}^{n} x_{ji}$

(5.49) $x_i = \sum_{i=1}^{n} x_{ij}$

If the difference between the demand and supply prices is greater than the transportation costs then flows from region *i* to region *j* will occur until the difference between the supply price in region *j* (p^j) and the demand price in region *i* (p_i) is equal to the transportation costs (t_{ji}) as stipulated in Equation (5.50).The concept of price arbitrage has been discussed in the earlier section.

(5.50) $p_j - p^i \leq t_{ij}$

[35]The details of the econometric equations have been discussed in the earlier part of this chapter.

Equation (5.50), an inequality constraint, can be treated as equality by incorporating a slack variable, $w_{ij,}$ as discussed in the non-linear programming section giving Equation (5.51):

(5.51) $$p_j - p^i - t_{ij} + w_{ij} = 0$$

As discussed in the Kuhn-Tucker conditions, either there are no profits ($w_{ij}= 0$) or there are no trade flows ($x_{ij}= 0$) in order for a competitive equilibrium to hold. In this case, the trade flows are the Lagrange multipliers.

(5.51) $$w_{ij} * x_{ij} = 0$$

The equations (5.45) to (5.51), together with the non-negativity conditions, can be solved simultaneously to find the optimal solution. Lee and Seaver (1973) employed the simplex tableau to prove that this procedure is equivalent to the quadratic programming algorithm.

Linear Complementarity Problem and Lemke's algorithm

In this section, the linear complementarity problem that exists in the spatial equilibrium and the solution through the Lemke's algorithm will be discussed. Friesz et al. (1983) has noted that the linear complementarity problem could be solved efficiently using Lemke's algorithm (Lemke 1965).

The inclusion of ad valorem tariffs in the spatial equilibrium model may mean that the integrability conditions are violated where the matrix of coefficients of the demand and supply functions is not symmetric (Takayama and Judge 1971; Devadoss 2009). In this case, the spatial equilibrium model can be formulated as a linear complementarity problem as in Equation (5.52).

(5.52) $$w = Mz + q$$
$$w \geq 0, z \geq 0$$
$$w_i z_i = 0 \text{ for all } i$$

where M is a real *n x n* matrix and w and z are the vectors in R^n. It is clear from the constraints $w \geq 0, z \geq 0$ and $w_i z_i = 0$ that w and z are required to be nonnegative and at least one of w_i or z_i must be zero.

An algorithm for the linear complementarity problem was developed by Lemke (1965). From the Equation (5.52), $w = Mz + q$ is viewed as a dictionary[36] for w which are regarded as basic variables (index of variables in the solution) and z as non-basic variables (index of variables not in the solution). If $q \geq 0$, the corresponding basic feasible solution, $z = 0$ and $w = q$, then this dictionary is feasible and optimal solutions are obtained. Otherwise, an artificial variable z_0 is added into the Equation (5.52) as $w = Mz + q + z_0$ and creates one pivot.

The process will stop once z_0 is non-basic and there must be either w_i or z_i as a non-basic variable. In other words, w_i and z_i are complementary and only one of them can be in the solution. The Lemke algorithm together with the econometric formulation will be used in this study to solve the spatial equilibrium model. The model will be further modified with the inclusion of research and development (R&D) expenditures as an element in the yield function. The details of the inclusion of the R&D expenditures into the spatial equilibrium model will be discussed in Chapter 7.

Concluding Remarks

This chapter has been made up of two sections: the econometric specification and the formulation of the spatial equilibrium model. The general specifications of the behavioural equations, including consumption demand, stocks demand, area harvested and yield equations were outlined. The specifications differed for each country depending on the behaviour of the individual country's economic agents. The econometric estimation results for each country will be explained in detail in the next chapter.

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[36] A dictionary is defined as a system of equations corresponding to a feasible solution.

The standard spatial equilibrium model by Takayama and Judge (1971), using the price formulation was discussed in detail with a two-region example in both graphical and mathematical form. Furthermore, this standard model was modified to reflect the nature of this study. The modifications included exchange rates, domestic subsidies and import quotas. Apart from these modifications, the inclusion of ad valorem tariffs into the model was also discussed and will be employed in one of the scenarios with the assumed removal of BERNAS. Although, numerous solution algorithms exist for solving quadratic programming problems as used in spatial equilibrium models, the econometric formulation developed by Lee and Seaver (1971) together with the Lemke algorithm were chosen to simulate the rice industry in Malaysia and the rest of the world. The estimation results for all the countries and the simulation model validations (through graphical and statistical methods) will be discussed in the next chapter.

Chapter 6: Estimation Results and Model Validation

Introduction

In the previous chapter, the theoretical framework for the behavioural equations was discussed. In the first section of this chapter, the results for the behavioural equations for six regions will be discussed in detail. These equations will be estimated using two-stage least squares and the first-order autocorrelation correction will be used when an autocorrelation problem occurs. The supply equation is an identity consisting of the area harvested, yield and the conversion of paddy to rice[37]. The exogenous variables used in the consumption demand, area harvested, yield and stocks demand equations will be collapsed into the intercept, thus creating a new set of demand and supply equations to be used in the spatial equilibrium model. The following section describes the inclusion of the estimated parameters into the simulation model and the dynamic simulation of the model for the period from 1982 to 2009. The model validation, using graphical and statistical methods will be discussed in the final section.

Estimation Results

Behavioural equations for this study were estimated using annual data from 1980 to 2009. Definitions and sources of data are given in Appendix A. As time series data are subject to trends over time, all the data were tested for stationarity using the Augmented Dickey-Fuller test (Engle and Granger 1987). To avoid spurious regressions and biased t-statistics, a deterministic time trend was included in some of the equations to capture the trends.

The behavioural equations for the spatial equilibrium model consist of four stochastic equations and one identity for each country: Malaysia, Thailand, Vietnam, Pakistan, Indonesia and the rest of the world. Altogether, there were 24 stochastic equations

[37]Paddy is rice in the husk, which is still in the field (also known as un-milled rice) and rice is the final product for consumption after removing of the husks and polishing. Usually paddy is harvested with 25 percent moisture content and then sent to the mills for drying and producing rice. So, the conversion rate is the rate at which the paddy is converted into rice. This rate differs across the countries in this study with a range of 0.65 to 0.67.

included in the model. The equations were consumption demands, stocks demands, area harvested and yield equations, and six identities for the supply functions. The Time Series Processor (TSP) software was used to estimate the simultaneous behavioural equations.

All the equations were diagnosed for misspecification problems using the Ramsey Regression Specification Error Test (RESET) and found that the linear functional forms were appropriate for all the countries. The ordinary least squares (OLS) method was used to estimate the area harvested equations. However, the two-stage least squares (2SLS) method was used to estimate the consumption demand, stocks demand and yield equations since the price was an endogenous variable. A set of instrumental variables was used in the two-stage least squares procedures.

A Durbin-Watson test was used to detect any autocorrelation problems, and if found, then the model was corrected using the Cochrane-Orcutt procedure. With autocorrelation the mean of the error term generally remains constant at zero. If the serial correlation is ignored, all inferences are invalid and the problems worsen if lagged dependent variables exist in the model (Pindyck and Rubinfeld 1998). A correlation will exist between the error term and one of the explanatory variables when there is a lagged dependent variable in which case the OLS estimates become biased. Therefore, it was essential to test for autocorrelation using the Durbin-Watson test. When the lagged dependent variables were used, as in the area harvested equations, the Durbin-Watson test is not valid and thus, Durbin's h (Dh) test was used to diagnose autocorrelation problems.

Several regression measures, including the R-squared (R^2), the t-statistic, standard errors, F-ratio and Durbin-Watson statistic (or Durbin's h-statistic in autocorrelation cases) were used to evaluate the estimated relationships. The R^2 is the coefficient of determination which measures the goodness of fit between the estimated regressions[38], whereas the t-statistic is used to test the significance of individual

[38]Unlike in the case of a single regression, the R^2 is used as an informal measure of the goodness of fit in the multiple regression systems and to validate the regression analysis under different alternatives (Pindyck and Rubenfield 1998).

parameters. Whilst the t-statistic is used for the individual significance, the F-ratio is a test for the overall significance of the regression model.

The prior expectations for the signs for each of the equations were discussed in the previous chapter. Most of the behavioural equations conformed to the expected signs but in some countries, there were a few exceptions. However, the price variable in the stocks demand equation was removed as it was not significant in all the countries. It was assumed, that in all the countries, the stocks demand largely represents the transactions motive only and with little in the way of speculative demand. In the next section, the results for each country's behavioural equations are provided in detail.

Malaysia sub-model

The estimates of the behavioural equations for Malaysia are given in Table 6.1. The sub-model estimated coefficients appear to conform to the theoretical expectations and to have significant results.

In the consumption demand equation, the income (GDP1) and population (POP1) variables were significant at one and five per cent levels respectively. The estimated income coefficient had a positive sign which indicates that rice is a normal good in Malaysia and this result was consistent with the study by Tey et al. (2008). Yet, other studies have shown that rice is an inferior good (Ito et al. 1989; Baharumshah 1991). As shown in Table 6.1, the goodness of fit, R^2, has a high value reflecting the fact that the regression equation explains 97 per cent of variation in the dependent variable.

The stocks demand equation was estimated as a function of the price of rice (P1), production (S1) and lagged closing stocks (D7(-1)) but the result was not satisfactory as the sign on the price variable was not consistent with the theory and for solutions to the spatial equilibrium model to be obtained a non-positive coefficient is required. Thus, the price variable was removed from the equation and it was assumed that the transactions motive for the stock demand was more significant in Malaysia. The equation was further improved by incorporating an intercept (DM196) dummy variable to reflect the influences of BERNAS[39] after its privatization in 1996. However, the dummy variable was not statistically significant.

The area harvested equation was estimated several times using various substitutes for paddy planting area but the results were not as expected. Despite the inclusion of the price of palm oil (PPO1) in the equation, the R^2 was still low at 0.304. However, after incorporating the per unit subsidy into the area harvested model, the R^2 was generally improved to 0.55 and provided some significant results. The per unit subsidy[40] (PPS1) had a positive coefficient that was significant at the one per cent level. This indicates that the area harvested in Malaysia is likely to be strongly dependent on the subsidies given by the government.

Finally, the yield equation was estimated as a function of the rainfall (R1) and fertilizer consumption per hectare (FC1). The rice yield was found to be responsive to the fertilizer consumption per hectare as the parameter was highly significant at the one per cent level. The rainfall was not statistically significant and one possible reason is that approximately half of the paddy land depends on irrigation and the drainage system and is not rainfed. The R^2 was 0.75 which was considered a good fit and the signs of the coefficients were as expected. The reported yield function in Table 6.1 was re-estimated with R&D expenditures included and the results will be discussed in the next chapter.

[39] The role of BERNAS has been discussed in detail in the earlier chapters.

[40] The per unit subsidy was obtained by dividing the total subsidies by the total production of paddy. Subsidies consisted of the paddy price subsidy, fertilizer subsidy and other incentives. Details on these subsidies were explained in Chapter 3.

Table 6.1 The behavioural estimations for Malaysia

Consumption Demand

D1 = -2.183 – 0.146E-03 P1 + 0.189E-03 PW1+ 0.130E-05 GDP1 + 0.273POP1 - 0.128T
(1.849) (0.364E-03) (0.155E-03) (0.316E-06)*** (0.147)** (0.073)*

R^2 = 0.971 Adjusted R^2 = 0.964 DW = 1.676

Stocks Demand

D7 = -0.114 + 0.162 S1(-1) + 0.688D7(-1)+ 0.059DM196
(0.276) (0.243) (0.167)*** (0.065)*

R^2 = 0.735 Adjusted R^2 = 0.704 D.W. = 1.797

Area Harvested

A1 = 0.468 + 0.212 A1(-1) + 0.544E-05 P1(-1) - 0.209E-05PPO1 + 0.205E-03PPS1
(0.095)*** (0.153) (0.128E-04) (0.342E-05) (0.448E-04)***

R^2 = 0.554 Adjusted R^2 = 0.453 D.W h. = 2.137

Yield

Y1 = 2.124 + 0.613E-03R1 + 0.475 FC1
(0.242)*** (0.139E-02) (0.055) ***

R^2 = 0.767 Adjusted R^2 = 0.749 D.W. = 1.699

Note : Figures in parentheses denote the standard errors and *** , ** and * indicate significant at 1, 5 and 10 per cent significant level respectively. DM196 is the intercept dummy variable used in the stocks demand equation to reflect BERNAS's involvement in the rice industry after 1996.

Thailand sub-model

The estimated coefficients for the behavioural equations in Thailand conform to prior expectations. The results are presented in Table 6.2. It is apparent that rice is a normal good as the coefficient for the income variable (GDP2) was positive and statistically significant at the five per cent level. This result is inconsistent with previous studies on domestic demand in Thailand which showed a negative income coefficient (Ito et al. 1989 and Isvilanonda 2002). However, from a recent study by Isvilanonda and Kongrith (2008) it was found that the estimated expenditure (income) elasticity for the whole country was 0.082, thus in the more recent work rice can be considered as a normal good. The time trend was removed from the consumption demand equation as all the variables were integrated of order 1, I(1) .

For the stocks demand equation, the lagged production and lagged stocks demand coefficient estimates were highly significant at the one per cent level which indicated that the transactions motive is likely to play an important role in Thailand's rice industry. Dummy variables were used to capture the structural changes in Thailand but the results were not satisfactory. Thus, those dummy variables were removed from the equation.

In the area harvested equation, the price of cassava was included as a substitute crop and the coefficient had the expected sign as in theory but was not significant. Other crops that could be substitutes for rice, such as the price of palm oil, rubber and maize were also included in the equation but the results did not have the negative sign as expected and thus were removed from the equation. The lagged area harvested was highly significant at the one per cent level and this result was consistent with the study by Sachchamarga and Williams (2004). Based on the compilation from previous studies on Thailand's rice industry, the price elasticity of supply ranged from 0.02 to 0.65 with an average of 0.25 (Chouen et al. 2006; Siamwalla and Setboonsarng 1989; Vanichjakvong 2002). The result from this study also found a similar elasticity of an average of 0.23.

The yield equation was regressed as a function of the fertilizer consumption per hectare and annual rainfall. Both the coefficients were found to be significant at one and five per cent levels respectively. From the results, we found that the farmers in Thailand were very responsive towards the rainfall and the usage of fertilizers.

Table 6.2 The behavioural estimations for Thailand

Consumption Demand

D2 = 7.769 – 0.285E-04P2 + 0.689E-02 POP2+ 0.204E-06GDP2
(0.180)*** (0.282E-04) (0.0359) (0.990E-07)**

R^2 = 0.827 Adjusted R^2 = 0.806 D.W. = 1.774

Stocks Demand

D8 = -2.148 + 0.194 S2(-1) + 0.676 D8(-1)
(0.870)** (0.069)*** (0.171) ***

R^2 = 0.715 Adjusted R^2 = 0.693 D.W. = 1.858

Area Harvested

A2 = 2.896 + 0.665 A2(-1) + 0.315E-04 P2(-1) – 0.8494E-05PC2 + 0.0164 T
(1.797)* (0.205)*** (0.672E-04) (0.393E-03) (0.017)

R^2 = 0.676 Adjusted R^2 = 0.603 D.W. h = 2.048

Yield

Y2 = 1.174 + 0.379E-03 R2 + 4.180 FC2
(0.283)*** (0.182E-03)** (0.380)***

R^2 = 0.845 Adjusted R^2 = 0.833 D.W. = 1.622

Note : Figures in parentheses denote the standard errors and *** , ** and * indicate significant at 1, 5 and 10 per cent significant levels.

Vietnamese sub-model

The estimated coefficient signs for all behavioural equations for Vietnam were found to be consistent with the theory and the results are as presented in Table 6.3. All the variables were found to be statistically significant at one per cent except for the income coefficient at the five per cent significance level. Since the coefficient on the income variable was positive, rice in Vietnam can be regarded as a normal good and this result was consistent with the conclusions from previous studies, including Vu Hoang (2009) and Quang Le (2008) and Minot and Goletti (2000).

Unlike Malaysia and Thailand, Vietnam's stocks demand equation showed a higher R^2 of 0.92. Stocks demand was strongly dependent on the lagged stocks and lagged production. The price variable was tested in the model but the estimated coefficient had a positive sign which was contradictory to the theory. Assuming that the transactions motive is vital to the Vietnamese rice industry, the price variable was removed from the model.

All of the behavioural equations had an R^2 greater than 0.92 which revealed that the regressions were well behaved. The area harvested equation was regressed on the lagged area harvested, lagged price and a time trend. Dummy variables were used in the model to capture the changes in the economic conditions in Vietnam during the study period, but the estimates were not significant and the results were not adequate for a conclusion. Therefore, the dummies were removed from the model.

Similar to the other countries, farmers in Vietnam were found to respond to the fertilizer consumption per hectare and irrigation levels. These variables were found to be statistically significantly at the one and five per cent level respectively. A one per cent increase in the fertilizer consumption was found to lead to a 6.93 per cent increase in the yield. It is likely the yield equation could be improved further if weather variables were available to include in the model.

Table 6.3 The behavioural estimations for Vietnam

Consumption Demand

$$D3 = \underset{(1.657)^{***}}{-8.059} - \underset{(0.146E\text{-}06)^{***}}{0.382E\text{-}06\ P3} + \underset{(0.252)^{***}}{0.305\ POP3} + \underset{(0.957E\text{-}09)^{**}}{0.243E\text{-}08\ GDP3}$$

$R^2 = 0.967$ Adjusted $R^2 = 0.964$ D.W. = 1.355

Stocks Demand

$$D9 = \underset{(0.159)^{*}}{-0.294} + \underset{(0.014)^{**}}{0.032\ S3(-1)} + \underset{(0.127)^{***}}{0.704D9(-1)}$$

$R^2 = 0.920$ Adjusted $R^2 = 0.914$ D.W. = 1.808

Area Harvested

$$A3 = \underset{(25.15)}{8.684} + \underset{(0.211)^{***}}{0.089\ A3(-1)} + \underset{(0.358E\text{-}07)}{0.262E\text{-}07\ P3(-1)} + \underset{(0.135)}{0.034E\text{-}03\ T}$$

$R^2 = 0.964$ Adjusted $R^2 = 0.959$ D.W. = 1.872

Yield

$$Y3 = \underset{(0.357)^{***}}{1.305} + \underset{(0.472)^{**}}{0.394IRRI3} + \underset{(0.147)^{***}}{6.933FC3}$$

$R^2 = 0.955$ Adjusted $R^2 = 0.951$ D.W. = 1.669

Note : Figures in parentheses denote the standard errors and *** , ** and * indicate significant at 1, 5 and 10 per cent significant levels.

Pakistan sub-model

The two-stage least squares (2SLS) results for the consumption demand, stocks demand and yield and the ordinary least squares result for the area harvested in Pakistan are presented in Table 6.4. The results of behavioural equation estimations were found to be consistent with the theory and as expected. It is apparent that the price of wheat, when used as a substitute for rice, was highly significant at the one per cent level. In Pakistan, rice is the second staple food after wheat. This situation differs in other countries, including Malaysia, Thailand, Indonesia and Vietnam, where rice is the main staple food. Though, results from previous studies found that rice is a normal good in Pakistan (Mukhtar 2009; Muhamad 2008), for this study it was not possible to identify whether rice was a normal or inferior good in Pakistan since there was no significant income parameter for the model.

The stocks demand was regressed on the lagged stocks demand and lagged supply. Inclusion of the rice price in the stocks demand model did not provide any meaningful results, thus it was removed from the model. The results could not be improved further, even though various variables, including dummies, rice price, and production were used. Only the lagged stocks demand was found to be statistically significant at the one per cent level.

The estimated coefficients for the area harvested equation were consistent with *a priori* expectations. Unlike the demand estimates, the area harvested results appeared to agree with the study by Muhamad (2008). The price of wheat was used to represent the substitute crop for paddy area, which was tested separately in the model, but the results were not satisfactory, thus the variable was removed from the model. The results maybe better if the price of other substitute crops were to be included in the model but data limitations restricted the possible variables.

The yield equation was estimated as a function of fertilizer consumption and irrigation. The irrigation variable was found to be positive and statistically significant at the one per cent level. This result suggests that in Pakistan, the rice yield is largely dependent on the irrigation system.

Table 6.4 The behavioural estimations for Pakistan

Consumption Demand

D4 = 5.858 – 0.178E--04 P4 + 0.671E-04 PW4 + 0.047 GDP4 + 0.144 T
(3.984) (0.105E-04)*(0.177E-04)*** (0.049) (0.156)

R^2 = 0.652 Adjusted R^2 = 0.593 D.W. = 1.085

Stocks Demand

D10 = 0.210 + 0.037 S4(-1) + 0.637 D10(-1) -0.556E-02T
(0.319) (0.112) (0.153)*** (0.013)

R^2 = 0.416 Adjusted R^2 = 0.346 D.W. = 1.958

Area Harvested

A4 = 1.523 + 0.152 A4(-1) + 0.798E-05 P4(-1) + 0.0208 T
(0.684)** (0.382) (0.669E-05) (0.0105)**

R^2 = 0.846 Adjusted R^2 = 0. 819 D.W.h = 1.985

Yield

Y4 = -0.335 + 1.358IRRI4 + 0.097FC4
(0.369) (0.228)*** (0.195)

R^2 = 0.808 Adjusted R^2 = 0.793 D.W. = 1.034

Note : Figures in parentheses denote the standard errors and *** , ** and * indicate significant at 1, 5 and 10 per cent significant levels.

Indonesian sub-model

The behavioural estimations for Indonesia were found to conform to the prior expectations for all the coefficient signs. The consumption demand equation was regressed on the price of rice, price of wheat, population and a time trend. The gross domestic product (GDP) was included as an income proxy but was found not to have any significant results and was replaced with a time trend. Since there was no income parameter, it was not possible to identify whether rice was a normal or inferior good in Indonesia. The population variable parameter was found to be positive and highly significant at the one per cent level which reflected the influence on the rice demand in Indonesia of population.

In the stocks demand estimation, the lagged stocks demand parameter appeared to be significant at the one per cent level. Despite numerous tests conducted to improve the stocks demand estimates, the R^2 was still low at 0.57. Similar to Malaysia, the Indonesian rice industry is controlled by a state trading agency called Bulog. If the influence of Bulog could be captured into the model, the results would likely be better.

In the area harvested equation, the price of cassava was included in the model and the coefficient negatively influenced the paddy planted area. In the earlier models, the price of corn, maize and sugar were included as substitute crops to the rice planted area, but the coefficients were found not to be statistically significant and with unexpected signs. Thus, these variables were removed from the model. Farmers seem to respond to the previous year's area harvested, as the lagged area harvested parameter had a positive sign and a significant coefficient.

The rice yield in Indonesia was estimated as a function of irrigation, fertilizer consumption and a time trend. The estimate for the fertilizer consumption variable in the yield equation was found to be highly significant at the one per cent level. This finding was similar to Haryati and Aji (2005) where paddy productivity tended to decline if the fertilizer price rises since the farmers tended to reduce fertilizer usage.

Table 6.5 The behavioural estimations for Indonesia

Consumption Demand

D5 = -196.9 – 0.858E-06 P5 + 0.218E-06 PW5 + 1.497 POP5 - 4.117 T
(68.35)*** (0.803E-06) (0.714E-06) (0.465)*** (1.482)***

R^2 = 0.968 Adjusted R^2 = 0.963 D.W. = 1.458

Stocks Demand

D11 = -0.493 + 0.061 S5(-1) + 0.690 D11(-1)
(1.414) (0.052) (0.152)***

R^2 = 0.571 Adjusted R^2 = 0.538 D.W. = 1.718

Area Harvested

A5 = 1.239 + 0.892 A5(-1) + 0.243E-07 P5(-1) – 0.167-07 PCA5(-1)
(1.199) (0.120)*** (0.216E-06) (0.536E-06)

R^2 = 0.881 Adjusted R^2 = 0. 866 D.W. h = 1.828

Yield

Y5 = 3.143 + 0.077 IRRI5 + 3.135 FC5 + 0.877E-02 T
(1.068)*** (0.255) (0.829)*** (0.581E-02)

R^2 = 0.824 Adjusted R^2 = 0.803 D.W. = 1.335

Note : Figures in parentheses denote the standard errors and *** , ** and * indicate significant at 1, 5 and 10 per cent significant levels.

Rest of the world sub-model

The estimated results for all the behavioural equations in the rest of the world: the consumption demand, stocks demand, area harvested and yield for the rest of the world are given in Table 6.6. The consumption demand was regressed only on the price of rice and income since the coefficient for the price of wheat (assumed as a substitute good for rice), was found not to be significant and thus, removed from the equation. The coefficients were found to be statistically significant at the one per cent level and consistent with *a priori* expectations. The demand equation fitted the data well as the R^2 was 0.92.

Similar to the other sub-models in this study, the stocks demand for the rest of the world was regressed on the lagged supply, lagged stock demand and a time trend. All the variables were found to be statistically significant at the one per cent level and the high R^2 of 0.93 indicated that the variables were a good fit for the model.

In the area harvested equation, the time trend estimate appeared to be positive and significant. Besides the time trend, the lagged area harvested and the price of rice were included in the yield equation. Other substitute crops, such as corn, wheat, and rubber were used in the model, but did not improve the results further.

Since the fertilizer consumption data for the rest of the world were not available, the yield equation was estimated as a function of the lagged yield and a time trend. The R^2 was 0.98 which indicated a reasonably good fit for the regression model. Based on theory, all the coefficients for the behavioural equations had the expected signs.

Table 6.6 The behavioural estimations for the ROW

Consumption Demand				
D6 = 279.20	– 0.174 P6	+ 0.319E-05GDP6		
(10.230)***	(0.0312)***	(0.183E-06)***		
R^2 = 0.924	Adjusted R^2 = 0.919	D.W. = 0.895		
Stocks Demand				
D12 = -112.7	- 0.615 S6(-1)	+ 0.7581 D12(-1)	- 2.725 T	
(43.09)**	(0.205)***	(0.070)***	(0.778)***	
R^2 = 0.939	Adjusted R^2 = 0.932	D.W. = 1.254		
Area Harvested				
A6 = 89.13	+ 0.215 A6(-1)	+ 0.270E-02 P6(-1)	+ 0.184 T	
(36.210)**	(0.318)	(0.499E-02)	(0.084)**	
R^2 = 0.617	Adjusted R^2 = 0. 550	D.W. = 1.747		
Yield				
Y6 = 0.9628	+ 0.7101 Y6(-1)	+ 0.010 T		
(0.303)***	(0.100)***	(0.451E-02)**		
R^2 = 0.977	Adjusted R^2 = 0.975	D.W. h = 2.104		

Note : Figures in parentheses denote the standard errors and *** , ** and * indicate significant at 1, 5 and 10 per cent significant levels.

The full set of behavioural equations was solved simultaneously in the Time Series Processor (TSP) program[41]. The well-performing behavioural equations, in terms of goodness of fit, diagnostic statistics as well as consistency with economic theory were used in the simulation model. For the simulation model, the reduced form coefficients were required. Except for the price coefficients, all the other exogenous variable parameters multiplied by their variable values were collapsed into an intercepts variable that varied through time. In the next section a description of the simulation model will be given.

[41] Besides other econometric software, the Time Series Processor (TSP) software package was used because the econometric estimation and simulation calculations could be done in this software and the results can be written in Microsoft Excel. However, at a later stage, it was found that this software could not provide a unique solution for the spatial equilibrium simulations. Therefore, the coefficients and intercepts from the econometric results in TSP were transferred to Microsoft Excel so as to be available to solve the mathematical programming problem. A Lemke algorithm was written in Visual Basic for this purpose.

Simulation Based Model Results

The spatial equilibrium model consists of a set of non-linear simultaneous equations and constraints and these were formulated into a mathematical programming problem and solved using the Lemke algorithm written in Microsoft Excel Visual Basic 2010. The tableau for the spatial equilibrium model was formulated in the price domain, where the intercepts and slopes were in terms of quantity.

There were 24 primal constraints (dual variables) and 55 dual constraints (primal variables) in this model. The tableau consisted of 158 columns and 79 rows which included the import quotas and slack variables. Only 79 of the 158 variables were in the solutions and the rest of the variables were zero through the complementary slackness conditions. In the arbitrage conditions, the exchange rates (ER1, ER2, ER3, ER4 and ER5) were used to convert the local currency to US dollars[42].

Since this study is focused on the Malaysian rice industry, the domestic subsidies were included in the arbitrage equation as an 'own transport cost' (T11). Import quotas were included in the arbitrage conditions. As noted earlier, BERNAS has been given the exclusive rights to import rice without a tariff. Import tariffs will only be applied if the role of BERNAS is removed from the model. This situation will be modelled in a policy scenario and reported in the next chapter.

The baseline model is designed to replicate the actual scenario in the rice industry. Therefore, the baseline model was built with import quotas, domestic subsidies and the yield function with the R&D included. The econometrically estimated simulation model was dynamically solved for the period of 1982 to 2009. A model is said to be dynamic when the predetermined variables include lagged endogenous variables, where in this study the area harvested and stocks demand equations had lagged endogenous variables.

Using the Lemke algorithm written in the Visual Basic the model was simulated for the first period. For the second period, the lagged endogenous variables values from the first period were used in the equations and the model was dynamically simulated

[42]The modifications to the standard spatial equilibrium model were discussed in detail in Chapter 5.

over the range of the study period. For all the 28 periods of the simulations optimal solutions were obtained for the spatial equilibrium model.

It is essential to validate the model by comparing the historical data (original data) with the simulated series for each of the endogenous variables. These model validations, in terms of statistical and graphical measurements, will be discussed in the next section.

Model Validation using graphical analysis

Even with a well tracking model, with good statistical measures, it is important to evaluate the simulated model in terms of the turning points in the data. To validate the simulated model, the historical and simulated data for the endogenous variables: the consumption demand, stocks demand, area harvested, yield, market price and imports were plotted in Figures 6.1 to 6.42.

Except for the stocks demand, all the other simulated endogenous variables reflected the historical values well, which indicated that the model was plausibly simulated. Only in the rest of the world, was the stocks demand predicted with a good fit to the historical data, but in other countries, it gave a poor fit to the actual data. The reason could be that the government interventions in those countries, such as controlling buffer stocks to maintain the domestic prices do not reflect normal behavioural systems.

The simulated market price variable reflected the historical value reasonably well, even during the price spike in 2008. This suggested that the model has good basic structural properties. To complement the results from the graphical analysis, the model validations, using several statistical measures, including Theil's U statistics, are presented in the next section.

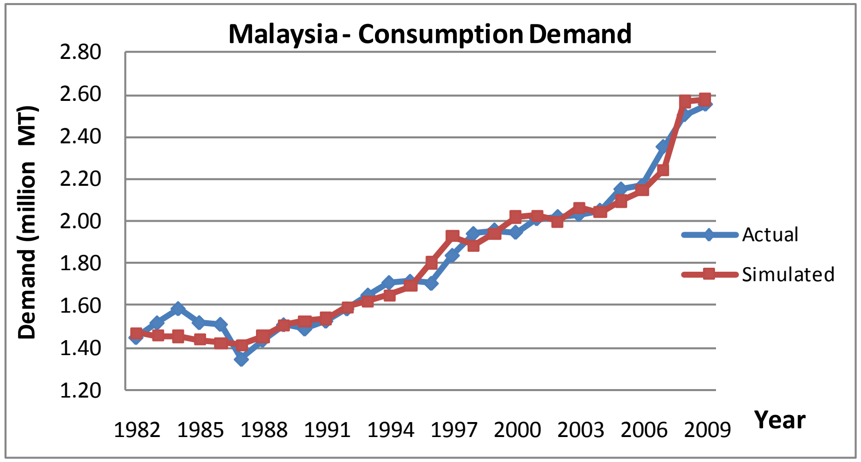

Figure 6.1 Actual and simulated values of consumption demand for Malaysia, 1982 - 2009

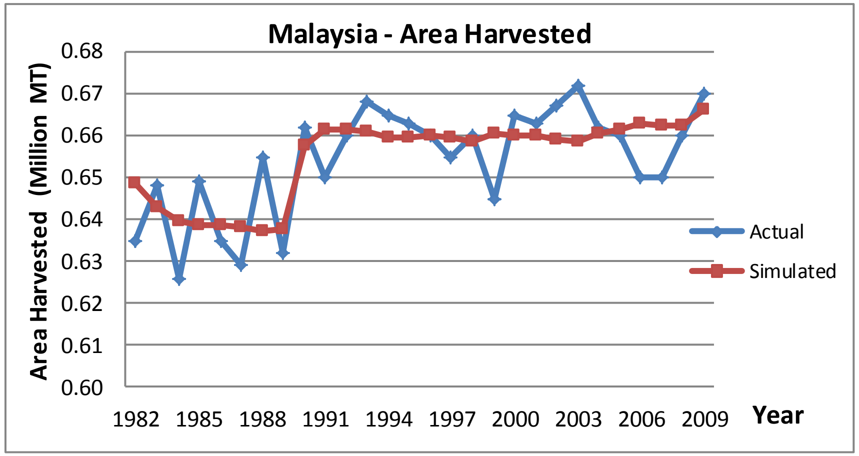

Figure 6.2 Actual and simulated values of area harvested for Malaysia, 1982 -2009

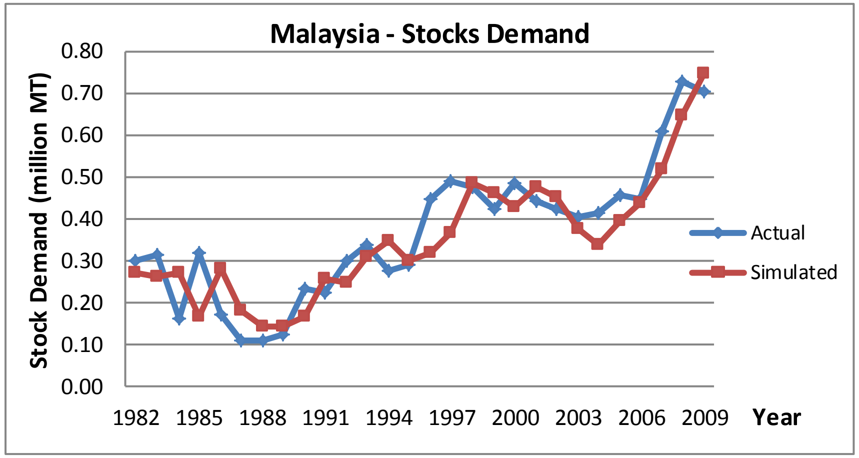

Figure 6.3 Actual and simulated values of stocks demand for Malaysia, 1982 -2009

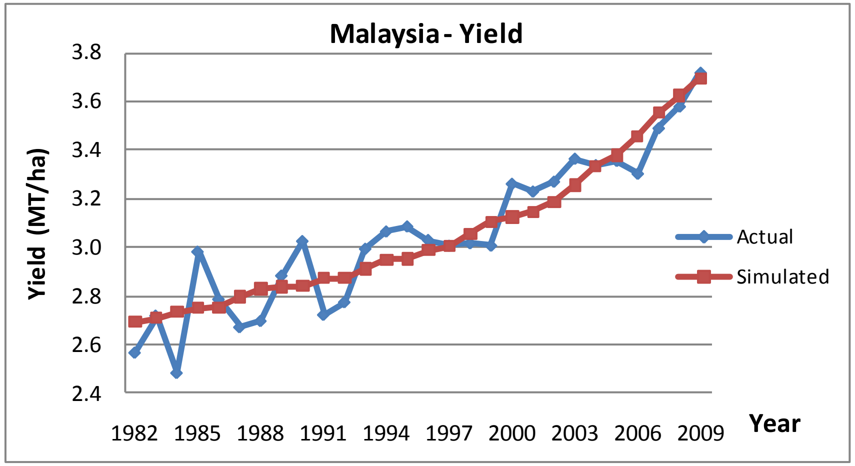

Figure 6.4 Actual and simulated values of yield for Malaysia, 1982 -2009

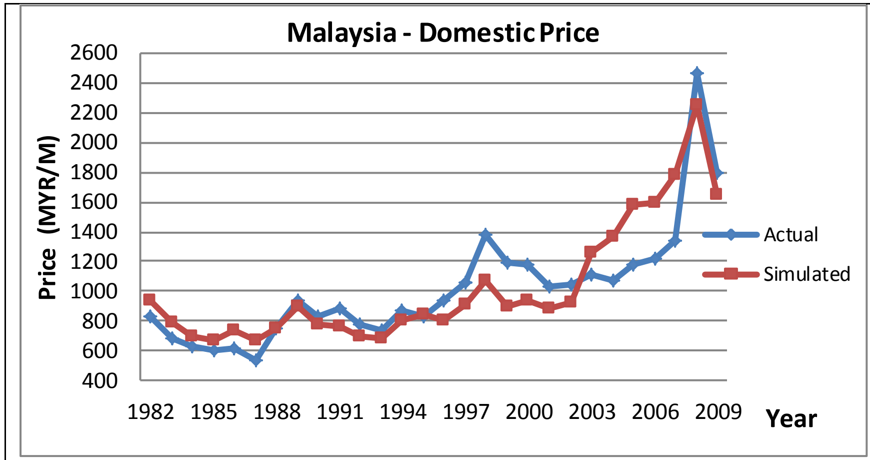

Figure 6.5 Actual and simulated values of domestic price for Malaysia, 1982 -2009

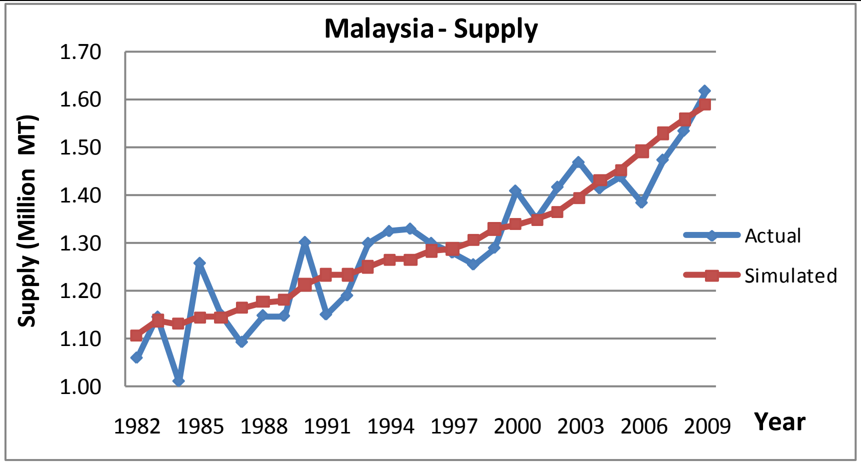

Figure 6.6 Actual and simulated values of supply for Malaysia, 1982 -2009

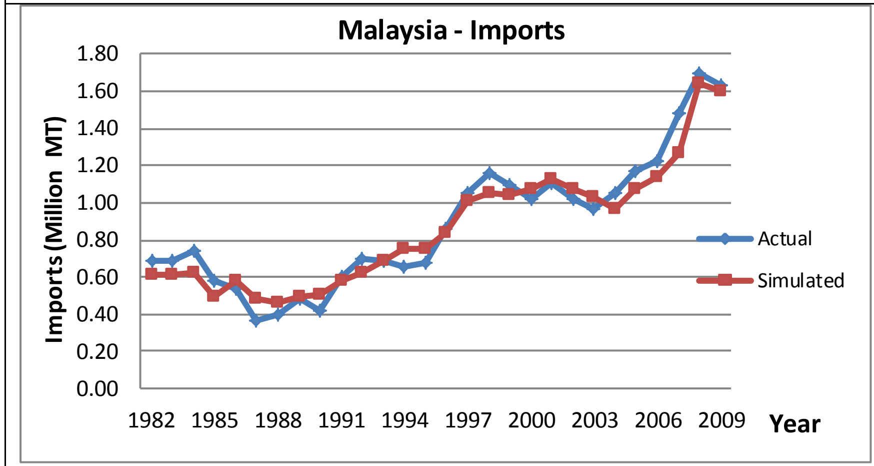

Figure 6.7 Actual and simulated values of imports for Malaysia, 1982 -2009

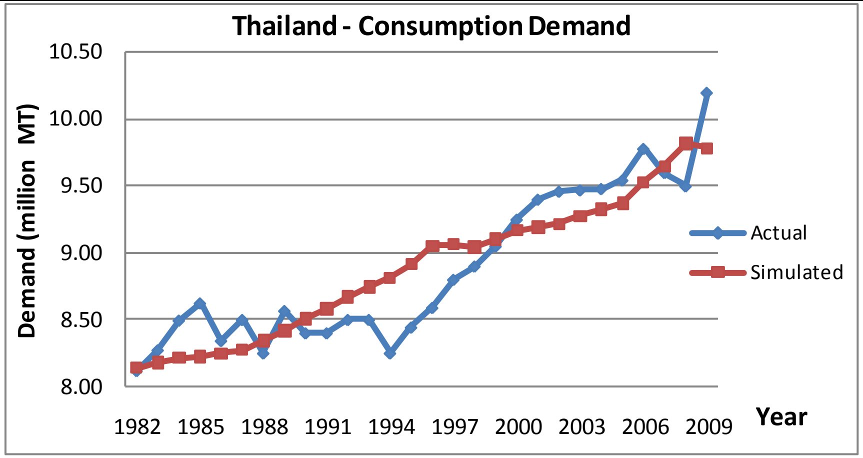

Figure 6.8 Actual and simulated values of consumption demand for Thailand, 1982 - 2009

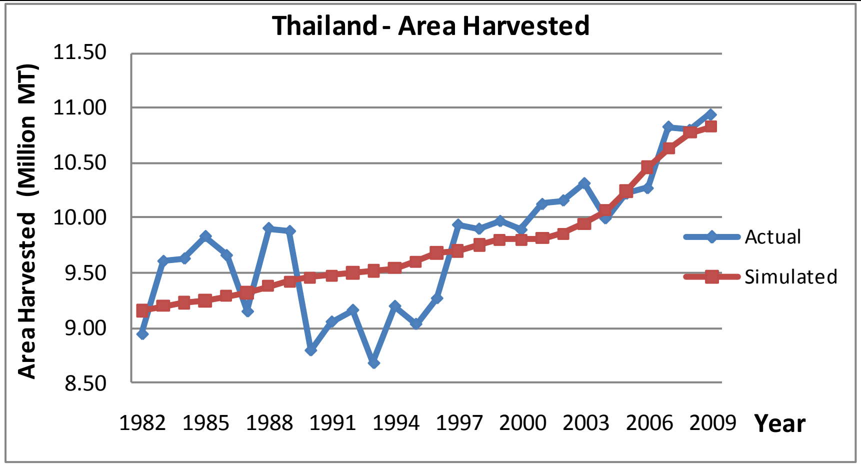

Figure 6.9Actual and simulated values of area harvested for Thailand, 1982 -2009

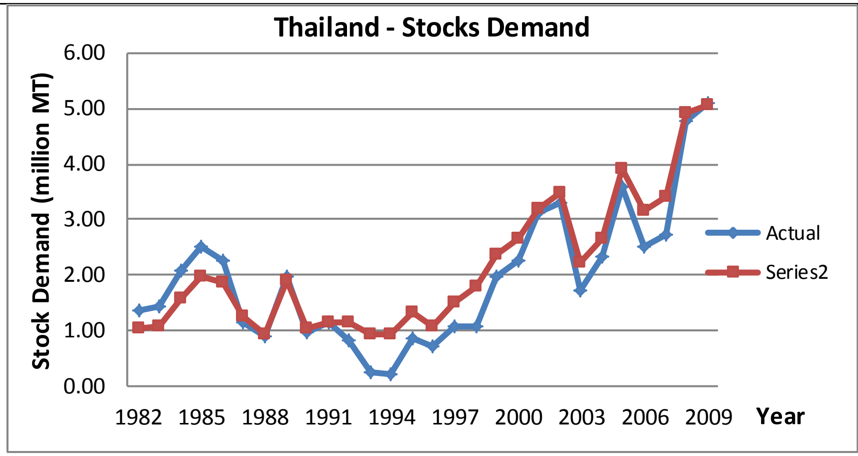

Figure 610 Actual and simulated values of stocks demand for Thailand, 1982 -2009

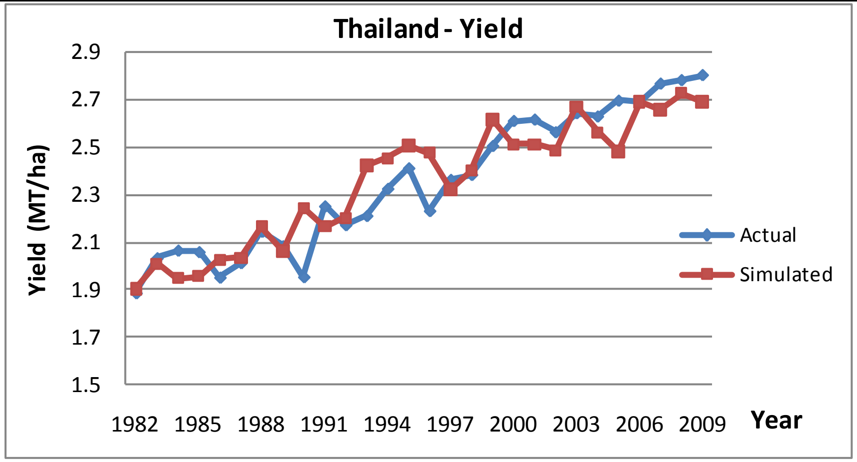

Figure 6.11Actual and simulated values of yield for Thailand, 1982 -2009

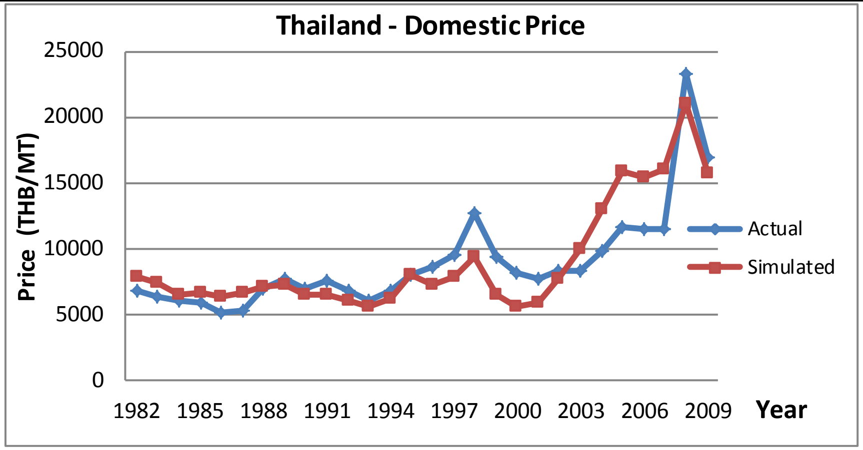

Figure 6.12Actual and simulated values of domestic price for Thailand, 1982 -2009

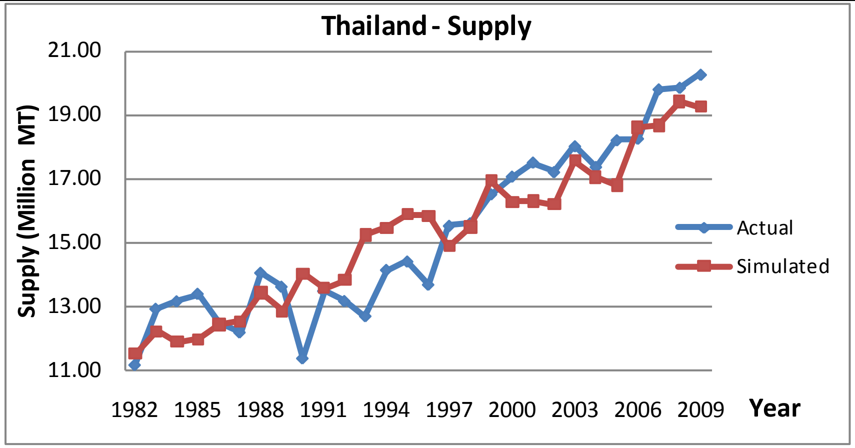

Figure 6.13Actual and simulated values of supply for Thailand, 1982 -2009

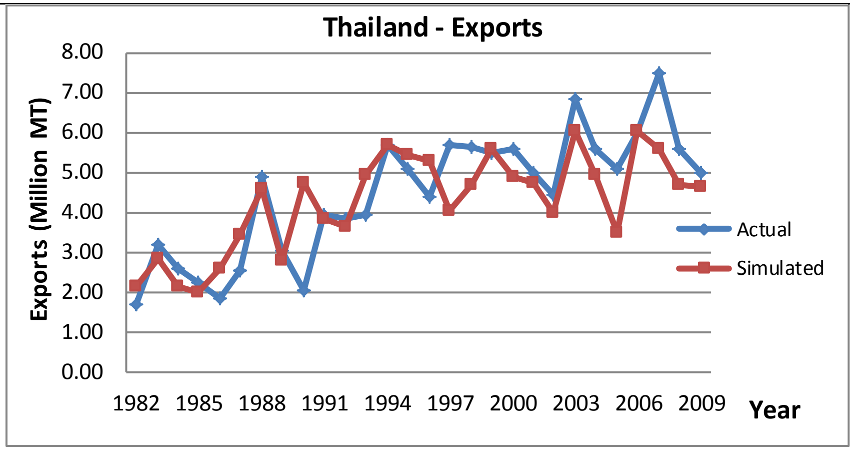

Figure 6.14 Actual and simulated values of exports for Thailand, 1982 -2009

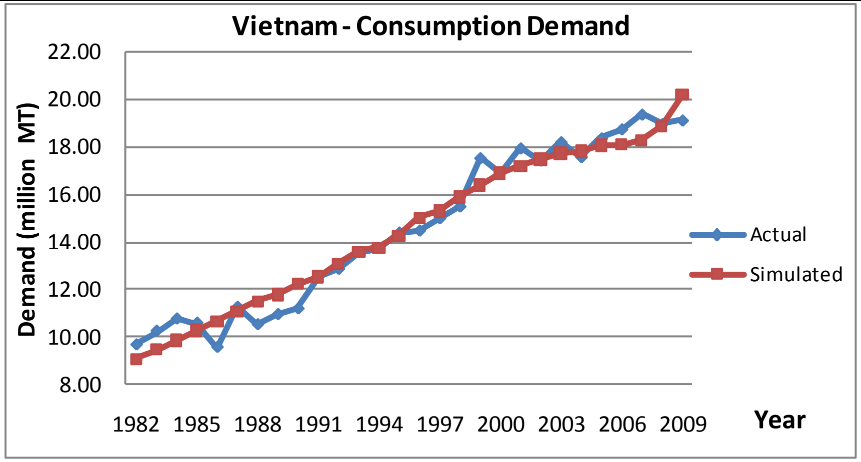

Figure 6.15Actual and simulated values of consumption demand for Vietnam, 1982 -2009

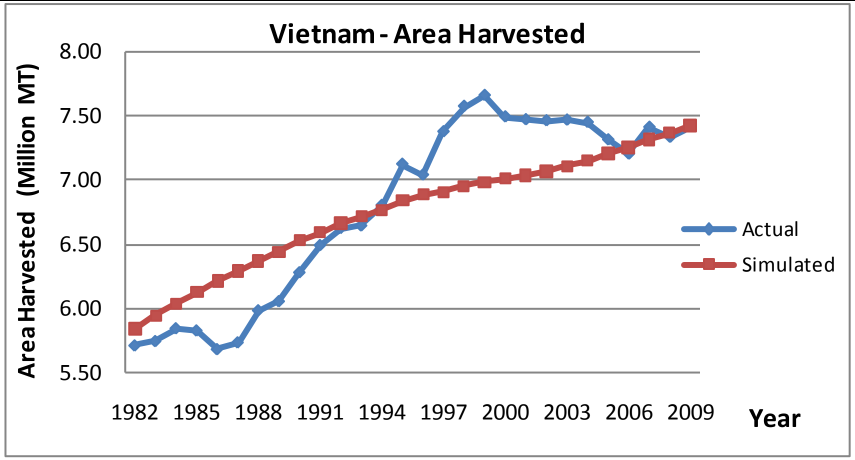

Figure 6.16Actual and simulated values of area harvested for Vietnam, 1982 -2009

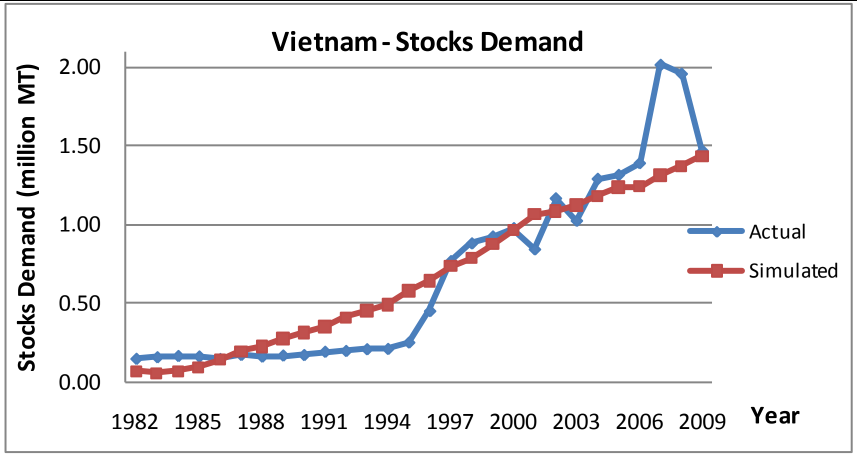

Figure 6.17 Actual and simulated values of stocks demand for Vietnam, 1982 -2009

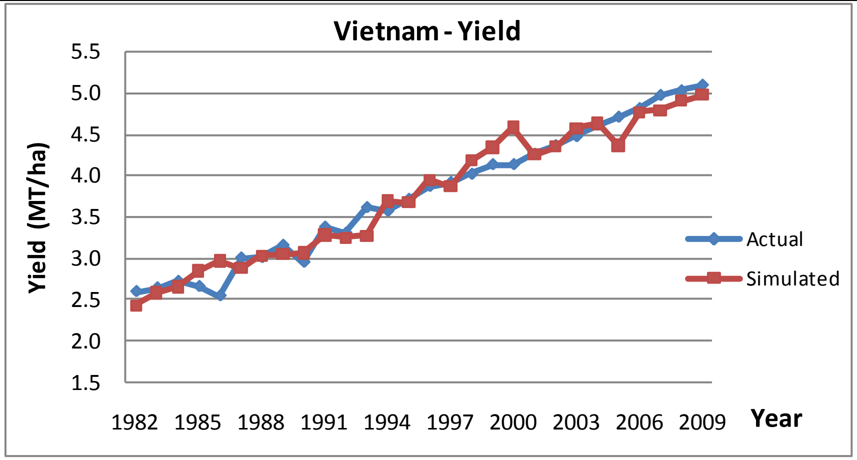

Figure 6.18Actual and simulated values of yield for Vietnam, 1982 -2009

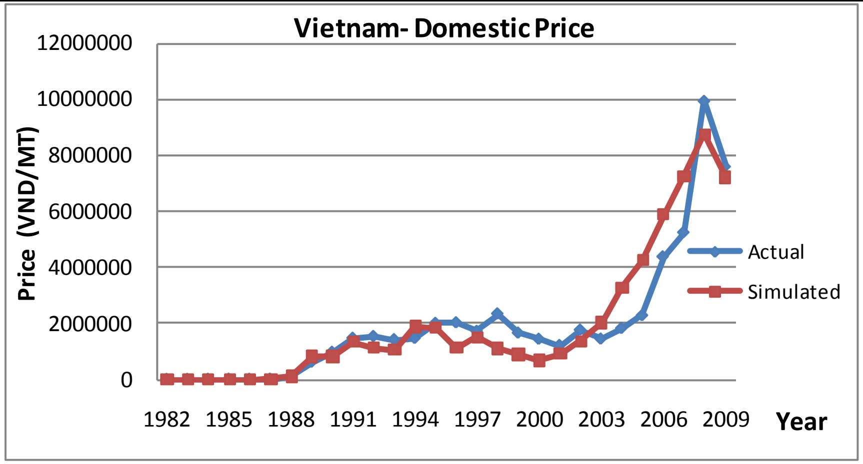

Figure 6.19Actual and simulated values of domestic price for Vietnam, 1982 -2009

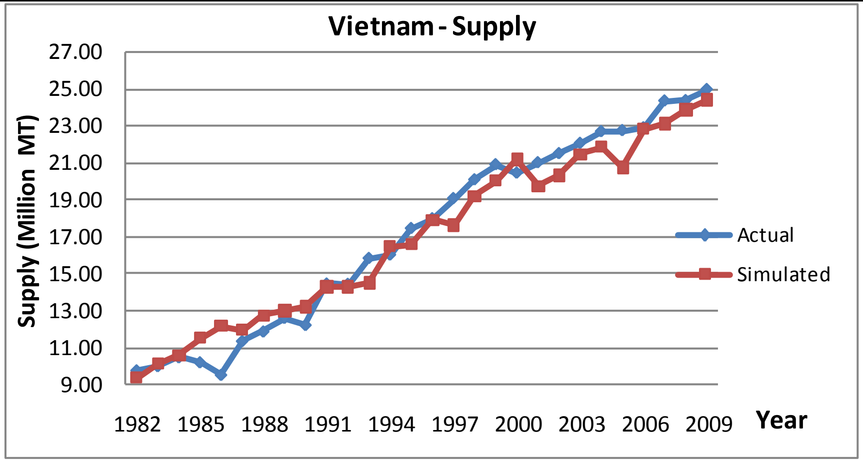

Figure 6.20Actual and simulated values of supply for Vietnam, 1982 -2009

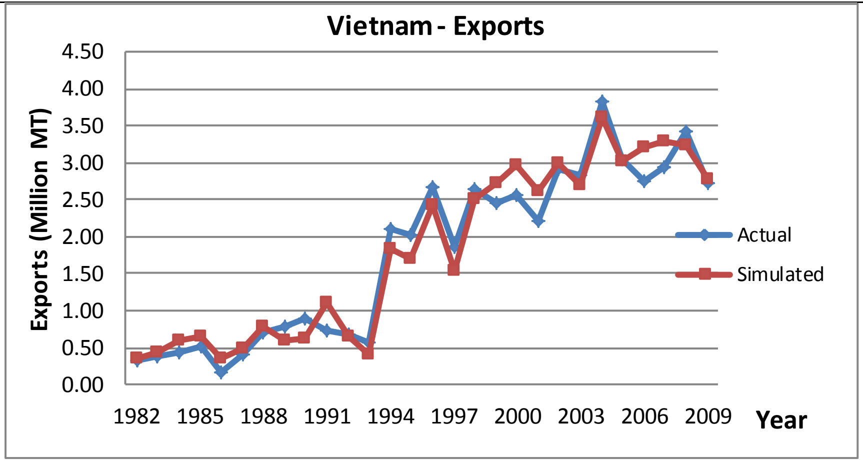

Figure 6.21 Actual and simulated values of exports for Vietnam, 1982 -2009

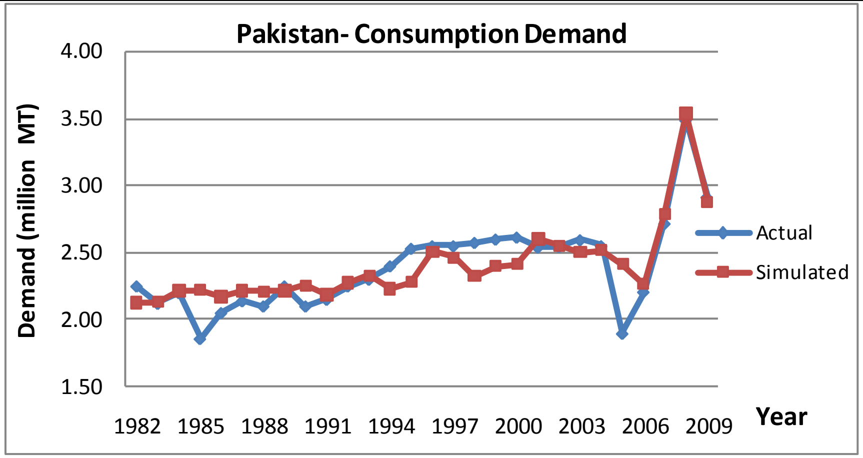

Figure 6.22Actual and simulated values of consumption demand for Pakistan, 1982 -2009

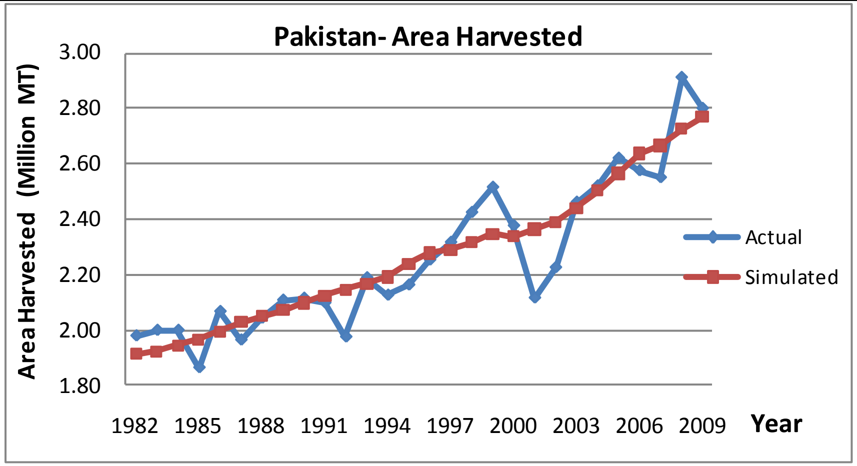

Figure 6.23Actual and simulated values of area harvested for Pakistan, 1982 -2009

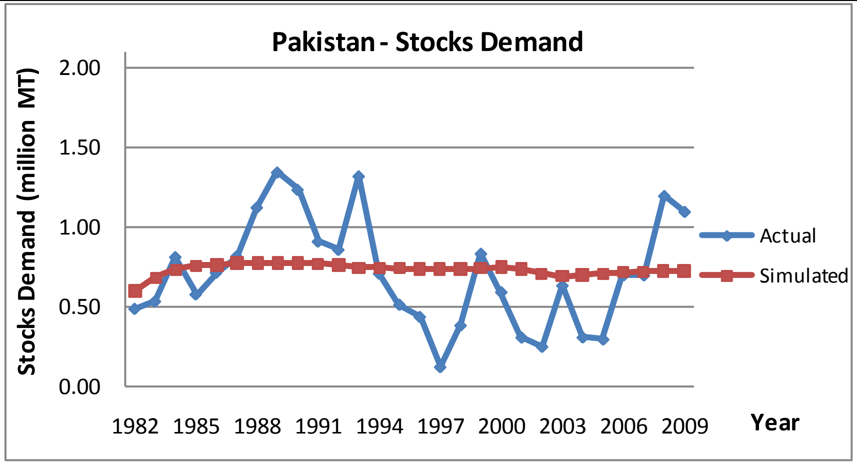

Figure 6.24Actual and simulated values of stocks demand for Pakistan, 1982 -2009

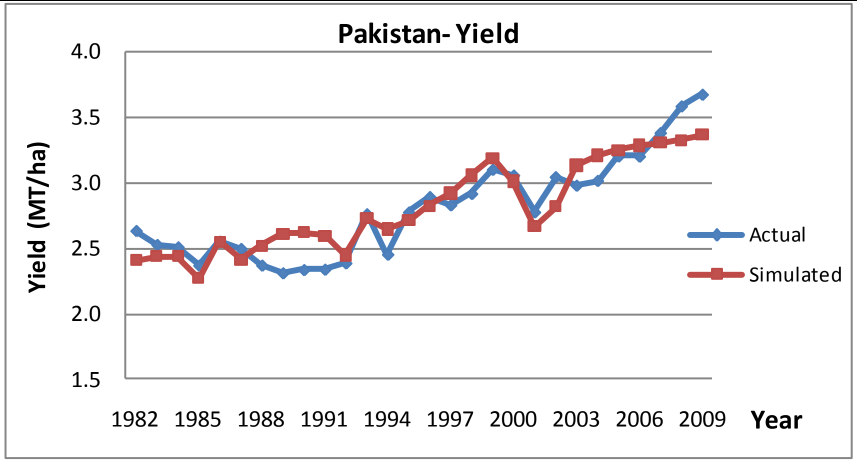

Figure 6.25Actual and simulated values of yield for Pakistan, 1982 -2009

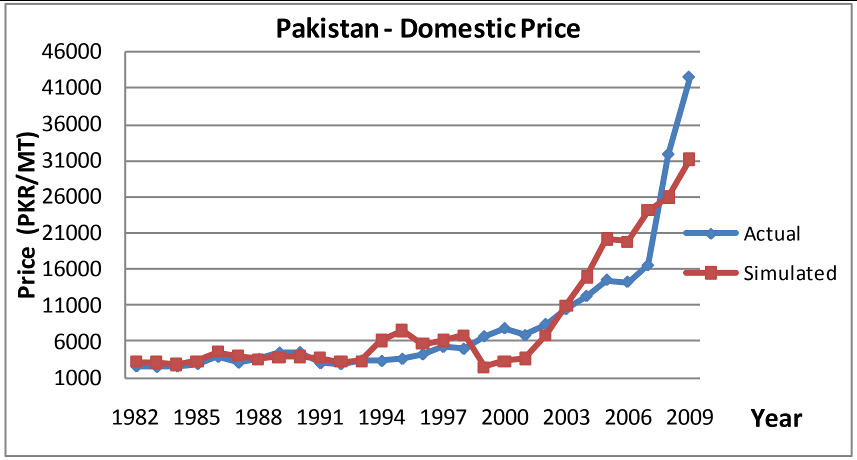

Figure 6.26Actual and simulated values of domestic price for Pakistan, 1982 -2009

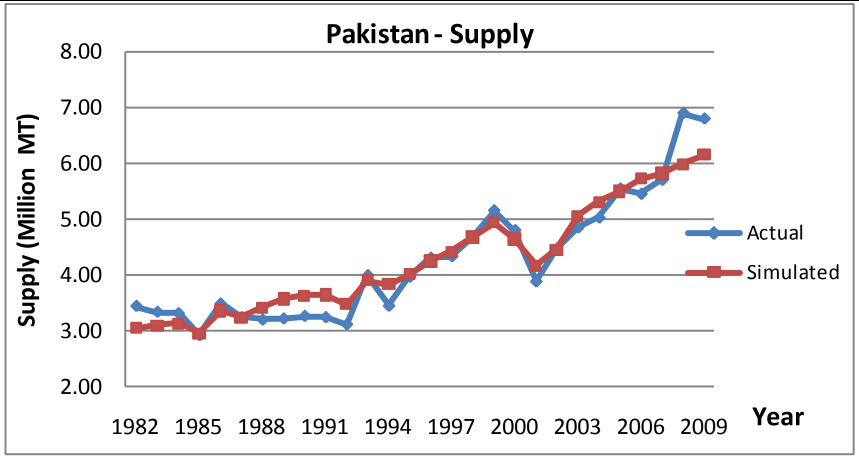

Figure 6.27Actual and simulated values of supply for Pakistan, 1982 -2009

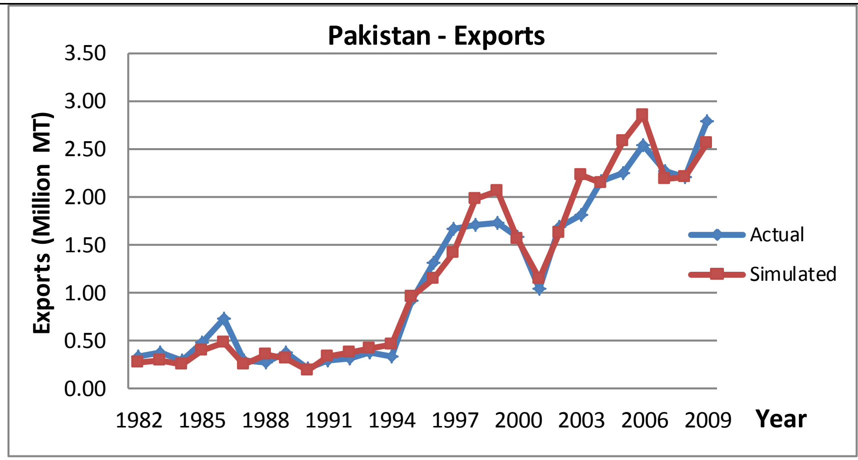

Figure 6.28 Actual and simulated values of exports for Pakistan, 1982 -2009

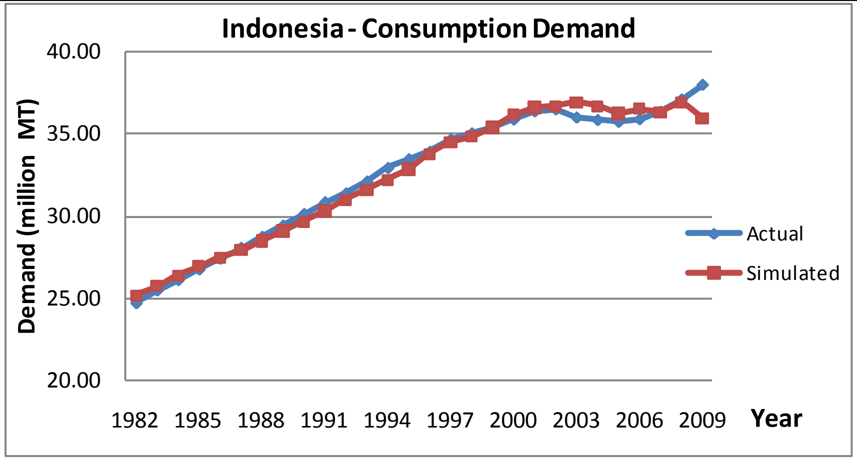

Figure 6.29Actual and simulated values of consumption demand for Indonesia, 1982 -2009

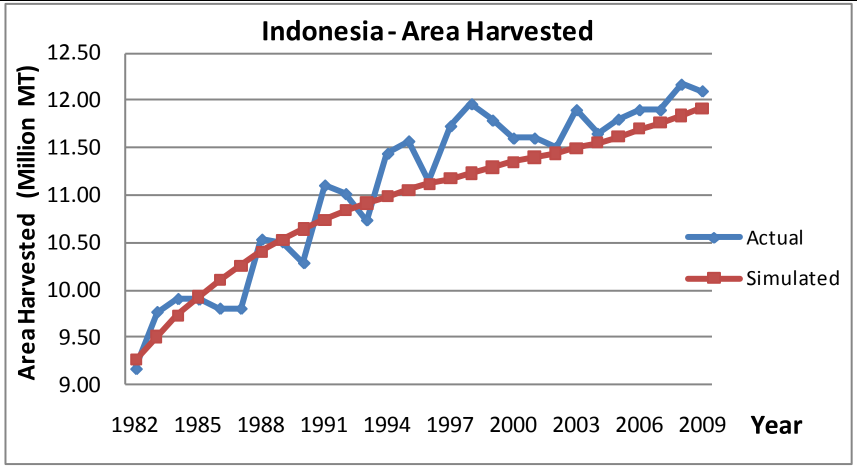

Figure 6.30Actual and simulated values of area harvested for Indonesia, 1982 -2009

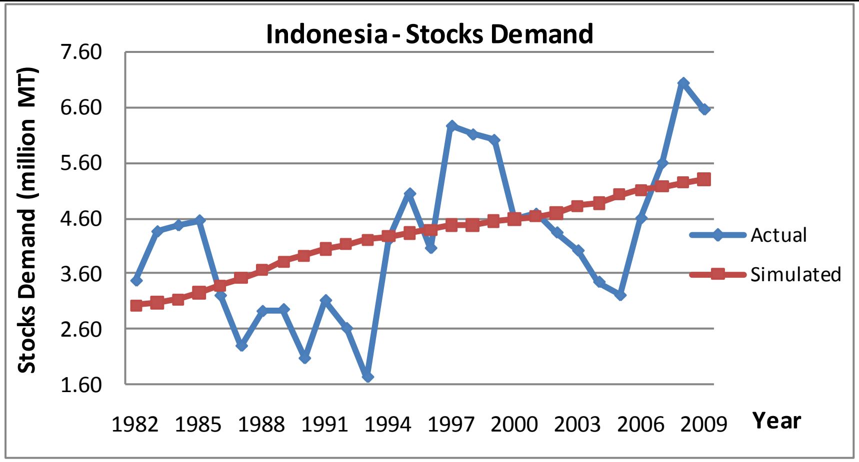

Figure 6.31Actual and simulated values of stocks demand for Indonesia, 1982 -2009

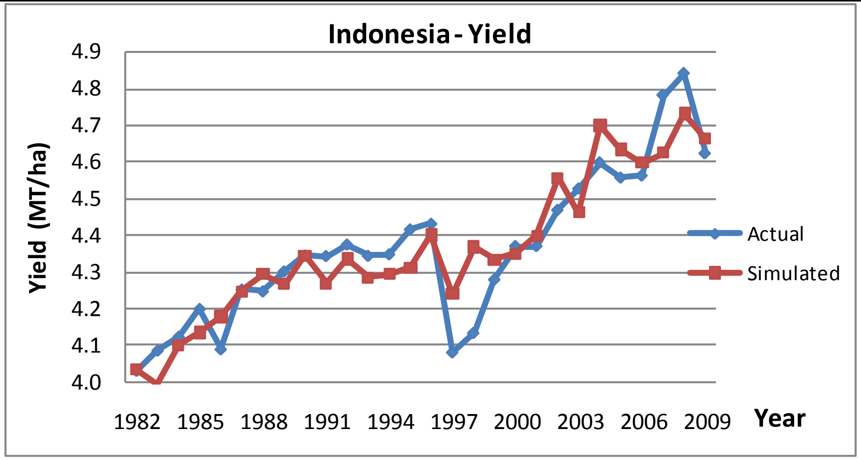

Figure 6.32Actual and simulated values of yield for Indonesia, 1982 -2009

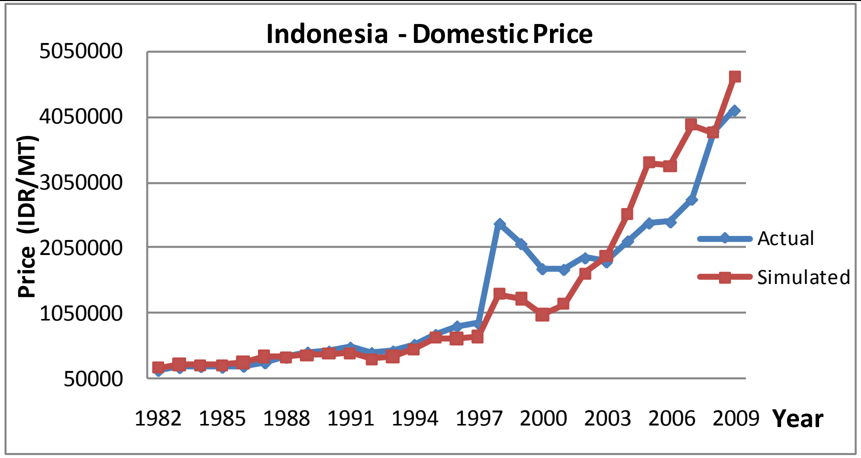

Figure 6.33Actual and simulated values of domestic price for Indonesia, 1982 -2009

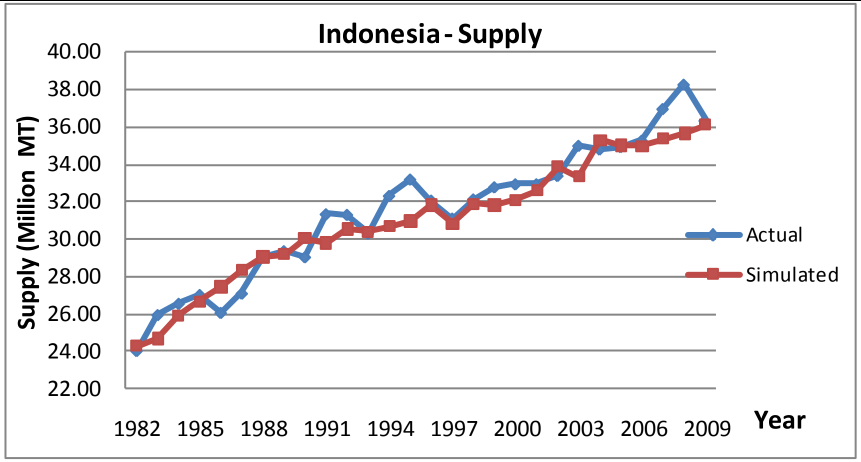

Figure 6.34Actual and simulated values of supply for Indonesia, 1982 -2009

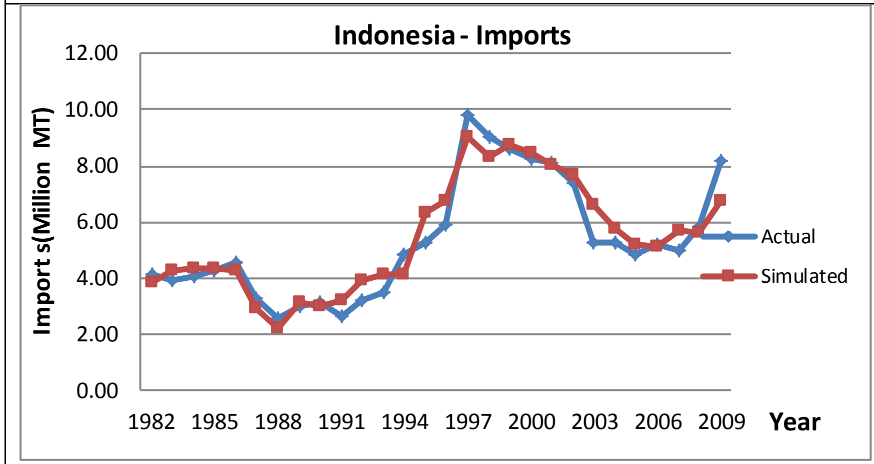

Figure 6.35 Actual and simulated values of imports for Indonesia, 1982 -2009

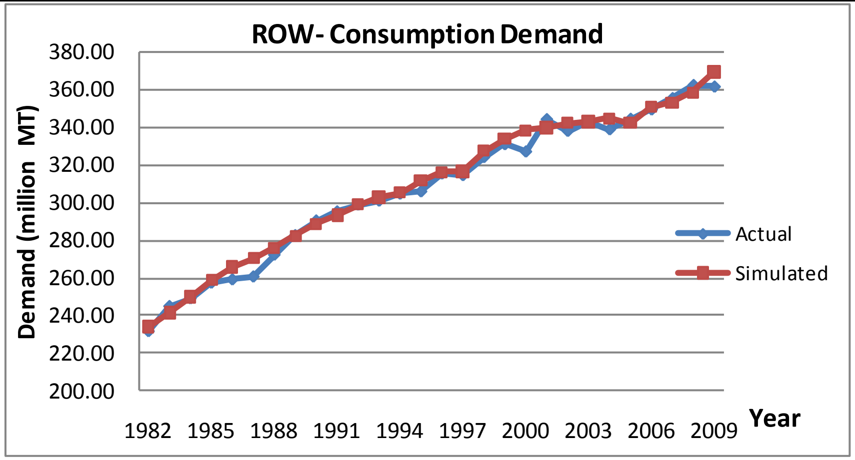

Figure 6.36 Actual and simulated values of consumption demand for ROW, 1982 -2009

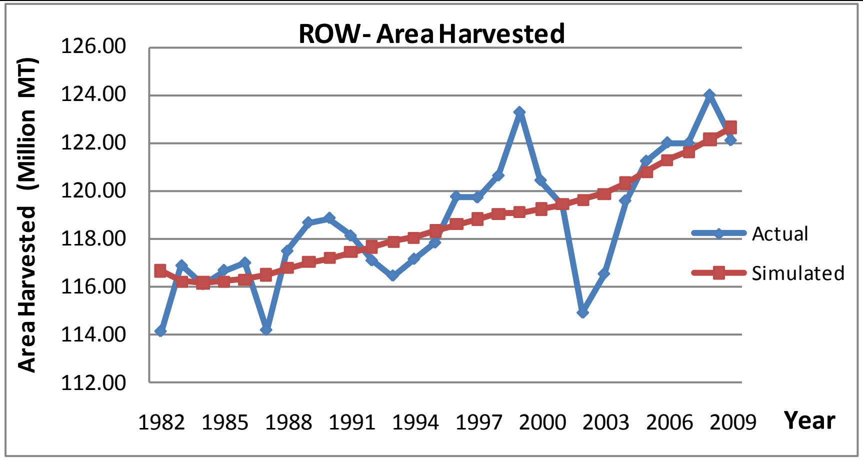

Figure 6.37 Actual and simulated values of area harvested for ROW, 1982 -2009

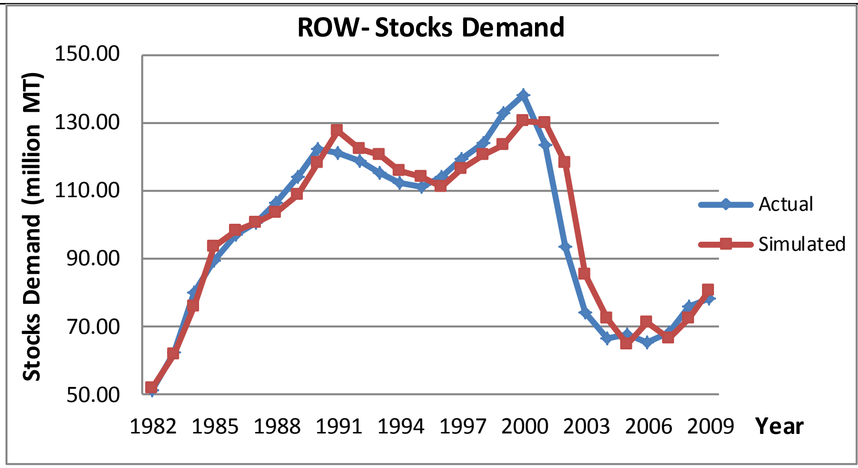

Figure 6.38 Actual and simulated values of stocks demand for ROW, 1982 -2009

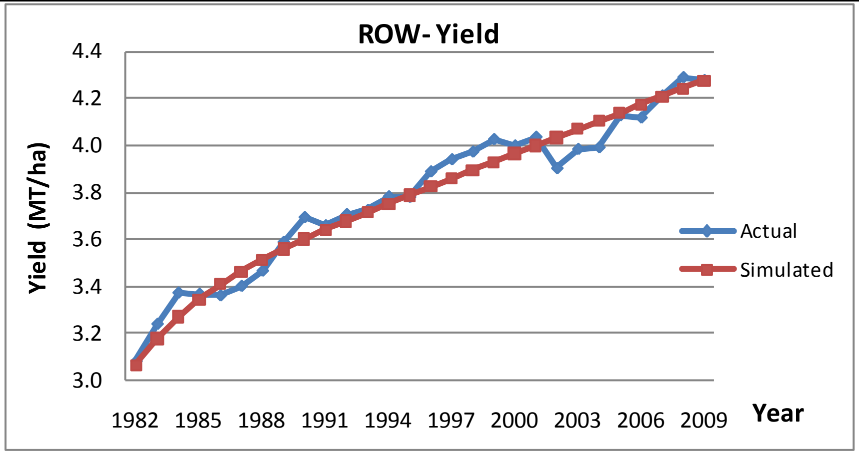

Figure 6.39 Actual and simulated values of yield for ROW, 1982 -2009

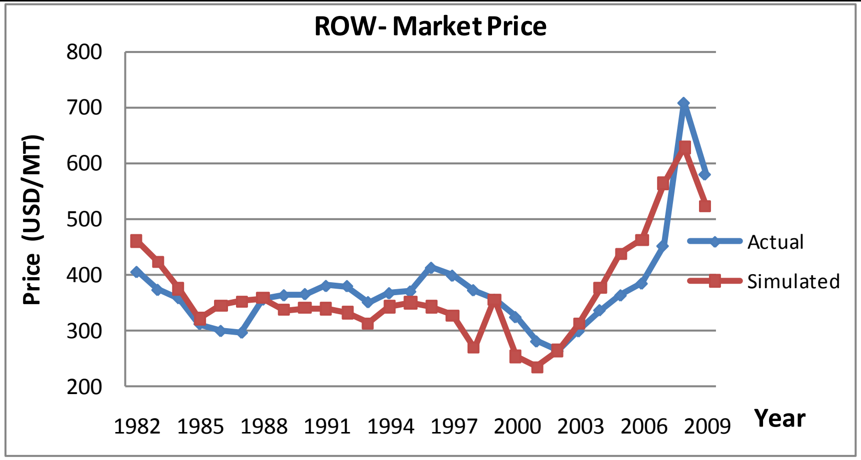

Figure 6.40 Actual and simulated values of market price for ROW, 1982 -2009

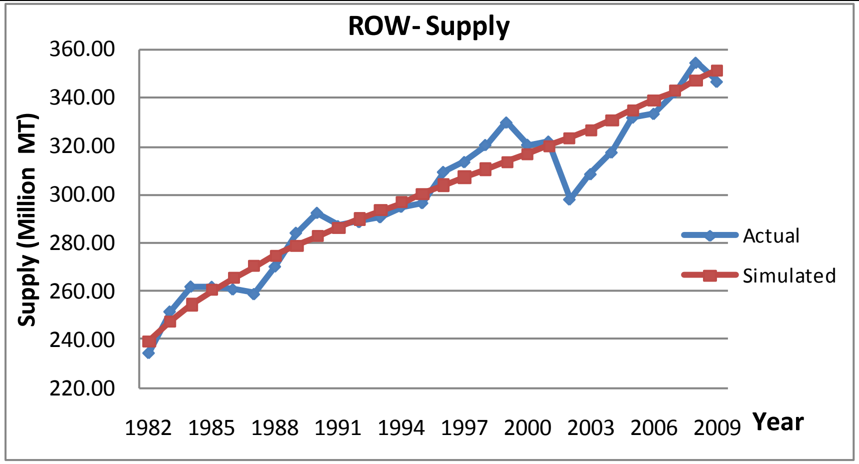

Figure 6.41 Actual and simulated values of supply for ROW, 1982 -2009

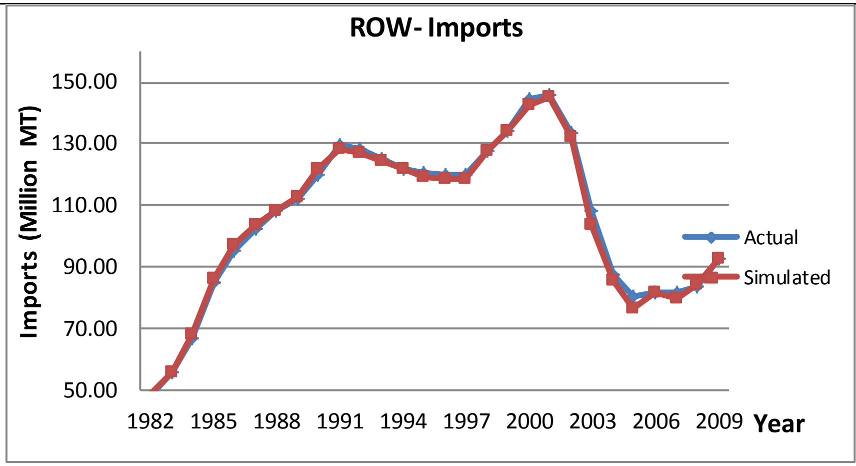

Figure 6.42 Actual and simulated values of imports for ROW, 1982 -2009

Model Validation using statistic measures

In any historical simulation model, it is possible that some simulated endogenous variables will track closely to the original data series but others will not (Pindyck and Rubinfeld 1998). As illustrated in Figure 6.1 to 6.42, some of the endogenous variables fitted the data well while others did not. Thus, some judgments need to be used to evaluate the individual variables as well as the simulation model as a whole. For this purpose, a set of statistics was used to examine quantitatively how well the individual simulated series track their actual data.

Mean-error or mean simulation error (ME) of an estimator is one of the ways to measure the difference between simulated and actual value of variables which is defined as:

(6.1) $$ME = \frac{1}{n}\sum_{t=1}^{n}(Y_t^s - Y_t^a)$$

where n is the number of periods in the simulation (28 periods), Y_t^s and Y_t^a are the simulated and actual values of the endogenous variables. This measure is not that reliable since ME can be close to zero if there are large positive and negative errors which cancel out the differences.

Root mean square error (RMSE) is a better measure than ME which quantifies the deviation of the simulated variables from the actual values and is defined as:

(6.2) $$RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(Y_t^s - Y_t^a)^2}$$

RMSE is more accurate in evaluating the simulated or predicted values compared with the corresponding actual values. The RMSE results were reported in Table 6.7. Most of the variables in all regions had low RMSE simulation errors except the market price variables which had a higher RMSE in Malaysia, Thailand and Pakistan. It is common in the historical simulation models that some of the variables show low RMSE simulation errors while others exhibit high RMSE.

Other measures used to evaluate the simulation model were *mean absolute error (MAE)* and *mean absolute percentage error* (MAPE) which expressed in term of percentage are defined as:

$$(6.3)\qquad MAE = \frac{1}{n}\sum_{t=1}^{n}\left|Y_t^s - Y_t^a\right|$$

$$(6.4)\qquad MAPE = \frac{1}{n}\left[\sum_{t=1}^{n}\left|\frac{Y_t^s - Y_t^a}{Y_t^a}\right| \times 100\right]$$

As shown in Table 6.7, MAPE for all the endogenous variables, except for stocks demand and prices, were close to zero. One of the measures to test that the individual variables fit the model well is by looking at the correlation coefficient. If the correlation coefficient is closer to one, the better is the simulated model. Except for the stocks demand variables in Pakistan and Indonesia and market price variables in Malaysia and Thailand which gave a lower correlation coefficient, the rest of the variables in all the countries performed well between the range of 0.75 to 0.99 as illustrated in Table 6.7.

Another simulation statistic to measure inequality between actual and predicted is Theil's inequality coefficient (U) defined as:

$$(6.5)\ U = \frac{\sqrt{\frac{1}{n}\sum_{t=1}^{n}(Y_t^s - Y_t^a)^2}}{\sqrt{\frac{1}{n}\sum_{t=1}^{n}(Y_t^s)^2} + \sqrt{\frac{1}{n}\sum_{t=1}^{n}(Y_t^a)^2}}$$

By looking at Equation 6.5, it is clear that the numerator of Theil's inequality coefficient is the RMSE (as in equation 6.2) but the denominator is scaled so that the coefficient is always between the range of zero to one. A value of Theil's inequality coefficient closer to zero indicates greater simulation accuracy compared with a value of one which suggest poor predictive performance. The results of Theil's inequality coefficient measures are presented in Table 6.7. The simulated endogenous variables fit the actual data reasonably well as the Theil's inequality coefficients were between the ranges of 0.00 to 0.24.

The Theil's inequality can be decomposed into three meaningful parts as follows:

(6.6) $$\frac{1}{n}\sum(Y_t^s - Y_t^a)^2 = (\bar{Y}^s - \bar{Y}^a)^2 + (\sigma_s - \sigma_a)^2 + 2(1-\rho)\sigma_s\sigma_a$$

Where $\bar{Y}^s$ and $\bar{Y}^a$ are the means of the simulated and actual series respectively, while σ_s and σ_a are the standard deviations, and ρ is the respective correlation coefficient. The proportions of inequality are defined as follow:

(6.7) Bias Proportion, $$U^B = \frac{(\bar{Y}^s - \bar{Y}^a)^2}{\frac{1}{n}\sum(Y_t^s - Y_t^a)^2}$$

(6.8) Variance Proportion, $$U^V = \frac{(\sigma_s - \sigma_a)^2}{\frac{1}{n}\sum(Y_t^s - Y_t^a)^2}$$

(6.9) Covariance Proportion, $$U^C = \frac{2(1-\rho)\sigma_s\sigma_a}{\frac{1}{n}\sum(Y_t^s - Y_t^a)^2}$$

As in the Equation 6.7, the bias proportion (U^B) is an indication of the systematic error, which measures the difference between the average values (means) of the simulated and actual series. It can be suggested from the results, as shown in Table 6.7, that there was no systematic bias presented in the model since the values of the bias proportion were smaller than 0.2[43].

The variance proportion (U^V) is similar to bias proportion and represents the difference between variation of the simulations and variation of the actual series. If the variance proportion was small as presented in Table 6.7, it means that the fluctuations in the actual series were well represented by the simulated series for all the endogenous variables. However, there were some exceptions in the case of the

[43]Values of the bias proportion of inequality above 0.1 or 0.2 would indicate the presence of systematic bias and a model revision is usually necessary (Pindcyk and Rubinfeld 1998).

stocks demand variables in Vietnam, Pakistan, Indonesia and rest of the world variables where the variance proportions were quite large.

Finally, the covariance proportion (U^C) captures the balance of the remaining error after accounting for the bias and variance proportions. In other words, it measures the unsystematic error. Most of the simulation errors contribute to the covariance proportion, thus the simulation models would have a small variance proportion for the result to be unbiased.

Theoretically, the ideal distribution of inequality over the three proportions is $U^B = U^V = 0$ and $U^C = 1$. The results of all the inequalities are reported in Table 6.7 and the summation of bias, variance and covariance proportions may not be equal to one due to errors in rounding.

Concluding Remarks

In this chapter, the behavioural equations and the historical simulation results for all the countries were presented in detail. The behavioural equations, with the estimation period from 1980 to 2009, were discussed for each of the individual countries. The econometric results suggest that the models fit the historical data reasonably well using the R-squared value as a measure, albeit with a few exceptions, in some countries. The independent variables used in the regression depend on the individual country's economic agents and data availability. The estimated coefficients were consistent with the existing literature in most of the countries. Altogether, there were 24 stochastic equations and 6 identities analysed in this chapter.

For the spatial equilibrium model, the behavioural equations were reformulated to a set of equations where the exogenous variables and the intercept in each equation were collapsed into a new intercept for each time period. Then, the simulation based model was dynamically simulated over the period of 1982 to 2009 using the Lemke algorithm in the Excel Visual Basic program.

The dynamic spatial equilibrium model was validated using graphical analysis and statistical error measurements, including mean absolute errors, root mean square errors and Theil's inequality coefficients. Except for the stocks demand variable in Pakistan and Indonesia, the overall statistical outcomes showed that the simulated endogenous variables tracked the actual series closely. Hence, this dynamic model can be used in the policy analysis to examine what implications there may be if other alternative policies were taken. Some policy experiments, using the dynamic spatial equilibrium model will be discussed in the next chapter.

Table 6.7 Model validation statistics

Malaysia						
Validation Statistics	**Consumption Demand**	**Stocks Demand**	**Area Harvested**	**Yield**	**Supply**	**Market Price**
Correlation Coefficient (R)	0.98	0.75	0.70	0.92	0.92	0.56
Root Mean Square Error (RMSE)	0.07	0.11	0.01	0.11	0.05	265.60
Mean Absolute Error (MAE)	0.05	0.08	0.00	0.09	0.04	214.70
Mean Absolute Percent Error (MAPE)	0.03	0.32	0.01	0.04	0.04	0.15
Theil's Inequality Coefficient (U)	0.02	0.14	0.00	0.02	0.02	0.24
Bias Proportion (U^B)	0.05	0.00	0.04	0.00	0.00	0.10
Variance Proportion (U^V)	0.00	0.08	0.17	0.04	0.04	0.17
Covariance Proportion (U^C)	0.95	0.92	0.77	0.96	0.96	0.73

Thailand						
Validation Statistics	**Consumption Demand**	**Stocks Demand**	**Area Harvested**	**Yield**	**Supply**	**Market Price**
Correlation Coefficient (R)	0.89	0.66	0.78	0.91	0.90	0.66
Root Mean Square Error (RMSE)	0.25	1.02	0.37	0.11	1.14	2125.00
Mean Absolute Error (MAE)	0.22	0.86	0.32	0.08	0.92	1680.00
Mean Absolute Percent Error (MAPE)	0.02	0.39	0.03	0.03	0.06	0.34
Theil's Inequality Coefficient (U)	0.01	0.21	0.01	0.02	0.03	0.19
Bias Proportion (U^B)	0.00	0.04	0.00	0.01	0.00	0.01
Variance Proportion (U^V)	0.05	0.04	0.12	0.05	0.08	0.18
Covariance Proportion (U^C)	0.95	0.92	0.87	0.94	0.92	0.80

Table 6.7 Model validation statistics (cont.)

Vietnam						
Validation Statistics	**Consumption Demand**	**Stocks Demand**	**Area Harvested**	**Yield**	**Supply**	**Market Price**
Correlation Coefficient (R)	0.98	0.94	0.93	0.97	0.99	0.94
Root Mean Square Error (RMSE)	0.64	0.22	0.33	0.18	1.00	0.00
Mean Absolute Error (MAE)	0.51	0.15	0.27	0.14	0.81	0.00
Mean Absolute Percent Error (MAPE)	0.04	0.43	0.04	0.04	0.05	0.26
Theil's Inequality Coefficient (U)	0.02	0.13	0.02	0.02	0.02	0.13
Bias Proportion (U^B)	0.00	0.00	0.01	0.00	0.04	0.01
Variance Proportion (U^V)	0.04	0.33	0.30	0.01	0.03	0.02
Covariance Proportion (U^C)	0.96	0.66	0.58	0.99	0.97	0.97

Pakistan						
Validation Statistics	**Consumption Demand**	**Stocks Demand**	**Area Harvested**	**Yield**	**Supply**	**Market Price**
Correlation Coefficient (R)	0.87	0.45	0.93	0.91	0.96	0.91
Root Mean Square Error (RMSE)	0.16	0.32	0.09	0.16	0.30	3671.00
Mean Absolute Error (MAE)	0.11	0.26	0.06	0.13	0.24	2497.00
Mean Absolute Percent Error (MAPE)	0.05	0.61	0.03	0.05	0.06	0.31
Theil's Inequality Coefficient (U)	0.03	0.21	0.02	0.02	0.03	0.15
Bias Proportion (U^B)	0.00	0.00	0.00	0.00	0.00	0.00
Variance Proportion (U^V)	0.06	0.46	0.05	0.08	0.17	0.08
Covariance Proportion (U^C)	0.93	0.54	0.95	0.92	0.83	0.91

Table 6.7 Model validation statistics (cont.)

Indonesia						
Validation Statistics	**Consumption Demand**	**Stocks Demand**	**Area Harvested**	**Yield**	**Supply**	**Market Price**
Correlation Coefficient (R)	0.99	0.47	0.96	0.89	0.96	0.94
Root Mean Square Error (RMSE)	0.57	1.27	0.31	0.09	1.08	0.00
Mean Absolute Error (MAE)	0.42	1.06	0.26	0.07	0.82	0.00
Mean Absolute Percent Error (MAPE)	0.01	0.30	0.02	0.02	0.03	0.21
Theil's Inequality Coefficient (U)	0.00	0.14	0.01	0.01	0.02	0.13
Bias Proportion (U^B)	0.00	0.00	0.11	0.00	0.09	0.00
Variance Proportion (U^V)	0.00	0.36	0.09	0.03	0.10	0.16
Covariance Proportion (U^C)	0.99	0.64	0.80	0.97	0.71	0.84
Rest of the World						
Validation Statistics	**Consumption Demand**	**Stocks Demand**	**Area Harvested**	**Yield**	**Supply**	**Market Price**
Correlation Coefficient (R)	0.99	0.83	0.74	0.98	0.96	0.79
Root Mean Square Error (RMSE)	4.35	14.40	1.75	0.06	8.76	62.17
Mean Absolute Error (MAE)	3.31	10.80	1.31	0.05	6.65	53.95
Mean Absolute Percent Error (MAPE)	0.01	0.12	0.01	0.01	0.02	0.14
Theil's Inequality Coefficient (U)	0.01	0.07	0.00	0.00	0.01	0.08
Bias Proportion (U^B)	0.18	0.00	0.00	0.03	0.00	0.02
Variance Proportion (U^V)	0.00	0.40	0.17	0.03	0.00	0.04
Covariance Proportion (U^C)	0.82	0.59	0.83	0.94	0.99	0.94

Chapter 7: Results of the Policy Simulations

Introduction

In this chapter the econometrically estimated simulation model from the previous chapter will be modified and then used to evaluate a set of policy experiments. The data and empirical model for the yield function with R&D expenditures included will be explained in the first section. The modelling of the length and shape of R&D lags in the Malaysian rice industry will then be discussed in the following section. Eight alternative yield models with two different lag lengths will be tested and the most appropriate model then used in the spatial equilibrium model for simulation purposes. The R&D expenditure elasticities will be computed from the regression results and compared with the existing literature. A baseline scenario with existing domestic subsidies, R&D expenditures and import quotas will be developed and four different scenarios will be simulated and the results compared.

Empirical estimation of the yield function

As discussed in Chapter 4, there are various methods used to measure the economic consequences of agricultural research. In this study, the econometric approach is used and a direct estimate is made of the yield function with the aggregated research expenditures that have been employed through time. Following from Chapter 5, the yield function (Equation (5.1)) for Malaysia is re-formulated by including the aggregated R&D expenditure variable in the right hand side of the Equation (7.1) and removing the fertilizer consumption per hectare (FC_t)[44]:

(7.1) $Y_t = \phi_1 + \phi_2 R_t + \phi_k R\&D_{t-i} + \mu_i$

where

Y_t = Yield (tonnes/ha) in year t;

R_t = Annual rainfall in mm;

$R\&D_{t-i}$ = Nominal aggregated R&D expenditures lagged *i* years for *i* = 1 to 35

ϕ_2 = parameters on the rainfall variable.

ϕ_k = aggregated coefficients for the R&D expenditure for *k* = 3 to 38

[44]The fertilizer consumption per hectare and R&D variables were found to be highly correlated and thus, the fertilizer consumption per hectare variable was removed from the yield equation.

Equation (7.1) also includes a rainfall variable as a measure of the seasonal conditions, which can significantly affect the yield. The rainfall and aggregated research variables were expected to be positively related to yield.

Data for the R&D expenditure were obtained from three sources[45]:

- Data from 1971-1980 were drawn from Pardey and Roseboom (1989).
- Data from 1980-2004 were obtained from the Agricultural Science and Technology Indicator (ASTI) (2012).
- Data from 2004-2009 were obtained from the Ministry of Science and Technology, Malaysia.

To gauge the effect of R&D on productivity, it is important to consider the lags that are associated with the research phases of: gestation, adoption and dis-adoption. Lagged values of R&D expenditures when included in Equation (7.1) can lead to a multicollinearity problem as well as seriously reducing the degrees of freedom (Alston et al. 1995). Therefore, a distributed lag structure has generally been assumed in most of the studies (e.g. in Thirtle et al. 2008; Sheng et al. 2011; Alene 2010). The research expenditure variable (R&D) was computed as a weighted sum of public expenditures lagged for 16 years and 35 years[46]. Three types of lag shapes were used and included an inverted "V", trapezoid and gamma distributions with two different combinations of λs and δs (the parameters that define the shape of the distribution).

Eight yield functions with alternative R&D lag specifications for Equation (7.1) were estimated to identify the most preferred function to be included into the spatial equilibrium model. The eight alternatives were[47]:

- Inverted "V" with 16 years lag period
- Inverted "V" with 35 years lag period
- Trapezoid with 16 years lag period

[45] Based on information from the Ministry of Science and Technology, the data for rice research expenditure were calculated as seven percent of the total agricultural R&D expenditure.

[46]The selection of 16 and 35 years for the lag between R&D expenditures and agricultural productivity was based on some of the literature reviewed in Chapter 3. For the 35-year lag, the R&D data were backcasted.

[47]The values for the parameters of the gamma function of δ=0.75 and λ=0.75 and δ=0.6 and λ=0.8 were selected based on the peak at the 6^{th} or 8^{th}year. Various values were tested and these two combination gave the best results.

- Trapezoid with 35 years lag period
- Gamma distribution with 16 years lag period and δ=0.75 and λ=0.75
- Gamma distribution with 35 years lag period and δ=0.75 and λ=0.75
- Gamma distribution with 16 years lag period and δ=0.6 and λ=0.8
- Gamma distribution with 35 years lag period and δ=0.6 and λ=0.8

Estimation results: effect of R&D expenditures on yield

The regression estimates and test statistics for the eight alternative models for 16 year and 35 year lags are presented in Table 7.1 and Table 7.2 respectively. It is interesting to note that in all models, the R&D expenditure variable was statistically significant at the one per cent level. These results indicate that the R&D expenditure has a positive and significant effect on the Malaysian rice industry. The rainfall variable had a positive sign as expected, however it was not statistically significant. Despite the insignificant results for the rainfall variable, the R-squared (R^2) value had a higher value with the range of 80.5 to 85.1 per cent. The null hypothesis in relation to autocorrelation was rejected in all the models, as the Durbin-Watson statistics were in the acceptable zone rather than in the indeterminate area.

The aggregate lagged R&D expenditure was in logarithmic form for the inverted "V" and trapezoid models. In the case of the gamma distribution, the estimated coefficients were in a linear form. The test statistics and R-squared (R^2) values reported in Table 7.1 and Table 7.2 were used to select the most preferred model. The model with the highest R^2 and log likelihood values was taken to be the most appropriate model to choose. On the basis of these characteristics, the gamma distribution with δ=0.6 and λ=0.8 with lag of 16 years turned out to be the preferred model for inclusion in the spatial equilibrium model[48].

[48]The selection of 16-year lag period seems to be contradictory with the existing literature, e.g. Mullen and Cox (1995), Sheng et al. (2011) and Alston et al. (2010). These authors selected longer lags such as 35 or 50 years. However, based on the regression results, the 16-year lag period was preferred in this study because of a better fit. The results for the 35-year lag period were not as good as those with the 16-year lag and the reason may be that the backcasted data contributed little to the explanation of the relationship.

Based on the regression results, the estimated coefficients on the R&D expenditure variables for each time period were plotted in Figure 7.1 and Figure 7.2 for 16 and 35 year lags respectively. Figure 7.1 illustrates the shapes of all the lag structures; inverted "V", trapezoid and gamma distributions for a 16-year lag period. It is obvious from Figure 7.1 that the peak impact occurred after eight years for all distribution functions using the 16-year lag period for R&D expenditures. The peak impact varied more with the 35 year lags in R&D expenditure as in Figure 7.2. Overall, the shape of the lag structures of trapezoid, inverted V and gamma distributions were reasonable because the impact of agricultural research on productivity or yield increments were expected to rise until it reaches the maximum level and then eventually decline due to obsolete techniques or availability of new and improved varieties.

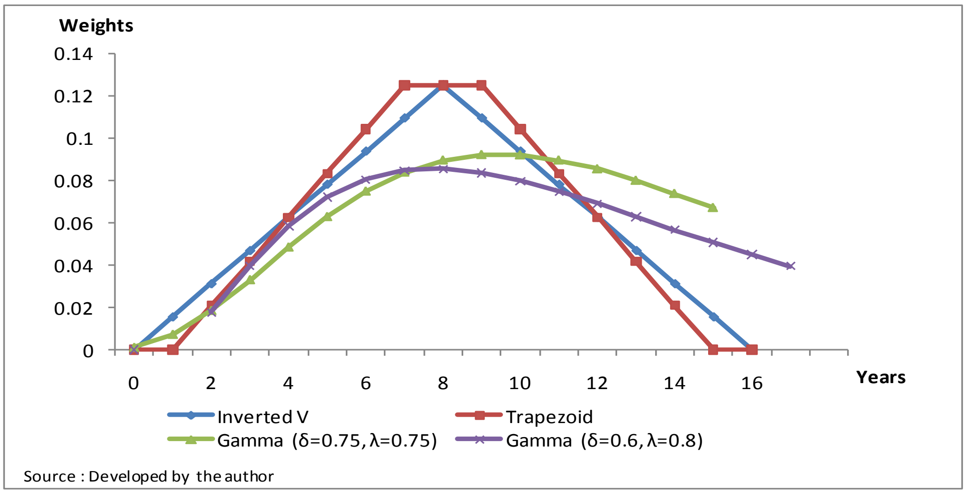

Figure 7.1 Alternative distributed lag structures for R&D (lag of 16 years)

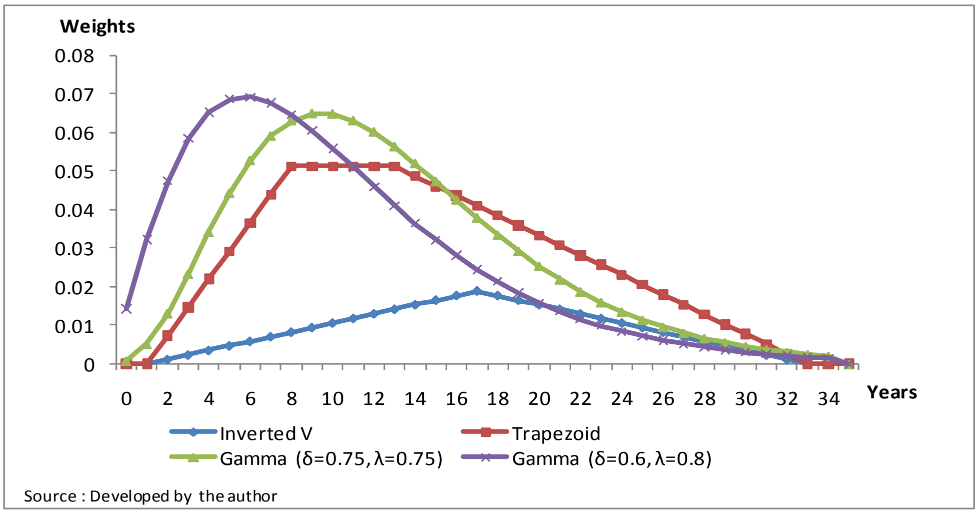

Figure 7.2 Alternative distributed lag structures for R&D (lag of 35 years)

Table 7.1 Regression results for inverted V, trapezoid and gamma distributions (lag of 16 years)

Dependent Variable : Yield (tonnes/ha)

Independent Variables	Inverted "V"		Trapezoid		Gamma (δ=0.75, λ=0.75)		Gamma (δ=0.6, λ=0.8)	
	Coefficients	t-stats	Coefficients	t-stats	Coefficients	t-stats	Coefficients	t-stats
Constant	1.250	5.234***	1.251	5.229***	2.413	12.76***	2.432	12.90***
Rainfall	0.0013	1.146	0.0013	1.144	0.011	1.099	0.0011	1.015
$R\&D_{t-1}$	0.0000	9.97***	0.000	9.94***	0.0000	11.61***	0.0006	11.75***
$R\&D_{t-2}$	0.0053	9.97***	0.000	9.94***	0.0002	11.61***	0.0013	11.75***
$R\&D_{t-3}$	0.0106	9.97***	0.007	9.94***	0.0005	11.61***	0.0019	11.75***
$R\&D_{t-4}$	0.0158	9.97***	0.014	9.94***	0.0009	11.61***	0.0023	11.75***
$R\&D_{t-5}$	0.0211	9.97***	0.021	9.94***	0.0014	11.61***	0.0026	11.75***
$R\&D_{t-6}$	0.0264	9.97***	0.028	9.94***	0.0018	11.61***	0.0027	11.75***
$R\&D_{t-7}$	0.0317	9.97***	0.035	9.94***	0.0021	11.61***	0.0027	11.75***
$R\&D_{t-8}$	0.0370	9.97***	0.042	9.94***	0.0023	11.61***	0.0027	11.75***
$R\&D_{t-9}$	0.0423	9.97***	0.042	9.94***	0.0025	11.61***	0.0025	11.75***
$R\&D_{t-10}$	0.0370	9.97***	0.042	9.94***	0.0026	11.61***	0.0024	11.75***
$R\&D_{t-11}$	0.0317	9.97***	0.035	9.94***	0.0026	11.61***	0.0022	11.75***
$R\&D_{t-12}$	0.0264	9.97***	0.028	9.94***	0.0025	11.61***	0.0020	11.75***
$R\&D_{t-13}$	0.0211	9.97***	0.021	9.94***	0.0024	11.61***	0.0018	11.75***
$R\&D_{t-14}$	0.0158	9.97***	0.014	9.94***	0.0022	11.61***	0.0016	11.75***
$R\&D_{t-15}$	0.0106	9.97***	0.007	9.94***	0.0021	11.61***	0.0014	11.75***
$R\&D_{t-16}$	0.0053	9.97***	0.000	9.94***	0.0019	11.61***	0.0013	11.75***
$\sum$R&D	0.3381		0.3378		0.0279		0.0320	
R-squared	0.8050		0.8043		0.8476		0.8507	
Adjusted R-squared	0.7906		0.7898		0.8363		0.8396	
Durbin-Watson Statistics	1.576		1.577		1.953		1.988	
Log likelihood	16.60		16.54		20.29		20.60	

***,** and *denote significant at the 1, 5 and 10 per cent levels of probability respectively. Figures in the parentheses are standard errors. Except for the gamma distribution, the R&D expenditures are in logarithmic form.

Table 7.2 Regression results for inverted V, trapezoid and gamma distributions (lag of 35 years)

Dependent Variable : Yield (tonnes/ha)

Independent Variables	**Inverted "V"**		**Trapezoid**		**Gamma (δ=0.75, λ=0.75)**		**Gamma (δ=0.6, λ=0.8)**	
	Coefficients	**t-stats**	**Coefficients**	**t-stats**	**Coefficients**	**t-stats**	**Coefficients**	**t-stats**
Constant	1.731	8.147***	1.820	8.813***	2.476	12.73***	2.485	1.61***
Rainfall	0.0013	1.134	0.0013	1.148	0.011	1.099	0.0011	1.010
∑R&D [a]	0.3019	10.53***	0.2992	10.78***	0.0862	11.35***	0.1083	11.17***
R-squared	0.8212		0.8280		0.8418		0.8377	
Adjusted R-squared	0.8080		0.8152		0.8301		0.8256	
Durbin-Watson Statistics	1.714		1.777		1.880		1.832	
Log likelihood	17.90		18.48		19.74		19.35	

*** denotes significant at 1 per cent level. Except for the gamma distribution, the R&D expenditures are in logarithm.
[a] The coefficients for each time period are omitted due to space limitation but can be seen graphically in Figure 7.2.

R&D Elasticity

The aggregate elasticities with respect to R&D expenditures were calculated and found to be positive and significant at a one per cent significance level for the eight alternative models, as shown in Table 7.1 and Table 7.2. The aggregate elasticities were derived as the sum of the annual effects over the full period of the lags (16 and 35 years) and ranged from 0.10 to 0.13. Thus, a 10 per cent increase in the R&D expenditures led to as much as a 1.3 per cent increase in yield per year. The computed elasticities in this study were compared with the previous literature and it seems that they fit well into the acceptable elasticity ranges. Some comparisons are shown in Table 7.3.

Table 7.3 R&D elasticities of agricultural productivity

Study	**Sample**	**Period**	**R&D Elasticity**
Zachariah et al. (1989)	Canada broiler market	1968-1984	0.27
Fox et al (1992)	Canada cattle research	1968-1984	0.57
Fan et al. (2008)	Indian agriculture	1951-1993	0.11
Haque et al. (1989)	Canadian haying-hen research	1968-1984	0.24-0.25
Sheng et al. (2011)	Australian broadacre agriculture	1953-2007	0.20-0.24
Mullen and Cox (1995)	Australian broadacre agriculture	1953-1988	0.14
Thirtle et al. (2008)	UK agriculture	1953-2005	0.11-0.52
Alene (2010)	African agriculture	1970-2004	0.10-0.20
Salim and Islam (2010)	Australian agriculture	1977-2005	0.49
Present Study (2012)	**Malaysia rice research**	**1980-2009**	**0.10-0.13**

The range of values for the R&D elasticities, as shown in Table 7.3, reflect the fact that the elasticities were calculated based on different lag structures, various industries and using different methods. As illustrated in Table 7.3, most of the R&D elasticities were computed for developed countries except the ones for Indian and African agriculture. The author is not aware of any studies that have calculated the R&D elasticity for the agricultural sector as a whole or particularly in the rice industry in Malaysia[49]. So, the results in this study may provide a significant contribution to the R&D literature for Malaysia.

The yield function, with the aggregated R&D expenditures (gamma distribution with 16-year lag period) was used in the baseline spatial equilibrium model. In the next section, the policy simulations using four scenarios will be analysed.

Policy Simulations

In this section, four scenarios are analysed and compared with the baseline model. The first two scenarios were similar to each other but differ in the percentages of re-distribution of public funds between subsidies and R&D expenditures. The last two scenarios were designed to reflect the situation of the removal of BERNAS and free trade respectively. The results of each scenario are explained in detail in this section.

Baseline Scenario

The baseline scenario is designed to represent the actual situation of the Malaysian rice industry in a world context with the current policy settings. In this scenario, domestic subsidies, existing R&D allocations and import quotas were used in simulating the spatial equilibrium model. The coefficients and intercepts, including regression errors from the econometric estimations, were used to simulate the baseline model. The dynamic recursive model was solved for the period 1982 to 2009 using a Lemke algorithm written in Visual Basic[50]. The baseline model results reflected the actual data very well when the econometric errors were included in the calculated intercepts. This approach was adopted on the assumption that all the relevant economic behaviours were included in the

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[49] Various searches were undertaken such as in the Web Of Science database, the Econlit database, Google Scholar and a Google search in an attempt to find any available R&D elasticity estimates for the Malaysian agricultural sector.

[50] The dynamic recursive simulation over the historical period involved using the simulation values of the previous period for the lagged endogenous variables.

econometric estimates, that is, the behaviours relevant to the policy experiments. Thus, it was assumed that the behaviours included in the error terms remained the same between experiments.

In the baseline model, there were a few years where the simulated market prices were higher than the actual prices. In those years, the import quotas were found to be effective. Since there were no ‘official’ import quotas in the Malaysian rice industry, the actual imports were used as an indicator of the effective import quotas. When the simulated imports were less than or equal to the import quota, there were no changes in the market prices. However, when the simulated imports exceeded the quota, the market prices increased as expected.

The key variables, such as market prices, consumption demands, stock demands, area harvested, yield and supply in the baseline model fit the actual data very well. Therefore, using the baseline model for policy simulations will be plausible. The baseline model validations, using graphical and statistical measures were presented in an earlier chapter. The key variables in the baseline model simulation will be compared with the policy experiment results in the following scenarios.

Scenario 1: Substituting 10 per cent of subsidy funds to R&D expenditures

As discussed in Chapter 2, the Malaysian government has spent more than MYR1 billion in 2009 in terms of subsidies to protect its rice industry. A useful question to examine is what would have happened if 10 per cent or 25 per cent of the subsidy allocations were re-distributed to R&D activities over the years[51]? Will the production of rice increase or decrease? To answer these questions, two different percentages were tested in this section. For each time period from 1980 to 2009, the subsidy amount was reduced by 10 per cent and the same amount was added into the R&D expenditures[52]. The per unit subsidy used in the arbitrage condition was reduced by 10 per cent in the Scenarios 1 and 2.

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[51]The figures were selected arbitrarily.
[52]A new set of aggregate lagged R&D expenditure data were used in the gamma distribution with δ=0.6 and λ=0.8 and a lag of up to 16 years.

In this scenario, using the R&D expenditure and rainfall coefficients, the yield function was re-estimated using the new R&D expenditure data with an addition of 10 per cent of the subsidy allocations and the spatial equilibrium model dynamically simulated over the time period.

The simulated values for the baseline model and scenario 1 of the key endogenous variables: market price, consumption demand, stocks demand, supply, area harvested, yield and import quantity are depicted in Appendix Table B.1. The impacts of the re-distribution of public funds from the subsidy to R&D expenditures on the endogenous variables in Malaysia and each of the other countries are reported in panels (a) to (f) in Appendix Table B.1.

When 10 per cent of the subsidy allocation was re-distributed to the R&D expenditure, the supply of rice increased over time. The yield improvement through R&D raised the profitability of production at any given price and resulted in higher production over the years. As shown in Appendix Table B.1 (a), on average the supply increased by 43.6 per cent and imports decreased by 56.9 per cent in scenario 1 compared with the baseline model. As a result of the reduction in the subsidy allocation, the market price, on average, decreased by 3.9 per cent and this led the consumption demand increasing by 0.2 per cent. As expected, the re-distribution of 10 per cent of the subsidy to R&D expenditure had no effect on the area harvested. In this study, the R&D expenditures were aimed at yield improvements rather than area expansion or competition between crops.

The impacts of domestic policy changes in Malaysia on other countries are also depicted in panels (b) to (f) in Appendix Table B.1. As Malaysia is considered a small importing country, its policy changes have little impact on the major exporting countries like Vietnam and Thailand. The market prices decreased in all the exporting regions (Thailand, Vietnam and Pakistan) ranging from 0.7 to 0.8 per cent indicating a loss to the exporting regions' producers and the exports were also reduced in the range of 0.1 to 0.4 per cent. In the importing regions, Indonesia, and the Rest of the World, although the market price drops, imports increase. In terms of supply, very small changes occurred in all regions indicating that changes in Malaysian policy would not significantly affect the production of rice in other regions.

It is interesting to note that a 10 per cent redistribution of subsidies into R&D expenditure could reduce imports by 43.6 per cent from the baseline model. In the next policy simulation, the percentage of redistribution will be increased to 25 per cent.

Scenario 2: Substituting 25 per cent of subsidy funds to R&D expenditures

In this scenario, 25 per cent of the domestic subsidy funds allocated to the rice industry were shifted to the R&D expenditures. What makes the difference between this scenario and previous scenarios is the non-linearity of the model. If the model is linear, then if 25 per cent of subsidies are re-allocated, the percentages changes in the previous scenario and this scenario should be the same. However, in a nonlinear model the changes between the two scenarios will be different.

The rice imports dropped dramatically from 65 per cent in 1982, the first year of the simulation, to 100 per cent in 1986 (the fifth period) till the end of the simulation in 2009. The results are indicative that Malaysia would no longer need to import rice from 1986 if the government had re-allocated the public funds (removed 25 per cent of funds from the domestic subsidy and invested in the R&D expenditures). As shown in Appendix Table B.2 (a), the import quantities in Column 20 were zero after 1986 indicating that Malaysia might have achieved a self-sufficiency level in 1986. These results are not surprising because the amount of subsidies is large and 25 per cent from them would more than double the actual R&D expenditures. For instance, in 2009, 25 per cent of subsidies was MYR260 million and the existing R&D expenditures were merely MYR45 million. If the amount of MYR260 million was contributed into R&D activities, which were related to yield improvements, it would be expected that the average increase in yield will be by 107 per cent from the baseline scenario. To further analyse the stability of the R&D coefficient in the yield function, a sensitivity analysis will be discussed later in this chapter.

In this scenario the supply of rice increased by 106.5 per cent as a result of the positive supply response compared with 43.6 per cent in Scenario 1. Increases in supply shift the supply curve downwards and to the right and as a result the market prices decreased by an average of 23.4 per cent from the baseline model. Thus, the domestic demand increased by 1.2 per cent.

The impact of the redirection of 25 per cent of the subsidy funds to the R&D expenditures has the same effect on other regions as in scenario 1 but with a higher level of change. All the exporting regions had a decrease in exports in the range of 0.4 to 1.0 per cent. In this scenario, the importing regions, including the Rest of the World showed an increase in imports on average of 1.7 to 8.3 per cent change from the baseline scenario. Except for market prices and the export/import variables, there were no changes in other key variables in all the regions. In both the scenarios, scenario 1 and 2, the results were that the shift in the use of public funds from domestic subsidies to R&D expenditures were very effective in Malaysia and had little effect on the trading partners.

In the next scenarios, other policy changes, such as removal of import quotas and removal of all other trade barriers will be analysed. It is assumed that the R&D expenditures will be the same as in the baseline model for the next scenarios.

Scenario 3: Removal of BERNAS and implementation of ad valorem tariffs

The main difference between this scenario and the baseline scenario is in the removal of the sole rice importer status of BERNAS. What would happen if BERNAS never existed? If BERNAS never existed, then it is likely there would be tariffs on rice imports.

In this policy scenario, the import quotas were removed and replaced with import tariffs of 20 per cent for imports from ASEAN countries and 40 per cent from the Rest of the World. Following Devadoss et al. (2009), the ad valorem tariffs were incorporated into the spatial equilibrium model. The simulation results for this scenario were presented in Appendix Table B.3 in panels (a) to (f).

The implementation of ad valorem tariffs of 20 and 40 per cent on rice imports in Malaysia increased the domestic price by an average of 17.8 per cent from the baseline scenario and this led to a drop in the consumption demand by 1.2 per cent as shown in Appendix Table B.3 (a) column 3 and 6. When the market price rises, the supply of rice increased by 0.3 per cent. In the last column, the import quantity declined from an average of 0.53 million Tonnes to 0.51 million Tonnes, which is about a 4.0 per cent drop from the baseline scenario.

The changes in the key variables in this scenario and the baseline scenario for other countries are given in Appendix Table B.3 panels (b) to (f). Despite small magnitude changes, the results of the impact of ad valorem tariffs were similar with the findings from Devadoss et al. (2009). All exporting countries reduced their exports by less than one per cent since the prices dropped in these countries. Market prices decreased in importing regions and led to increased demand and thus imports increased in those regions. Analogous to the previous scenarios, the impact of Malaysia's policy change does impact its trading partners though they are small in magnitude. Greater changes could be anticipated if the trading partners' import tariffs were taken into account. This could be one of the limitations of this study.

Scenario 4: Removal of all forms of trade barriers in the Malaysian rice industry

In this final scenario, the domestic subsidies and import quotas were both removed and the rice market allowed to function as though it were in a free trade environment. The simulated endogenous variables in this scenario were compared with the baseline model and the results were reported in Appendix Table B.4 panels (a) to (f). The results were consistent with the outcomes in the literature where in a free trade environment, the supply decreases and imports increase.

The market price was unchanged when the domestic subsidies were removed. The reason is that the market price was based on the retail price and only the supply price dropped when the subsidies were removed. However, when the import quotas were also eliminated at the same time, the market prices in this scenario dropped from those in the baseline scenario for the years where the import quotas were effective. It is interesting to note that if the government eliminated all forms of trade barriers, including subsidies, the changes in the supply of rice dropped by an average of 10.4 per cent from the baseline scenario as depicted in Appendix Table B.4 (a) Column 12. The results were consistent with the theory; elimination of a subsidy will reduce the supply. However, the small percentage changes in supply in these results suggest that providing domestic subsidies to improve production might not be effective solution. Overall, the results from this scenario suggest that removing all trade barriers, especially domestic subsidies would only slightly affect the domestic supply and the imports of rice on average increased by 15.6per cent from the baseline scenario.

In the free trade scenario, all the exporting regions showed a slight increase in their exports as shown in Appendix Table B.4 panel (b) to (d) to offset the increased imports from Malaysia. Overall, in Scenario 2 the re-allocation of 25 per cent of the subsidy funds to R&D expenditures had significant effects of reducing imports and largely achieving self-sufficiency in rice. However, in the free trade scenario, Malaysia would increase its imports compared to the current situation.

Consumer Expenditure, Producer Revenue and Consumer Surplus

The consumer expenditure, producer revenue and consumer surplus were calculated for all the scenarios[53]. The calculations of the consumer expenditure and producer revenue for Malaysia are presented in Appendix C. In Table 7.4, the percentage changes in consumer expenditure, consumer surplus and producer revenue from the baseline scenario for each of the four scenarios are given.

Notably, in scenarios 1 and 2, the average consumer expenditure decreased by 3.6 and 22.7 per cent respectively. The average producer revenue increased by 40.5 and 66.5 per

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[53]The producer surpluses were not calculated since in any given period the supply quantity was fixed and the supply response function has lagged dependent variables involved. Calculations in the case of a lagged price in the supply response has been shown in Martin and MacLaren (1976).

cent in scenarios 1 and 2 respectively. Interestingly, the changes in the consumer surplus in scenario 2 are the highest with an increase of 23.1 per cent from baseline scenario. These results suggest that the redirection of the government funds from domestic subsidies to R&D expenditures could make both the consumers and producers better off. The producers were better off with the removal of BERNAS (which replaced ad valorem tariffs with import quotas), however, the consumers were worse off with the average consumer expenditure increasing by 16.6 per cent from the baseline scenario. In this scenario, the consumer surplus falls by 17.97 per cent. In the final scenario, the produces were worse off compared with the baseline scenario by 22.7 per cent on average because the supply of rice dropped in scenario 4.

Based on the results given in Table 7.4, the consumers and producers were both better off in scenarios 1 and 2, in effect, because the use of funds in R&D was more effective in increasing yield than the subsidies. Thus, the re-distribution of public funds from domestic subsidies to yield improvement through R&D activities would seem to be a more effective solution for increasing production and reducing import dependency assuming these are goals of the government.

In Table 7.4, the producer revenue was based on the overall economy. What happens to the income per farmer? In 2009 there were 172,230 paddy farmers in Malaysia. Using a simple calculation, in the baseline scenario, total producer revenue in 2009 was MYR3,616.63 million and scenario 2 was MYR7,461.11 million, therefore income per worker is estimated to be as follows:

Baseline Scenario: Income per worker = $\frac{\text{MYR 3,616.63 million}}{172{,}230}$ = **MYR20,998 per year.**

Scenario 2: Income per worker = $\frac{\text{MYR 7,461.11 million}}{172{,}230}$ = **MYR43,320 per year.**

From the simple calculations, it is clear that farmers' income could be improved through yield improvements compared with providing subsidies for them.

Table 7.4 Changes in consumer expenditure, producer revenue and consumer surplus, 1982-2009

Year	Baseline -v- Scenario 1			Baseline -v- Scenario 2			Baseline -v- Scenario 3			Baseline -v- Scenario 4		
	Changes in Consumer Expenditure (%)	Changes in Producer Revenue (%)	Changes in Consumer Surplus (%)	Changes in Consumer Expenditure (%)	Changes in Producer Revenue (%)	Changes in Consumer Surplus (%)	Changes in Consumer Expenditure (%)	Changes in Producer Revenue (%)	Changes in Consumer Surplus (%)	Changes in Consumer Expenditure (%)	Changes in Producer Revenue (%)	Changes in Consumer Surplus (%)
1982	-0.15	12.91	0.16	-0.37	31.72	0.40	18.78	16.69	-20.60	0.10	-16.65	0.00
1983	-5.08	10.53	5.39	-5.36	29.03	5.69	13.27	11.52	-14.26	-4.74	-23.15	5.15
1984	-0.26	18.02	0.27	-0.63	44.02	0.67	18.17	16.12	-20.51	0.13	-20.86	0.00
1985	-8.15	9.30	8.60	-8.61	32.08	9.07	9.81	8.37	-10.46	-7.72	-26.88	8.27
1986	-21.03	0.38	21.51	-21.99	23.72	22.65	18.13	16.00	-20.56	-0.12	-21.35	-0.12
1987	-0.46	23.56	0.49	-25.44	25.66	26.45	19.16	15.44	-20.42	0.15	-24.00	0.00
1988	-4.08	22.48	4.37	-21.11	34.87	22.33	14.48	12.81	-15.75	-3.55	-21.04	3.97
1989	-0.32	27.11	0.34	-14.15	45.30	15.19	18.66	17.22	-20.64	0.18	-15.21	0.00
1990	-14.09	12.53	15.19	-34.40	18.15	36.40	2.48	2.35	-2.71	-13.58	-32.06	14.81
1991	-0.41	32.78	0.45	-22.69	45.86	24.07	18.76	15.70	-20.59	0.23	-22.41	-0.01
1992	-4.24	29.93	4.52	-28.61	40.02	30.03	14.44	11.91	-15.64	-3.57	-26.78	4.04
1993	-0.54	32.82	0.57	-27.63	40.26	28.84	19.05	15.15	-20.47	0.24	-25.63	-0.01
1994	-0.48	34.03	0.52	-23.39	47.51	24.62	18.92	15.76	-20.53	0.22	-22.65	0.00
1995	-0.50	35.17	0.53	-24.39	48.55	25.60	14.27	15.56	-20.37	0.23	-23.36	0.00
1996	-3.90	34.01	4.19	-27.88	48.02	29.43	14.72	12.27	-16.09	-3.23	-26.30	3.71
1997	-0.47	40.76	0.51	-24.58	58.61	26.02	18.76	15.58	-20.59	0.26	-23.72	0.00
1998	-0.49	43.71	0.54	-18.47	73.14	19.95	18.44	16.62	-20.71	0.31	-18.98	-0.01
1999	-6.09	39.37	6.61	-25.95	65.38	27.65	12.12	10.81	-13.38	-5.22	-24.94	5.99
2000	-0.66	45.10	0.72	-22.05	70.73	23.47	18.68	16.08	-20.61	0.32	-21.54	-0.01
2001	-0.77	47.97	0.82	-25.44	71.42	26.77	18.88	15.69	-20.52	0.29	-23.80	-0.01
2002	-14.07	33.97	15.00	-38.69	51.25	40.46	2.59	2.85	-3.38	-13.03	-33.65	14.18
2003	-25.65	20.32	27.07	-24.54	79.36	25.92	18.82	15.59	-20.56	0.36	-23.14	-0.01
2004	-0.89	54.24	0.95	-26.47	82.14	27.84	18.87	15.52	-20.53	0.36	-24.37	-0.01
2005	-0.82	56.55	0.88	-23.57	90.70	24.91	18.81	15.95	-20.55	0.34	-22.33	-0.01
2006	-0.80	60.49	0.86	-29.43	87.42	31.01	18.78	15.11	-20.57	0.31	-26.71	-0.02
2007	-0.78	59.49	0.84	-24.77	93.73	26.21	18.67	15.71	-20.47	0.19	-23.60	0.08
2008	-0.40	61.86	0.45	-20.48	102.14	22.70	17.86	17.70	-20.95	0.27	-14.17	0.00
2009	-0.60	61.65	0.66	-19.55	-20.48	21.07	18.48	16.85	-20.70	0.25	-19.75	-0.01
Mean	**-3.56**	**40.48**	**4.39**	**-22.69**	**-22.65**	**23.05**	**16.56**	**14.37**	**-17.97**	**-1.39**	**-22.74**	**2.14**

Sensitivity Analysis on the R&D coefficients

A sensitivity analysis was conducted to test the effects of changes in the R&D coefficient on the key variables; supply, demand, imports and market prices for all the scenarios. The actual aggregate R&D coefficient of 0.033was increased and decreased by one per cent. The averages of the variable data from 1982-2009 are reported in the first half of Table 7.5. The percentage changes in the key variable responses relative to a percentage change in the R&D coefficients can be expressed as elasticity and these are presented in the second half of Table 7.5.

From Table 7.5, it is interesting to note that a one per cent change in the R&D coefficient leads to a 0.004 and a 0.006 percentage change in the average supply in Scenarios 1 and 2 respectively. In both these scenarios, higher allocations of R&D expenditures were used and that could be one of the reasons for the higher response towards an increase in the R&D coefficient. The import responsiveness towards changes in the R&D coefficient was also higher for both scenarios compared with other scenarios. Overall, the R&D coefficients respond in the same way for all scenarios.

Table 7.5 Sensitivity analysis with R&D coefficients

Item	Average Supply	Average Demand	Average Import	Average Market Price
Average data for sensitivity analysis (1982-2009)				
Aggerate R&D = 0.0333				
Baseline	1.300	1.812	0.529	1032.601
Scenario 1	1.867	1.815	0.228	992.088
Scenario 2	2.686	1.834	0.014	791.506
Scenario 3	1.303	1.791	0.508	1215.284
Scenario 4	1.165	1.813	0.611	1014.054
Aggerate R&D (+1%) = 0.0336				
Baseline	1.302	1.810	0.528	1030.161
Scenario 1	1.875	1.814	0.227	991.068
Scenario 2	2.701	1.832	0.014	791.343
Scenario 3	1.305	1.791	0.507	1213.305
Scenario 4	1.167	1.813	0.611	1012.718
Aggerate R&D (-1%) = 0.0329				
Baseline	1.298	1.814	0.529	1034.931
Scenario 1	1.860	1.817	0.229	993.165
Scenario 2	2.670	1.835	0.015	791.669
Scenario 3	1.301	1.792	0.509	1217.167
Scenario 4	1.163	1.814	0.612	1015.279
Sensitivity changes expressed as elasticities [a]				
Aggerate R&D (+1%) = 0.0336				
Baseline	0.0014	-0.0009	-0.0013	-0.0024
Scenario 1	0.0040	-0.0007	-0.0035	-0.0010
Scenario 2	0.0059	-0.0007	-0.0327	-0.0002
Scenario 3	0.0015	-0.0002	-0.0017	-0.0016
Scenario 4	0.0017	-0.0003	-0.0013	-0.0013
Aggerate R&D (-1%) = 0.0329				
Baseline	0.0014	-0.0009	-0.0013	-0.0023
Scenario 1	0.0040	-0.0008	-0.0035	-0.0011
Scenario 2	0.0059	-0.0008	-0.0327	-0.0002
Scenario 3	0.0014	-0.0002	-0.0018	-0.0015
Scenario 4	0.0017	-0.0004	-0.0012	-0.0012

[a] Note rounding errors give slightly different values for the 1% increase compared to the decrease

Concluding Remarks

In this chapter, the econometrically estimated recursive spatial equilibrium model was used to analyse the impact of government policies in the Malaysian rice industry. This included the re-allocation of public funds from domestic subsidies to R&D expenditure focused on rice yields. To evaluate the impact of R&D expenditures, various length of lag and lag structure were tested in the yield function. It was found that the gamma distribution with a 16-year lagged period and δ=0.6 and λ=0.8 was the most appropriate form of distribution. It was also found that the R&D elasticities, which fell in the range of 0.10 to 0.13, agreed well with the R&D elasticities in the available literature.

The baseline scenario was based on the actual situation with existing subsidies, R&D expenditures and import quotas. Four scenarios were simulated and compared with the baseline scenario. The results from scenario 2, where 25 per cent of the subsidy funds were re-allocated to R&D expenditures, was found to move Malaysia close to self-sufficiency in rice production with zero import quantities. Furthermore, the consumer expenditure reductions and producer revenue gains in this scenario were significant compared with the baseline scenario. Sensitivity analysis was used to assess the effect of changes in the R&D coefficients on key variables in the model. The results suggest that supply is particularly sensitive to changes in the coefficients.

Chapter 8: Summary, Conclusions and Implications

Introduction

In this chapter, an overview of the thesis is presented and followed by a summary of the results based on the discussions in the previous chapters. Conclusions drawn from the results are provided in the following section. The limitations of this study and some suggestions for further research are discussed later in this chapter.

Overview of the thesis

Food security is often seen as an important issue for most of the countries in the world. It can also be a political issue when food prices rise rapidly relative to other prices. Malaysia is not an exception in this case. The government spends millions of Ringgit Malaysia from public funds to support and protect the rice industry. One of the methods used is to provide subsidies to farmers to increase their production. Besides subsidies, the government also spends funds on research and development activities. Do such subsidies really increase the production of rice? If so why is Malaysia still importing rice? To answer these questions, an econometrically estimated dynamic spatial equilibrium model was developed.

In the model, there were 24 stochastic equations and 6 identities for six regions namely Malaysia, Thailand, Vietnam, Pakistan, Indonesia and the rest of the world. These stochastic equations were estimated using time-series data for the period of 1980 to 2009. All time-series data were tested for stationarity using the Augmented Dickey-Fuller test which found that most of the data were stationary at level 1. The consumption demand, stocks demand and yield equations were estimated using two-stage least squares (2SLS). Instrumental variable regression methods were employed since there were endogenous prices and simultaneous equations. The supply function was constructed as an identity comprising of the area harvested, yield and the conversion rate of paddy to rice. When an autocorrelation problem occurred, the equations were re-estimated using first-order serial autocorrelation corrections. The signs of all parameters conformed to prior expectations and the coefficients for all exogenous variables were collapsed into the intercept and used to simulate the spatial equilibrium model.

Research and development (R&D) expenditures were incorporated in the yield function for Malaysia. Eight models with alternative R&D lag lengths and shapes were tested and it was found that the gamma distribution with δ=0.6 and λ=0.8 with lag of 16 years was the most preferred model. This was then included in the spatial equilibrium model. The computed R&D elasticities for the Malaysian rice industry were found to be in the range of 0.10 to 0.13, which was consistent with the existing R&D literature. Since no R&D elasticities for the Malaysian agricultural sector seem to have been previously published, these elasticities therefore contribute to the R&D literature on Malaysia.

The spatial equilibrium model was formulated using a primal-dual approach in a mathematical programming model which used an objective function of maximizing the net social revenue function (as discussed in Chapter 6). The model was modified to include some of the Malaysian government's interventions such as ad valorem tariffs, domestic subsidies, import quotas and exchange rates. The econometric equations were estimated using the Time Series Processor (TSP) software. However, this software failed to provide unique solutions for the simulations since the Kuhn-Tucker conditions are not usually included in standard simulation packages. Therefore, the spatial equilibrium model was simulated dynamically using a Lemke algorithm written in Visual Basic in Microsoft Excel.

The baseline scenario, incorporating the existing policies: domestic subsidies and import quotas were developed for the period 1982 to 2009. Using statistical and graphical methods, validation tests were performed using the historical simulation. The simulated endogenous variables were found to replicate the historical values well. The approach used for the simulation experiments was to feed the errors of the econometrically estimated equations back into the simulation. Four policy experiments were simulated and the simulation results were compared with the baseline scenario.

Summary of the results

The results for this thesis can be divided into two parts: econometric and simulation results. The econometric results were in line with a *priori* expectation and the equations appeared to be well behaved. All equations performed satisfactorily as expected in the regression analysis with most having more than a 90 per cent R-squared (R^2) value. The variables selected for the stochastic equations depended on the nature of the individual countries and their economic agents. The demand and supply elasticities for most of the countries were consistent with the existing literature.

The simulated endogenous variables (market price, domestic demand, stocks demand, area harvested, yield and supply) in the baseline scenario represented the historical values reasonably well. In the baseline scenario, for some of the years it was found that the import quota was effective. Remarkably, the import quota seemed to be applicable in Malaysia since BERNAS acted as an implicit import quota. The historical simulation values were used to compare to the results of a set of policy experiments in Malaysia.

In the first scenario, 10 per cent of the subsidy funds were re-allocated to the R&D expenditures. It was found that the rice yield increased by 43.6 per cent from the baseline scenario and resulted in higher production. Higher production led to a drop in the market price by 3.9 per cent and thus, imports dropped by 56 per cent. This indicated that the government could reduce import dependency by investing in yield improvements through R&D activities. As anticipated, not much changed in the endogenous variables for other countries in this scenario as Malaysia is essentially a small country in terms of the world rice industry.

Similar to the first scenario, the second scenario was also based on a re-allocation of the public funds used for subsidies to R&D expenditure but with a different percentage allocation of 25 per cent. In this scenario, it is worth noting that the imports dropped dramatically to zero from the fifth year in the simulation. The results were not surprising because 25 per cent of the subsidy amounts were large enough to make significant changes in the yield function. To understand the impact of different levels of the R&D expenditure the coefficient in the yield equation a sensitivity analysis was carried out in order to see the effect of changes in the coefficients on the different policy scenarios.

A third scenario was developed to examine the importance of the role of the sole importer, BERNAS, in the Malaysian rice industry. Removal of BERNAS means that the import quotas were removed and replaced with import tariffs. The ad valorem tariffs were incorporated into the spatial equilibrium model. Not surprisingly, the market price increased by 17 per cent and as a result, consumption dropped by 1.2 per cent. This followed by a decrease in the imports by 4 per cent from the baseline scenario. The results are suggestive that the roles of BERNAS do have an impact on the Malaysian rice industry. One of the roles of BERNAS is to provide rice at a reasonable price domestically. However, if BERNAS was removed, then import tariffs would be effective and the domestic price would increase. Price increases for a staple food are not likely to be looked upon favourably by Malaysian consumers unless the government eliminates import tariffs for rice, thereby keeping prices down. If the government abolished BERNAS and removed import tariffs under the free trade agreements, the market price would not be affected much and consumers would be better off as explained in the free trade scenario.

Finally, in the fourth scenario, all forms of trade barriers were eliminated. Eliminating subsidies reduces the production of rice by about 10.4 per cent and the imports increase by about 15.6 per cent. The domestic market price only decreased by 1.8 per cent on average due to the removal of import quotas, however, for those years where the import quotas were not effective, the prices increased in the range of 0.05 to 0.18 per cent from the baseline scenario. The results from this scenario suggest that removing the subsidies and import quotas would not significantly affect the supply or demand for rice in Malaysia. Therefore, the government could readily re-allocate the subsidy funds to other avenues such as R&D activities.

Implementing changes in the Malaysian rice industry does have some impacts on the trading partners but these are generally small. The reason behind this is that Malaysia is a small importing country in terms of world rice trade.

Overall, the present study provides a broad perspective on policy in the Malaysian rice industry and of the impacts when some of the government policies are changed.

Conclusions

Based on the findings in this study, the following conclusions are drawn.

1. The R&D elasticities computed in this study indicated that when the government invests ten per cent of the rice subsidies in R&D expenditures focussed in rice yields, the yield in the Malaysian rice industry will increase by about 1.3 per cent.
2. The study showed that the reallocation of the government's limited funds from subsidies to the R&D expenditures increased the production and reduced import dependency.
3. The simulation results indicated that the government's objective of achieving 90 per cent self-sufficiency in rice could be achieved if at least 25 per cent of the existing subsidy funds were reallocated to R&D expenditures related to the yield improvements.
4. Both the consumers and producers could be better off if the allocation of the public funds were directed to R&D activities related to yield improvements rather than subsidies. The findings suggest that income per farmer could increase by twofold from the current situation if the government invested 25 per cent of the subsidy funds to yield increasing R&D related activities.
5. This study found that the existence of the sole importer, BERNAS, in the rice industry did not have very significant effects. Therefore, it is suggested that the government could eliminate BERNAS and remove import tariffs and operate in a free trade environment and that could provide benefits both to consumers and producers as well as the nation's economy.

6. Under the AFTA and the WTO free trade agreements, the government should eliminate all types of trade barriers, including domestic subsidies. The present study has suggested that the Malaysian government could eliminate subsidies and use the public funds for more effective purposes.

Limitations of the study

As in any empirical studies, there are some limitations. In the case of the present study many of the limitations are related to data availability. In this section, some of the limitations that were encountered throughout the study will be discussed.

1. Due to unavailability of data on research expenditure, particularly for the rice industry, a proxy percentage was obtained from MOSTI (2012) and this was used to estimate the impact of rice research on the supply of rice. If more disaggregate data were available and used in the model, the results may be improved and this may better capture the partial impacts of research at a particular time. Efforts to significantly improve the research data collection would appear to be worthwhile.
2. In this research, it is assumed that rice is a homogeneous good. This assumption was made since the data were not available for the various grades of rice. In reality, rice is a heterogeneous good in which different income groups consume different grades of rice. A more detailed result would be obtained if classification of the different types of rice that have been produced as well as traded were available.
3. Since most of the time series data were only available from the 1980s, this study could only use a 16-year lag for the R&D variable. For the 35-year lag, the data were backcasted to 1958. More accurate research impacts could be realized if the time series data on R&D expenditure were available for at least 50 years. Data collection for the R&D expenditure is still at an early stage in Malaysia and there may be high payoffs to a better understanding of the relationships between R&D expenditure and productivity.

4. In this study, the trade policies in other countries were assumed unchanged during the time period due to time and data limitations as well as the complexity of the policies in the other countries. The baseline scenarios were developed to reflect the actual situation in each country as well as possible.
5. The dynamic simulation using the spatial equilibrium model was developed in a partial equilibrium framework for a single commodity. If the model was extended for multiple commodities, the cross effects of policy changes in one industry to other commodities could be measured.
6. In incorporating the effects of investment in yield increasing research rather than in other forms of support for the rice industry it needs to be recognised that such an approach will involve relatively long lag times following such a policy change. It is also possible that the different ways in which yield increases could be obtained may also have different lags. Further, there is some uncertainty in the length of lag responses built into the model. In addition, government may not be willing to wait for such results in terms of impact.

Recommendation for further research

Based on the limitations discussed above, there are several possible avenues for further research.

1. The dynamic spatial equilibrium model was constructed based on several assumptions. One of the key assumptions is that the farm, market and export prices are the same, whereas in the real markets there are differences between those prices. For further work, the margins between the prices could be incorporated into the model. It may also be important to include trade policies in other countries and other commodities that interact with rice in the model.
2. In the current context, the rice data was aggregated and assumed to be homogeneous. Disaggregate data on rice such as Basmati, Japonica and other varieties could be included into the model for more precise results.

3. In the present study, the historical simulation was developed to analyse dynamically what could have happened if the policy changes occurred 30 years back. For further research, the model could be extended to apply policy changes to a forecast period. This may assist the policymakers in allocating the limited public funds across the sectors.
4. Having included trade in rice by using a spatial equilibrium model under the assumption that there were no spillovers of R&D results from one country to another a challenging issue to include in further modelling work would be the spillover of research results from one country to another along with the relevant pattern of adoption integrated into a trade model.

Final Comments

Food security is currently a major topic of debate among developed and developing countries. For the same issue, government interventions through various supports and control measures in the agricultural sectors cannot be avoided. However, these interventions are not the only alternative. Research and development could be better used as one of the options to increase production and reduce import dependency, as this also is one of the concerns in the importing countries like Malaysia. Nevertheless, R&D investments are still in the infant stages of development in most developing countries. The proportion of government funds for R&D in these countries is small compared with those in the developed countries.

From the results in this study it is suggested that the Malaysian government could transfer funds from subsidies to R&D and thereby increase rice production and potentially achieve the self-sufficiency objectives. However, this transfer depends upon the government's time frames to achieve its objectives. Subsidies have an immediate impact while long periods are required for the impacts of research to flow. Furthermore, from a political economy point of view, the implementation of a policy such as removing subsidies may have a direct effect on the farmers, the majority of whom are Bumiputera who have been a focus of government support. Therefore, the implementation of such a policy change may need to be gradual and reflect a longer-term strategic direction in relation to Malaysian agriculture.

The key policy recommendation from the present study is to eliminate the limited public funds allocated to subsidies and increase the allocations for R&D related activities and to other important sectors such as education, health and transportation. With these more effective allocations, the country may well also be able to achieve a higher level of economic growth.

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Appendix A: Variable Definitions and Sources of Data

In this study, annual time series data from 1980 to 2009 were used. The list of data and definitions are presented in this appendix. The code numbers used for the countries are one to six which represent Malaysia, Thailand, Vietnam, Pakistan, Indonesia and the Rest of the World respectively. The units for each variable are given in parentheses. The sources of data are also presented in the appendix and the full reference list is given in the reference section.

The endogenous variable names are bold and underlined. The estimation period was from 1980 to 2009, while for the simulation period was from 1982 to 2009.

Table A.1: Definitions and sources of data

Symbols	Definitions	Sources
	Malaysia (1)	
<u>A1</u>	**<u>Area harvested to rice (million ha)</u>**	USDA(2011), PSD Online
<u>S1</u>	**<u>Milled production (million tonne)</u>**	USDA(2011), PSD Online
IM1	Market year rice imports (million tonne)	USDA(2011), PSD Online
EX1	Market year rice exports (million tonne)	USDA(2011), PSD Online
<u>D1</u>	**<u>Domestic consumption of rice (million tonne)</u>**	USDA(2011), PSD Online
<u>D7</u>	**<u>Ending stocks of rice (million tonne)</u>**	USDA(2011), PSD Online
PW1	Price of wheat (unit value of import) (MYR/tonne)	FAOSTAT (2011)
<u>Y1</u>	**<u>Yield (tonnes/ha)</u>**	USDA(2011), PSD Online
GDP1	Gross domestic product (MYR Mill.)	World Development Indicators (2011)
CPI1	Consumer price index (2005=100) (%)	USDA-ERS (2010)
<u>P1</u>	**<u>Price of rice (unit value of import) (MYR/tonnes)</u>**	FAOSTAT (2011)
PPO1	Price of palm oil (forward futures) (MYR/Tonnes)	International Monetary Fund (2011)
PPS1	Per unit subsidy for rice (MYR)	Ministry of Agriculture, Malaysia (2011)
R1	Average rainfall (mm)	Department of Irrigation and Drainage, Malaysia (2010)
POP1	Population (Mill.)	World Development Indicators (2011)
ER1	Exchange rate (MYR/USD)	World Development Indicators (2011)
FC1	Fertilizer consumption per ha for rice (000 tonne)	International Rice Research Institute (2012)

Table A.1 (continued)

Symbols	Definitions	Sources
	Thailand (2)	
A2	**Area harvested to rice (million ha)**	USDA(2011), PSD Online
S2	**Milled production (million tonne)**	USDA(2011), PSD Online
IM2	Market year rice imports (million tonne)	USDA(2011), PSD Online
EX2	Market year rice exports (million tonne)	USDA(2011), PSD Online
D2	**Domestic consumption of rice (million tonne)**	USDA(2011), PSD Online
D8	**Ending stocks of rice (million tonne)**	USDA(2011), PSD Online
P2	**Price of rice (unit value of Export)(THB/tonne)**	FAOSTAT (2011)
PW2	Price of wheat (unit value of import) (THB/tonne)	FAOSTAT (2011)
PPO2	Price of palm oil (THB/tonne)	Office of Agricultural Economics, Thailand (2011)
PC2	Price of cassava (THB/tonne)	Office of Agricultural Economics, Thailand (2011)
PSC2	Price of sugar cane (THB/tonne)	Office of Agricultural Economics, Thailand (2011)
GDP2	Gross domestic product (THB Mill.)	World Development Indicators (2011)
Y2	**Yield (tonne/ha)**	USDA(2011), PSD Online
POP2	Population (Mill.)	World Development Indicators (2011)
ER2	Exchange rate (THB/USD)	World Development Indicators (2011)
FC2	Fertilizer consumption per ha for rice (000 tonne)	International Rice Research Institute (2012)
	Vietnam (3)	
A3	**Area harvested to rice (million ha)**	USDA(2011), PSD Online
S3	**Milled production (million tonne)**	USDA(2011), PSD Online
IM3	Market year rice imports (million tonne)	USDA(2011), PSD Online
EX3	Market year rice exports (million tonne)	USDA(2011), PSD Online
D3	**Domestic consumption of rice (million tonne)**	USDA(2011), PSD Online
D9	**Ending stocks of rice (million tonne)**	USDA(2011), PSD Online
P3	**Price of rice (unit value of Export) (VND/tonne)**	FAOSTAT (2011)
PW3	Price of wheat (unit value of import) (VND/Tonnes)	FAOSTAT (2011)
GDP3	Gross domestic product (VND Mill.)	World Development Indicators (2011)
Y3	**Yield (tonne/ha)**	USDA(2011), PSD Online
ER3	Exchange rate (VND/USD)	World Development Indicators (2011)
FC3	Fertilizer consumption per ha for rice (000 Tonnes)	International Rice Research Institute (2012)
IRRI3	Irrigated agriculture area (000 ha)	International Rice Research Institute (2012)

Table A.1 (continued)

Symbols	Definitions	Sources
	Pakistan (4)	
A4	**Area harvested to rice (million ha)**	USDA(2011), PSD Online
S4	**Milled production (million tonne)**	USDA(2011), PSD Online
IM4	Market year rice imports (million tonne)	USDA(2011), PSD Online
EX4	Market year rice exports (million tonne)	USDA(2011), PSD Online
D4	**Domestic consumption of rice (million tonne)**	USDA(2011), PSD Online
D10	**Ending stocks of rice (million tonne)**	USDA(2011), PSD Online
P4	**Price of rice (unit value of Export) (PKR/Tonnes)**	FAOSTAT (2011)
PW4	Price of wheat (PKR/Tonnes)	FAOSTAT (2011)
GDP4	Gross domestic product (PKR Mill.)	World Development Indicators (2011)
Y4	**Yield (tonne/ha)**	USDA(2011), PSD Online
POP4	Population (Mill.)	World Development Indicators (2011)
ER4	Exchange rate (PKR/USD)	World Development Indicators (2011)
FC4	Fertilizer consumption per ha for rice (000 tonne)	International Rice Research Institute (2012)
IRRI4	Irrigated agriculture area (000 ha)	International Rice Research Institute (2012)
	Indonesia (5)	
A5	**Area harvested to rice (million ha)**	USDA(2011), PSD Online
S5	**Milled production (million tonne)**	USDA(2011), PSD Online
IM5	Market year rice imports (million tonne)	USDA(2011), PSD Online
EX5	Market year rice exports (million tonne)	USDA(2011), PSD Online
D5	**Domestic consumption of rice (million tonne)**	USDA(2011), PSD Online
D11	**Ending stocks of rice (million tonne)**	USDA(2011), PSD Online
P5	**Price of rice (unit value of Import) (IDR/tonne)**	FAOSTAT (2011)
PW5	Price of wheat (unit value of Import) (IDR/tonne)	FAOSTAT (2011)
PCA5	Price of cassava (IDR/tonne)	FAOSTAT (2011)
GDP5	Gross domestic product (IDR Mill.)	World Development Indicators (2011)
Y5	**Yield (tonne/ha)**	USDA(2011), PSD Online
POP5	Population (Mill.)	World Development Indicators (2011)
ER5	Exchange rate (IDR/USD)	World Development Indicators (2011)
FC5	Fertilizer consumption per ha for rice (000 tonne)	International Rice Research Institute (2012)
IRRI5	Irrigated agriculture area (000 ha)	International Rice Research Institute (2012)

Table A.1 (continued)

Symbols	Definitions	Sources
	Rest Of the World (ROW) (6)	
A6	**Area harvested to rice (million ha)**	USDA(2011), PSD Online
S6	**Milled production (million tonne)**	USDA(2011), PSD Online
IM6	Market year rice imports (million tonne)	USDA(2011), PSD Online
EX6	Market year rice exports (million tonne)	USDA(2011), PSD Online
D6	**Domestic consumption of rice (million tonne)**	USDA(2011), PSD Online
D12	**Ending stocks of rice (million tonne)**	USDA(2011), PSD Online
P6	**Price of rice (unit value of Import) (USD/tonne)**	FAOSTAT (2011)
PW6	Price of wheat (unit value of Export) (USD/tonne)	FAOSTAT (2011)
GDP6	Gross domestic product (USD Mill.)	World Development Indicators (2011)
CPI6	Consumer price index (2005=100) (%)	USDA-ERS (2010)
Y6	**Yield (tonne/ha)**	USDA(2011), PSD Online
PC6	Price of corn (USD/tonne)	FAOSTAT (2011)
DM196	Intercept dummy variable, 1 for 1996-2009 ; 0 otherwise	Computed by the author
DMP196	Slope dummy variable, 1 for 1996-2009 ; 0 otherwise	Computed by the author
T	Time trend	Computed by the author
T_{ij}	Transport cost from region i to j	Computed by the author
X_{ij}	Trade flows from region i to j	Derived in the model
W_{ij}	Slack variables	Derived in the model

Appendix B: Simulation Results for All Scenarios

Table B.1: Baseline versus Scenario 1 (10% of subsidy into R&D)

(a) Malaysia

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Import Quantity		
	Baseline (MYR/Mt)	Scenario 1 (MYR/Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)
1982	826.11	824.80	-0.16	1.45	1.45	0.01	0.31	0.37	20.75	1.08	1.24	14.98	0.65	0.65	0.00	2.57	2.95	14.98	0.37	0.27	-26.56
1983	708.51	671.05	-5.29	1.52	1.52	0.22	0.31	0.39	25.75	1.14	1.34	17.81	0.65	0.65	0.00	2.72	3.20	17.83	0.39	0.27	-30.74
1984	634.72	633.02	-0.27	1.59	1.59	0.01	0.17	0.25	50.54	1.02	1.23	20.76	0.63	0.63	0.00	2.48	3.00	20.84	0.42	0.29	-30.56
1985	652.19	597.05	-8.46	1.52	1.52	0.33	0.32	0.41	30.92	1.25	1.50	19.80	0.64	0.64	0.00	2.98	3.57	19.84	0.42	0.28	-34.42
1986	613.64	483.49	-21.21	1.52	1.52	0.22	0.18	0.29	62.01	1.17	1.44	23.68	0.64	0.64	0.00	2.79	3.45	23.78	0.21	0.12	-43.17
1987	528.60	526.07	-0.48	1.35	1.35	0.02	0.11	0.23	105.84	1.09	1.39	27.05	0.63	0.63	0.00	2.67	3.39	27.33	0.19	0.13	-31.42
1988	770.73	737.78	-4.28	1.43	1.44	0.21	0.11	0.24	122.30	1.14	1.48	29.32	0.65	0.65	0.00	2.70	3.49	29.40	0.29	0.19	-34.60
1989	938.60	935.47	-0.33	1.51	1.51	0.02	0.13	0.27	101.65	1.17	1.51	29.41	0.62	0.62	0.00	2.88	3.73	29.50	0.36	0.16	-56.96
1990	971.35	827.18	-14.84	1.48	1.49	0.89	0.23	0.38	68.49	1.28	1.67	30.63	0.65	0.65	0.00	3.03	3.95	30.67	0.30	0.17	-41.62
1991	878.41	874.57	-0.44	1.53	1.53	0.02	0.23	0.40	72.65	1.16	1.58	36.24	0.66	0.65	0.00	2.72	3.72	36.51	0.36	0.17	-52.09
1992	809.85	773.96	-4.43	1.58	1.59	0.21	0.30	0.48	59.53	1.19	1.63	37.84	0.66	0.66	0.00	2.77	3.83	37.94	0.47	0.20	-56.98
1993	731.66	727.57	-0.56	1.65	1.65	0.02	0.34	0.53	55.67	1.30	1.79	36.85	0.67	0.67	0.00	2.99	4.10	36.96	0.39	0.21	-45.11
1994	861.88	857.53	-0.50	1.71	1.71	0.02	0.28	0.48	71.14	1.34	1.84	37.64	0.67	0.67	0.00	3.07	4.22	37.71	0.31	0.17	-44.74
1995	827.65	823.36	-0.52	1.72	1.72	0.02	0.30	0.50	69.69	1.34	1.86	38.93	0.67	0.67	0.00	3.09	4.29	38.99	0.40	0.18	-54.44
1996	968.64	928.94	-4.10	1.70	1.71	0.21	0.46	0.68	46.82	1.31	1.86	41.77	0.66	0.66	0.00	3.03	4.30	41.82	0.56	0.24	-58.05
1997	1052.74	1047.47	-0.50	1.84	1.84	0.03	0.53	0.76	42.73	1.29	1.86	44.70	0.66	0.66	0.00	3.01	4.35	44.82	0.63	0.29	-54.90
1998	1386.58	1379.31	-0.52	1.94	1.94	0.03	0.48	0.71	49.22	1.26	1.85	47.07	0.64	0.64	0.00	3.02	4.44	47.16	0.63	0.27	-56.83
1999	1266.45	1184.80	-6.45	1.95	1.96	0.38	0.42	0.67	60.30	1.28	1.92	50.11	0.65	0.65	0.00	3.01	4.52	50.19	0.62	0.24	-61.54
2000	1180.51	1172.28	-0.70	1.95	1.95	0.04	0.49	0.76	56.41	1.42	2.11	49.06	0.67	0.67	0.00	3.26	4.87	49.26	0.59	0.17	-70.89
2001	1034.91	1026.57	-0.81	2.01	2.01	0.04	0.45	0.73	62.90	1.36	2.08	52.48	0.65	0.65	0.00	3.23	4.93	52.59	0.61	0.18	-70.33
2002	1122.04	957.01	-14.71	2.01	2.03	0.74	0.32	0.63	96.40	1.41	2.18	55.14	0.66	0.66	0.00	3.27	5.08	55.23	0.48	0.15	-69.07
2003	1107.12	812.42	-26.62	2.03	2.06	1.32	0.26	0.59	128.19	1.49	2.32	55.98	0.68	0.68	0.00	3.37	5.26	56.33	0.48	0.13	-73.78
2004	1062.47	1052.60	-0.93	2.05	2.05	0.04	0.32	0.66	103.88	1.44	2.29	59.18	0.66	0.66	0.00	3.34	5.34	59.82	0.69	0.17	-74.83
2005	1173.01	1162.90	-0.86	2.15	2.15	0.04	0.36	0.71	97.85	1.44	2.32	61.16	0.66	0.66	0.00	3.36	5.42	61.37	0.75	0.22	-70.84
2006	1217.52	1207.32	-0.84	2.17	2.17	0.04	0.45	0.82	80.47	1.40	2.31	65.88	0.65	0.65	0.00	3.30	5.48	66.00	0.87	0.31	-63.96
2007	1334.89	1323.96	-0.82	2.35	2.35	0.04	0.61	0.98	61.63	1.47	2.42	64.31	0.65	0.65	0.00	3.49	5.74	64.43	1.04	0.47	-54.88
2008	2465.68	2454.98	-0.43	2.50	2.50	0.04	0.73	1.12	53.91	1.54	2.53	64.72	0.66	0.66	0.00	3.58	5.90	64.84	1.08	0.48	-55.39
2009	1786.37	1774.97	-0.64	2.55	2.55	0.04	0.71	1.14	59.71	1.63	2.71	65.69	0.68	0.68	0.00	3.72	6.17	65.80	0.90	0.25	-72.19
Mean	**1032.60**	**992.09**	**-3.92**	**1.81**	**1.82**	**0.19**	**0.35**	**0.58**	**63.54**	**1.30**	**1.87**	**43.64**	**0.65**	**0.65**	**0.00**	**3.05**	**4.38**	**43.62**	**0.53**	**0.23**	**-56.89**
S.D	**393.68**	**402.24**	**6.88**	**0.33**	**0.33**	**0.31**	**0.16**	**0.25**	**27.37**	**0.15**	**0.41**	**15.88**	**0.01**	**0.01**	**0.00**	**0.31**	**0.91**	**15.93**	**0.23**	**0.09**	**14.85**
C.V.	**0.38**	**0.41**	**-1.75**	**0.18**	**0.18**	**1.66**	**0.47**	**0.44**	**0.43**	**0.12**	**0.22**	**0.36**	**0.02**	**0.02**	**-0.90**	**0.10**	**0.21**	**0.37**	**0.44**	**0.39**	**-0.26**

Table B.1 (continued)

(b) Thailand																					
Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
	Baseline (THB/Mt)	Scenario 1 (THB/Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)
1982	6750.90	6738.05	-0.19	8.12	8.12	0.00	1.34	1.34	0.00	11.14	11.14	0.00	8.94	8.94	0.00	1.89	1.89	0.00	3.69	3.69	-0.01
1983	6339.84	6324.28	-0.25	8.27	8.27	0.00	1.44	1.44	0.00	12.93	12.93	0.00	9.63	9.63	0.00	2.04	2.04	0.00	4.55	4.55	-0.01
1984	5969.29	5952.20	-0.29	8.49	8.50	0.00	2.08	2.08	0.00	13.12	13.12	0.00	9.61	9.61	0.00	2.07	2.07	0.00	3.98	3.98	-0.02
1985	5891.61	5869.43	-0.38	8.62	8.62	0.01	2.50	2.50	0.00	13.37	13.37	0.00	9.83	9.83	0.00	2.06	2.06	0.00	4.33	4.33	-0.02
1986	5102.45	5079.50	-0.45	8.34	8.34	0.01	2.27	2.27	0.00	12.45	12.45	0.00	9.66	9.65	0.00	1.95	1.95	0.00	4.34	4.34	-0.02
1987	5240.60	5214.76	-0.49	8.50	8.50	0.01	1.14	1.14	-0.01	12.17	12.17	0.00	9.15	9.15	0.00	2.01	2.01	0.00	4.79	4.79	-0.02
1988	6952.80	6924.42	-0.41	8.25	8.25	0.01	0.90	0.90	-0.02	14.07	14.07	0.00	9.93	9.93	0.00	2.15	2.15	0.00	6.06	6.06	-0.02
1989	7691.03	7661.30	-0.39	8.57	8.57	0.01	1.98	1.98	-0.01	13.58	13.58	-0.01	9.87	9.87	0.00	2.09	2.09	0.00	3.93	3.92	-0.03
1990	6908.66	6876.88	-0.46	8.40	8.40	0.01	0.94	0.94	-0.02	11.36	11.36	-0.01	8.81	8.81	0.00	1.96	1.96	0.00	4.90	4.89	-0.13
1991	7460.79	7425.16	-0.48	8.40	8.40	0.01	1.14	1.14	-0.02	13.54	13.54	-0.01	9.10	9.10	0.00	2.25	2.25	0.00	4.94	4.93	-0.03
1992	6777.41	6740.16	-0.55	8.50	8.50	0.01	0.81	0.81	-0.02	13.16	13.16	-0.01	9.17	9.17	0.00	2.17	2.17	0.00	4.98	4.98	-0.03
1993	6006.15	5965.98	-0.67	8.50	8.80	3.54	0.25	0.25	-0.08	12.64	12.64	-0.01	8.65	8.65	0.00	2.21	2.21	0.00	6.55	6.53	-0.27
1994	6743.43	6701.75	-0.62	8.25	8.25	0.01	0.20	0.20	-0.12	14.18	14.18	-0.01	9.23	9.23	0.00	2.33	2.33	0.00	5.99	5.99	-0.03
1995	7953.53	7910.85	-0.54	8.44	8.44	0.01	0.87	0.87	-0.03	14.52	14.51	-0.01	9.11	9.11	0.00	2.41	2.41	0.00	5.38	5.38	-0.04
1996	8546.68	8501.80	-0.53	8.59	8.91	3.70	0.70	0.70	-0.03	13.65	13.65	-0.01	9.26	9.26	0.00	2.23	2.23	0.00	8.89	8.88	-0.08
1997	9474.55	9415.85	-0.62	8.80	8.80	0.01	1.04	1.04	-0.03	15.46	15.46	-0.01	9.91	9.90	0.00	2.36	2.36	0.00	6.33	6.32	-0.04
1998	12639.43	12562.78	-0.61	8.90	8.90	0.02	1.08	1.08	-0.03	15.69	15.69	-0.01	9.97	9.97	0.00	2.39	2.39	0.00	6.76	6.76	-0.05
1999	9434.38	9359.76	-0.79	9.05	9.05	0.02	1.94	1.94	-0.02	16.41	16.41	-0.01	9.91	9.91	0.00	2.51	2.51	0.00	9.64	9.63	-0.17
2000	8228.25	8141.33	-1.06	9.25	9.25	0.02	2.23	2.23	-0.02	16.96	16.96	-0.01	9.84	9.84	0.00	2.61	2.61	0.00	7.45	7.44	-0.05
2001	7681.87	7584.40	-1.27	9.40	9.40	0.02	3.12	3.12	-0.02	17.52	17.52	-0.02	10.14	10.14	0.00	2.62	2.62	0.00	7.25	7.25	-0.06
2002	8175.30	8076.34	-1.21	9.46	9.46	0.02	3.32	3.32	-0.02	17.31	17.31	-0.02	10.23	10.22	0.00	2.57	2.57	0.00	7.64	7.64	-0.06
2003	8193.03	8092.67	-1.22	9.47	9.47	0.02	1.70	1.70	-0.04	18.00	18.00	-0.02	10.31	10.31	0.00	2.65	2.65	0.00	10.13	10.12	-0.05
2004	9837.92	9733.45	-1.06	9.48	9.48	0.02	2.31	2.31	-0.03	17.33	17.33	-0.02	9.98	9.98	0.00	2.63	2.63	0.00	11.57	11.52	-0.49
2005	11497.08	11389.68	-0.93	9.55	10.02	5.01	3.63	3.63	-0.02	18.37	18.36	-0.02	10.31	10.31	0.00	2.70	2.70	0.00	10.49	10.49	-0.06
2006	11456.12	11350.73	-0.92	9.78	10.33	5.56	2.51	2.51	-0.03	18.24	18.24	-0.02	10.26	10.26	0.00	2.69	2.69	0.00	12.72	12.70	-0.14
2007	11456.25	11358.00	-0.86	9.60	9.60	0.02	2.70	2.70	-0.03	19.76	19.76	-0.02	10.81	10.81	0.00	2.77	2.77	0.00	13.99	13.92	-0.49
2008	23245.70	23138.83	-0.46	9.50	10.13	6.59	4.81	4.81	-0.01	19.96	19.96	-0.02	10.86	10.86	0.00	2.78	2.78	0.00	12.68	12.62	-0.46
2009	16974.67	16863.76	-0.65	10.20	10.84	6.29	6.13	6.13	-0.01	20.41	20.41	-0.02	11.02	11.02	0.00	2.81	2.81	0.00	10.67	10.63	-0.39
Mean	**8879.63**	**8819.79**	**-0.67**	**8.88**	**8.99**	**1.18**	**1.97**	**1.97**	**-0.02**	**15.26**	**15.26**	**-0.01**	**9.77**	**9.77**	**0.00**	**2.35**	**2.35**	**0.00**	**7.31**	**7.30**	**-0.16**
S.D	**3828.28**	**3804.31**	**0.30**	**0.57**	**0.71**	**2.20**	**1.35**	**1.35**	**0.02**	**2.71**	**2.71**	**0.01**	**0.62**	**0.62**	**0.00**	**0.29**	**0.29**	**0.00**	**3.05**	**3.04**	**0.15**
C.V.	**0.43**	**0.43**	**-0.45**	**0.06**	**0.08**	**1.87**	**0.68**	**0.68**	**-1.36**	**0.18**	**0.18**	**-0.55**	**0.06**	**0.06**	**-0.65**	**0.12**	**0.12**	**4.41**	**0.42**	**0.42**	**-0.94**

Table B.1 (continued)

(c) Vietnam

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
	Baseline (VND/Mt)	Scenario 1 (VND/Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)
1982	524.19	523.31	-0.17	9.65	9.65	0.00	0.15	0.15	0.00	9.75	9.75	0.00	5.70	5.70	0.00	2.59	2.59	0.00	2.62	2.52	-3.74
1983	448.16	447.08	-0.24	10.23	10.23	0.00	0.16	0.16	0.00	10.01	10.01	0.00	5.74	5.74	0.00	2.64	2.64	0.00	0.53	0.53	-0.66
1984	3423.37	3414.05	-0.27	10.74	10.87	1.19	0.16	0.16	0.00	10.49	10.49	0.00	5.85	5.85	0.00	2.72	2.72	0.00	1.09	1.09	-0.09
1985	5599.16	5579.89	-0.34	10.57	10.72	1.41	0.16	0.16	0.00	10.22	10.22	0.00	5.83	5.83	0.00	2.65	2.65	0.00	3.56	3.56	-0.15
1986	3688.28	3668.43	-0.54	9.54	9.54	0.00	0.15	0.15	0.00	9.55	9.55	0.00	5.69	5.69	0.00	2.54	2.54	0.00	0.02	0.02	-0.47
1987	11069.84	10991.19	-0.71	11.25	11.25	0.00	0.17	0.17	0.00	11.43	11.43	0.00	5.77	5.77	0.00	3.00	3.00	0.00	0.16	0.16	-0.02
1988	168601.30	167920.66	-0.40	10.50	10.50	0.00	0.16	0.16	0.00	11.95	11.95	0.00	6.02	6.02	0.00	3.01	3.01	0.00	6.98	7.18	2.81
1989	909421.73	904259.30	-0.57	10.93	10.94	0.01	0.17	0.17	0.00	12.66	12.66	0.00	6.08	6.08	0.00	3.16	3.16	0.00	1.71	1.71	-0.09
1990	1211896.55	1203844.41	-0.66	11.18	11.18	0.02	0.17	0.17	0.00	12.27	12.27	0.00	6.30	6.30	0.00	2.95	2.95	0.00	1.09	1.09	-0.24
1991	2265479.50	2251465.17	-0.62	12.54	12.54	0.03	0.19	0.19	-0.01	14.49	14.48	0.00	6.50	6.50	0.00	3.38	3.38	0.00	1.93	1.92	-0.24
1992	2395569.83	2379140.95	-0.69	12.86	12.86	0.04	0.20	0.20	-0.01	14.44	14.44	-0.01	6.62	6.62	0.00	3.31	3.31	0.00	1.58	1.57	-0.36
1993	2242739.22	2225856.27	-0.75	13.58	13.58	0.04	0.21	0.21	-0.02	15.83	15.83	-0.01	6.63	6.63	0.00	3.62	3.62	0.00	2.24	2.23	-0.28
1994	2335602.24	2317428.95	-0.78	13.74	13.74	0.04	0.21	0.21	-0.03	16.03	16.02	-0.01	6.80	6.80	0.00	3.57	3.57	0.00	2.29	2.28	-0.31
1995	2925380.40	2906473.62	-0.65	14.40	14.40	0.04	0.25	0.25	-0.03	17.44	17.44	-0.01	7.11	7.11	0.00	3.72	3.72	0.00	3.00	2.99	-0.26
1996	3132102.74	3112562.46	-0.62	14.48	14.49	0.04	0.45	0.45	-0.02	17.90	17.90	-0.02	7.00	7.00	0.00	3.87	3.87	0.00	3.23	3.22	-0.27
1997	2841745.11	2819878.11	-0.77	15.00	15.01	0.04	0.77	0.77	-0.01	19.03	19.03	-0.02	7.35	7.35	0.00	3.92	3.92	0.00	3.71	3.70	-0.27
1998	3629661.37	3605074.25	-0.68	15.50	15.51	0.05	0.88	0.88	-0.01	19.98	19.97	-0.02	7.53	7.52	0.00	4.02	4.02	0.00	4.37	4.36	-0.26
1999	3177771.61	3150257.78	-0.87	17.55	17.56	0.05	0.92	0.92	-0.02	20.75	20.75	-0.02	7.60	7.60	0.00	4.14	4.14	0.00	3.17	3.15	-0.41
2000	2736866.82	2706169.21	-1.12	16.93	16.94	0.05	0.97	0.97	-0.02	20.30	20.29	-0.03	7.43	7.43	0.00	4.14	4.14	0.00	3.32	3.31	-0.43
2001	2469305.95	2437000.54	-1.31	17.97	17.97	0.05	0.84	0.84	-0.02	20.91	20.91	-0.03	7.43	7.43	0.00	4.27	4.27	0.00	3.09	3.07	-0.51
2002	3397235.81	3362037.16	-1.04	17.45	17.46	0.06	1.16	1.16	-0.02	21.42	21.41	-0.03	7.43	7.42	0.00	4.37	4.37	0.00	8.54	8.49	-0.56
2003	2897806.40	2860283.87	-1.29	18.24	18.25	0.06	1.02	1.02	-0.02	21.98	21.97	-0.04	7.43	7.43	0.00	4.48	4.48	0.00	3.89	3.87	-0.49
2004	3664086.62	3623189.64	-1.12	17.60	17.61	0.07	1.29	1.29	-0.02	22.62	22.62	-0.04	7.42	7.42	0.00	4.62	4.62	0.00	4.76	4.74	-0.45
2005	4219860.53	4177512.50	-1.00	18.40	18.41	0.07	1.31	1.31	-0.02	22.69	22.68	-0.05	7.29	7.29	0.00	4.72	4.72	0.00	4.27	4.25	-0.54
2006	4378584.39	4334086.55	-1.02	18.78	18.79	0.07	1.39	1.39	-0.03	22.90	22.88	-0.05	7.19	7.19	0.00	4.82	4.82	0.00	4.04	4.02	-0.61
2007	5256509.90	5210670.06	-0.87	19.40	19.42	0.07	2.02	2.02	-0.02	24.40	24.38	-0.05	7.42	7.41	0.00	4.98	4.98	0.00	4.37	4.34	-0.61
2008	9930875.48	9878581.02	-0.53	19.01	19.03	0.08	1.96	1.96	-0.02	24.37	24.35	-0.06	7.33	7.32	0.00	5.04	5.04	0.00	5.41	5.38	-0.55
2009	7606237.04	7551034.01	-0.73	19.15	19.17	0.09	1.47	1.47	-0.03	25.01	24.99	-0.06	7.42	7.41	0.00	5.11	5.11	0.00	6.34	6.31	-0.50
Mean	**2636360.48**	**2614619.66**	**-0.82**	**14.54**	**14.56**	**0.11**	**0.68**	**0.68**	**-0.02**	**17.17**	**17.17**	**-0.03**	**6.78**	**6.78**	**0.00**	**3.76**	**3.76**	**0.00**	**3.26**	**3.25**	**-0.38**
S.D	**2331940.89**	**2315878.10**	**0.30**	**3.41**	**3.41**	**0.33**	**0.59**	**0.59**	**0.01**	**5.19**	**5.19**	**0.02**	**0.69**	**0.69**	**0.00**	**0.82**	**0.82**	**0.00**	**2.01**	**2.02**	**0.91**
C.V.	**0.88**	**0.89**	**-0.36**	**0.23**	**0.23**	**2.94**	**0.88**	**0.88**	**-0.54**	**0.30**	**0.30**	**-0.81**	**0.10**	**0.10**	**-1.04**	**0.22**	**0.22**	**-22.18**	**0.62**	**0.62**	**-2.41**

Table B.1 (continued)

(d) Pakistan

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
	Baseline (PAK/Mt)	Scenario 1 (PAK/Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)
1982	4086.92	4080.30	-0.16	2.25	2.25	0.00	0.48	0.48	0.00	3.41	3.41	0.00	1.96	1.96	0.00	2.64	2.64	0.00	3.36	3.36	0.00
1983	3601.90	3593.03	-0.25	2.12	2.12	0.00	0.53	0.53	0.00	3.31	3.31	0.00	1.98	1.98	0.00	2.53	2.53	0.00	1.15	1.15	-0.01
1984	4677.45	4667.30	-0.22	2.20	2.20	0.01	0.81	0.81	0.00	3.29	3.29	0.00	1.98	1.98	0.00	2.51	2.51	0.00	3.01	3.01	0.00
1985	4877.55	4864.54	-0.27	1.86	1.86	0.01	0.58	0.58	0.00	2.90	2.90	0.00	1.85	1.85	0.00	2.37	2.37	0.00	2.90	2.90	0.00
1986	4307.54	4293.01	-0.34	2.05	2.05	0.01	0.72	0.72	0.00	3.52	3.52	0.20	2.08	2.08	0.00	2.56	2.56	0.21	1.33	1.35	2.13
1987	4070.22	4052.74	-0.43	2.14	2.14	0.01	0.81	0.81	0.00	3.22	3.21	0.00	1.95	1.95	0.00	2.50	2.50	0.00	1.13	1.13	-0.03
1988	5387.93	5367.73	-0.37	2.10	2.10	0.01	1.13	1.13	0.00	3.21	3.21	-0.01	2.05	2.05	0.00	2.37	2.37	0.00	0.80	0.80	-0.05
1989	7449.50	7425.75	-0.32	2.25	2.25	0.01	1.35	1.35	0.00	3.22	3.22	-0.01	2.10	2.10	0.00	2.32	2.32	0.00	0.75	0.74	-0.06
1990	7040.86	7013.90	-0.38	2.10	2.10	0.01	1.24	1.24	0.00	3.25	3.25	-0.01	2.11	2.10	0.00	2.34	2.34	0.00	1.26	1.26	-0.04
1991	6790.93	6757.70	-0.49	2.15	2.15	0.02	0.91	0.91	-0.01	3.24	3.24	-0.01	2.09	2.09	0.00	2.34	2.34	0.00	1.41	1.41	-0.04
1992	6819.01	6782.22	-0.54	2.25	2.25	0.02	0.86	0.86	-0.01	3.12	3.12	-0.01	1.98	1.98	0.00	2.39	2.39	0.00	0.92	0.92	-0.08
1993	8722.55	8677.95	-0.51	2.30	2.30	0.02	1.33	1.33	-0.01	4.06	4.05	-0.01	2.22	2.22	0.00	2.77	2.77	0.00	1.28	1.28	-0.07
1994	7459.46	7408.80	-0.68	2.40	2.40	0.02	0.71	0.71	-0.01	3.44	3.44	-0.01	2.12	2.12	0.00	2.46	2.46	0.00	3.39	3.39	-0.03
1995	7856.95	7802.75	-0.69	2.53	2.53	0.02	0.52	0.52	-0.02	3.99	3.99	-0.02	2.18	2.18	0.00	2.78	2.78	0.00	1.65	1.65	-0.07
1996	11562.12	11498.22	-0.55	2.55	2.55	0.03	0.44	0.44	-0.03	4.33	4.33	-0.02	2.26	2.26	0.00	2.90	2.90	0.00	1.85	1.85	-0.07
1997	11145.34	11068.39	-0.69	2.55	2.55	0.03	0.12	0.12	-0.11	4.33	4.33	-0.02	2.32	2.31	0.00	2.83	2.83	0.00	2.10	2.10	-0.07
1998	12978.26	12894.79	-0.64	2.57	2.58	0.04	0.38	0.38	-0.04	4.67	4.67	-0.02	2.42	2.42	0.00	2.92	2.92	0.00	2.48	2.45	-1.21
1999	16362.05	16264.37	-0.60	2.60	2.60	0.04	0.83	0.83	-0.02	5.11	5.11	-0.02	2.49	2.49	0.00	3.11	3.11	0.00	2.07	2.07	-0.10
2000	14267.38	14151.14	-0.81	2.61	2.62	0.05	0.58	0.58	-0.04	4.74	4.74	-0.03	2.34	2.34	0.00	3.06	3.06	0.00	2.38	2.38	-0.10
2001	13318.16	13182.29	-1.02	2.54	2.54	0.06	0.31	0.31	-0.08	3.89	3.89	-0.04	2.12	2.12	0.00	2.78	2.78	0.00	1.64	1.63	-0.17
2002	15107.67	14970.09	-0.91	2.56	2.56	0.06	0.27	0.27	-0.11	4.60	4.59	-0.04	2.28	2.28	0.00	3.05	3.05	0.00	2.08	2.07	-0.15
2003	16637.91	16498.19	-0.84	2.61	2.61	0.06	0.65	0.65	-0.05	4.91	4.91	-0.04	2.49	2.49	0.00	2.98	2.98	0.00	1.91	1.90	-0.16
2004	19172.25	19020.94	-0.79	2.56	2.56	0.07	0.31	0.31	-0.10	5.01	5.01	-0.04	2.51	2.51	0.00	3.02	3.02	0.00	2.78	2.78	-0.12
2005	19041.85	18882.93	-0.83	1.90	1.90	0.09	0.29	0.29	-0.12	5.53	5.53	-0.04	2.61	2.61	0.00	3.21	3.21	0.00	3.65	3.64	-0.10
2006	18725.60	18557.92	-0.90	2.21	2.21	0.09	0.69	0.69	-0.05	5.42	5.42	-0.04	2.56	2.56	0.00	3.21	3.21	0.00	2.81	2.81	-0.13
2007	21938.54	21765.66	-0.79	2.72	2.72	0.07	0.70	0.70	-0.06	5.70	5.69	-0.04	2.55	2.55	0.00	3.39	3.39	0.00	2.98	2.97	-0.14
2008	43383.11	43157.26	-0.52	3.49	3.49	0.07	1.20	1.20	-0.04	6.92	6.91	-0.04	2.92	2.92	0.00	3.59	3.59	0.00	2.92	2.92	-0.16
2009	35090.85	34826.52	-0.75	3.03	3.03	0.10	1.08	1.08	-0.06	6.67	6.66	-0.05	2.74	2.74	0.00	3.68	3.68	0.00	3.76	3.75	-0.16
Mean	**12567.14**	**12483.09**	**-0.67**	**2.40**	**2.40**	**0.04**	**0.71**	**0.71**	**-0.02**	**4.25**	**4.25**	**-0.02**	**2.26**	**2.26**	**0.00**	**2.81**	**2.81**	**0.01**	**2.13**	**2.13**	**-0.08**
S.D	**9357.39**	**9290.31**	**0.24**	**0.34**	**0.34**	**0.03**	**0.34**	**0.34**	**0.04**	**1.10**	**1.10**	**0.05**	**0.27**	**0.27**	**0.00**	**0.39**	**0.39**	**0.04**	**0.91**	**0.90**	**0.48**
C.V.	**0.74**	**0.74**	**-0.35**	**0.14**	**0.14**	**0.75**	**0.48**	**0.48**	**-1.60**	**0.26**	**0.26**	**-2.52**	**0.12**	**0.12**	**-0.86**	**0.14**	**0.14**	**5.79**	**0.42**	**0.42**	**-5.78**

Table B.1 (continued)

(e) Indonesia

Year	Demand Price Baseline (IND/Mt)	Demand Price Scenario 1 (IND/Mt)	Demand Price Change (%)	Consumption Demand Baseline (Mt)	Consumption Demand Scenario 1 (Mt)	Consumption Demand Change (%)	Stocks Demand Baseline (Mt)	Stocks Demand Scenario 1 (Mt)	Stocks Demand Change (%)	Supply Baseline (Mt)	Supply Scenario 1 (Mt)	Supply Change (%)	Area Harvested Baseline (Mt)	Area Harvested Scenario 1 (Mt)	Area Harvested Change (%)	Yield Baseline (Mt)	Yield Scenario 1 (Mt)	Yield Change (%)	Import Quantity Baseline (Mt)	Import Quantity Scenario 1 (Mt)	Import Quantity Change (%)
1982	220417.92	220048.49	-0.17	24.68	24.68	0.00	3.47	3.47	0.00	24.01	24.01	0.00	9.16	9.16	0.00	4.03	4.03	0.00	1.16	1.26	8.38
1983	297698.81	297083.60	-0.21	25.46	25.46	0.00	4.36	4.36	0.00	25.94	25.94	0.00	9.76	9.76	0.00	4.09	4.09	0.00	0.42	0.42	0.12
1984	327226.01	326484.60	-0.23	26.09	26.09	0.00	4.48	4.48	0.00	26.54	26.54	0.00	9.90	9.90	0.00	4.12	4.12	0.00	0.05	0.06	4.63
1985	285640.63	284733.69	-0.32	26.74	26.74	0.00	4.56	4.56	0.00	27.02	27.02	0.00	9.90	9.90	0.00	4.20	4.20	0.00	0.02	0.03	9.64
1986	272459.00	271339.52	-0.41	27.32	27.39	0.26	3.20	3.20	0.00	26.05	26.05	0.02	9.80	9.80	0.00	4.09	4.09	0.02	0.13	0.14	1.57
1987	366959.22	365307.92	-0.45	28.05	28.06	0.00	2.29	2.29	0.00	27.09	27.09	0.00	9.80	9.80	0.00	4.25	4.25	0.00	0.05	0.05	3.15
1988	485431.49	483539.79	-0.39	28.69	28.69	0.01	2.92	2.92	0.00	29.07	29.07	0.00	10.53	10.53	0.00	4.25	4.25	0.00	0.25	0.25	0.79
1989	498474.64	496427.62	-0.41	29.41	29.41	0.01	2.95	2.95	0.00	29.37	29.37	0.00	10.50	10.50	0.00	4.30	4.30	0.00	0.07	0.07	3.07
1990	535047.95	532759.03	-0.43	30.12	30.12	0.01	2.06	2.06	0.00	29.05	29.04	0.00	10.28	10.28	0.00	4.35	4.35	0.00	0.19	0.19	1.36
1991	603404.60	600681.45	-0.45	30.84	30.84	0.01	3.12	3.12	0.00	31.35	31.35	0.00	11.10	11.10	0.00	4.34	4.34	0.00	0.54	0.54	0.57
1992	572123.80	569146.76	-0.52	31.38	31.38	0.01	2.61	2.61	0.00	31.32	31.32	0.00	11.01	11.01	0.00	4.38	4.38	0.00	0.02	0.02	2.17
1993	807834.76	804523.36	-0.41	32.10	32.10	0.01	1.72	1.72	-0.01	30.32	30.32	0.00	10.74	10.74	0.00	4.34	4.34	0.00	0.89	0.90	0.44
1994	551955.19	548374.20	-0.65	32.92	32.93	0.01	4.22	4.22	0.00	32.34	32.33	-0.01	11.44	11.44	0.00	4.35	4.35	0.00	3.08	3.08	0.14
1995	640674.52	636823.01	-0.60	33.46	33.47	0.01	5.05	5.05	0.00	33.22	33.22	-0.01	11.57	11.57	0.00	4.42	4.42	0.00	1.08	1.08	0.44
1996	837383.94	833235.40	-0.50	33.91	33.92	0.01	4.06	4.06	0.00	32.09	32.09	-0.01	11.14	11.14	0.00	4.43	4.43	0.00	0.84	0.84	0.63
1997	1420080.96	1414635.64	-0.38	34.67	34.67	0.01	6.28	6.28	0.00	31.12	31.12	-0.01	11.73	11.73	0.00	4.08	4.08	0.00	5.76	5.77	0.11
1998	2982884.75	2964328.37	-0.62	35.03	35.05	0.04	7.12	7.12	0.00	32.15	32.15	-0.01	11.97	11.96	0.00	4.13	4.13	0.00	3.72	3.74	0.46
1999	2106093.05	2090592.61	-0.74	35.40	35.41	0.03	6.02	6.02	-0.01	32.81	32.81	-0.01	11.79	11.79	0.00	4.28	4.28	0.00	1.48	1.50	1.10
2000	1978203.24	1959955.57	-0.92	35.87	35.88	0.04	4.61	4.61	-0.01	32.98	32.97	-0.02	11.61	11.60	0.00	4.37	4.37	0.00	1.57	1.58	0.48
2001	2638333.93	2615822.70	-0.85	36.38	36.40	0.05	4.68	4.68	-0.01	32.97	32.97	-0.02	11.60	11.60	0.00	4.37	4.37	0.00	3.27	3.47	6.13
2002	1783108.72	1761658.97	-1.20	36.51	36.53	0.05	4.35	4.34	-0.02	33.43	33.42	-0.03	11.51	11.50	0.00	4.47	4.47	0.00	2.77	2.77	0.13
2003	1776162.22	1755411.45	-1.17	36.01	36.03	0.05	4.02	4.02	-0.02	35.05	35.04	-0.03	11.91	11.91	0.00	4.53	4.53	0.00	0.65	0.66	0.77
2004	2330491.99	2307275.17	-1.00	35.86	35.88	0.05	3.45	3.45	-0.03	34.85	34.84	-0.04	11.66	11.65	0.00	4.60	4.60	0.00	0.44	0.47	6.82
2005	2760119.84	2734205.29	-0.94	35.75	35.77	0.06	3.21	3.21	-0.03	34.98	34.97	-0.04	11.81	11.80	0.00	4.56	4.56	0.00	0.53	0.54	1.55
2006	2934158.00	2908675.73	-0.87	35.91	35.93	0.06	4.61	4.61	-0.03	35.33	35.31	-0.04	11.91	11.90	-0.01	4.56	4.56	0.00	1.98	2.02	1.72
2007	3068035.13	3042017.21	-0.85	36.35	36.37	0.06	5.61	5.61	-0.03	37.00	36.99	-0.05	11.90	11.90	-0.01	4.78	4.78	0.00	0.35	0.37	5.57
2008	4497103.28	4519500.18	0.50	36.87	36.85	-0.05	7.06	7.06	-0.02	38.32	38.30	-0.05	12.17	12.17	-0.01	4.84	4.84	0.00	0.26	0.26	0.67
2009	4476461.60	4442851.68	-0.75	38.01	38.03	0.07	6.59	6.58	-0.02	36.48	36.46	-0.04	12.13	12.13	0.00	4.62	4.62	0.00	1.06	1.10	3.64
Mean	**1501927.47**	**1492408.54**	**-0.63**	**32.49**	**32.50**	**0.03**	**4.24**	**4.24**	**-0.01**	**31.51**	**31.50**	**-0.02**	**11.08**	**11.08**	**0.00**	**4.36**	**4.36**	**0.00**	**1.17**	**1.18**	**1.60**
S.D	**1288063.58**	**1281932.42**	**0.35**	**4.04**	**4.04**	**0.05**	**1.46**	**1.46**	**0.01**	**3.68**	**3.67**	**0.02**	**0.88**	**0.88**	**0.00**	**0.21**	**0.21**	**0.00**	**1.39**	**1.40**	**2.68**
C.V.	**0.86**	**0.86**	**-0.55**	**0.12**	**0.12**	**1.69**	**0.35**	**0.35**	**-1.05**	**0.12**	**0.12**	**-1.13**	**0.08**	**0.08**	**-1.13**	**0.05**	**0.05**	**5.62**	**1.19**	**1.18**	**1.67**

Table B.1 (continued)

(f) Rest of the world																					
Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Import Quantity		
	Baseline (USD/Mt)	Scenario 1 (USD/Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)	Baseline (Mt)	Scenario 1 (Mt)	Change (%)
1982	406.31	405.75	-0.14	231.67	231.76	0.04	51.18	51.18	0.00	234.84	234.84	0.00	113.77	113.77	0.00	3.08	3.08	0.00	3.46	3.56	2.81
1983	372.71	372.04	-0.18	245.22	245.22	0.00	64.77	64.77	0.00	254.29	254.29	0.00	117.16	117.16	0.00	3.24	3.24	0.00	4.67	4.66	-0.10
1984	359.20	358.47	-0.20	249.12	249.12	0.00	79.70	79.70	-0.01	261.87	261.87	0.00	115.89	115.89	0.00	3.37	3.37	0.00	4.45	4.57	2.84
1985	312.30	311.48	-0.26	257.56	257.56	0.00	90.59	90.58	-0.01	263.16	263.15	0.00	116.64	116.63	0.00	3.37	3.37	0.00	5.03	5.17	2.83
1986	298.28	297.40	-0.29	259.51	259.66	0.06	98.77	98.76	-0.01	263.16	263.15	0.00	116.87	116.87	0.00	3.36	3.36	0.00	5.56	5.71	2.74
1987	296.35	295.34	-0.34	260.86	261.04	0.07	101.45	101.44	-0.01	259.83	259.82	0.00	114.03	114.02	0.00	3.40	3.40	0.00	5.68	5.86	3.09
1988	353.97	352.84	-0.32	272.77	272.96	0.07	109.39	109.38	-0.01	273.66	273.65	0.00	117.84	117.84	0.00	3.47	3.47	0.00	7.78	7.98	2.52
1989	363.65	362.50	-0.32	282.80	283.01	0.07	114.53	114.52	-0.01	284.91	284.90	0.00	118.49	118.49	0.00	3.59	3.59	0.00	5.95	6.15	3.40
1990	365.62	364.38	-0.34	290.65	290.86	0.07	122.74	122.73	-0.01	293.46	293.45	0.00	118.55	118.55	0.00	3.69	3.69	0.00	5.87	6.08	3.70
1991	379.65	378.26	-0.37	295.57	295.81	0.08	122.71	122.70	-0.01	288.88	288.87	0.00	117.83	117.82	0.00	3.66	3.66	0.00	7.38	7.62	3.31
1992	379.85	378.39	-0.39	299.16	299.41	0.09	119.94	119.93	-0.01	290.52	290.50	0.00	116.96	116.96	0.00	3.71	3.71	0.00	7.47	7.72	3.43
1993	351.75	350.17	-0.45	301.12	301.10	-0.01	115.10	115.09	-0.01	290.86	290.85	0.00	116.55	116.54	0.00	3.72	3.72	0.00	6.93	7.21	4.00
1994	366.50	364.85	-0.45	305.07	305.35	0.09	114.15	114.13	-0.01	297.57	297.56	0.00	117.40	117.40	-0.01	3.78	3.78	0.00	6.54	6.83	4.43
1995	369.36	367.64	-0.46	306.31	306.61	0.10	113.09	113.08	-0.01	298.86	298.85	0.00	117.99	117.98	-0.01	3.78	3.78	0.00	8.56	8.86	3.50
1996	412.79	411.01	-0.43	315.68	315.67	0.00	116.64	116.62	-0.01	312.29	312.28	0.00	119.85	119.84	-0.01	3.89	3.89	0.00	8.89	9.20	3.48
1997	399.08	397.21	-0.47	314.74	315.06	0.10	120.75	120.74	-0.01	315.59	315.58	-0.01	119.52	119.51	-0.01	3.94	3.94	0.00	8.03	8.08	0.53
1998	373.44	371.58	-0.50	324.25	324.57	0.10	124.19	124.17	-0.01	320.84	320.82	-0.01	120.50	120.50	-0.01	3.97	3.97	0.00	8.61	8.94	3.76
1999	356.67	354.69	-0.55	331.02	331.36	0.10	134.66	134.64	-0.01	331.98	331.96	-0.01	123.04	123.03	-0.01	4.03	4.03	0.00	9.61	9.95	3.59
2000	326.25	324.09	-0.66	327.00	327.37	0.12	137.90	137.89	-0.01	320.94	320.92	-0.01	119.76	119.75	-0.01	4.00	4.00	0.00	11.08	11.46	3.42
2001	281.35	279.15	-0.78	344.41	344.79	0.11	123.86	123.84	-0.01	322.59	322.58	-0.01	119.27	119.27	-0.01	4.04	4.04	0.00	7.87	8.26	4.87
2002	262.40	260.10	-0.88	338.48	338.89	0.12	95.68	95.66	-0.02	300.57	300.55	-0.01	114.94	114.93	-0.01	3.90	3.90	0.00	10.14	10.54	3.97
2003	297.39	294.97	-0.81	343.52	343.94	0.12	78.17	78.15	-0.02	313.34	313.32	-0.01	117.36	117.35	-0.01	3.99	3.99	0.00	14.81	15.23	2.86
2004	336.01	333.41	-0.77	339.25	339.70	0.13	69.74	69.72	-0.03	321.43	321.41	-0.01	120.16	120.16	-0.01	3.99	3.99	0.00	13.67	14.12	3.32
2005	362.04	359.37	-0.74	344.96	344.95	0.00	71.13	71.11	-0.03	335.65	335.63	-0.01	121.35	121.34	-0.01	4.13	4.13	0.00	14.14	14.61	3.30
2006	384.25	381.47	-0.72	349.81	349.75	-0.02	67.98	67.96	-0.03	336.40	336.37	-0.01	121.90	121.89	-0.01	4.12	4.12	0.00	13.55	14.03	3.59
2007	452.50	449.65	-0.63	355.70	356.19	0.14	69.47	69.45	-0.04	343.80	343.77	-0.01	121.80	121.79	-0.01	4.21	4.21	0.00	15.93	16.43	3.12
2008	708.15	704.95	-0.45	363.01	362.95	-0.02	77.09	77.06	-0.03	356.17	356.14	-0.01	123.88	123.87	-0.01	4.29	4.29	0.00	15.61	16.17	3.59
2009	580.83	577.60	-0.56	361.93	361.86	-0.02	79.75	79.73	-0.04	348.88	348.85	-0.01	121.70	121.69	-0.01	4.28	4.28	0.00	17.01	17.58	3.33
Mean	**375.31**	**373.53**	**-0.47**	**307.54**	**307.73**	**0.06**	**99.47**	**99.45**	**-0.01**	**301.30**	**301.28**	**0.00**	**118.61**	**118.60**	**-0.01**	**3.79**	**3.79**	**0.00**	**9.08**	**9.38**	**3.27**
S.D	**88.59**	**88.24**	**0.20**	**38.44**	**38.48**	**0.05**	**24.41**	**24.41**	**0.01**	**31.53**	**31.52**	**0.00**	**2.59**	**2.59**	**0.00**	**0.33**	**0.33**	**0.00**	**3.90**	**4.04**	**0.98**
C.V.	**0.24**	**0.24**	**-0.43**	**0.12**	**0.13**	**0.85**	**0.25**	**0.25**	**-0.79**	**0.10**	**0.10**	**-0.45**	**0.02**	**0.02**	**-0.49**	**0.09**	**0.09**	**-4.74**	**0.43**	**0.43**	**0.30**

Table B.2: Baseline versus Scenario 2 (25% of subsidy into R&D Expenditure)

(a) Malaysia																					
Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Import Quantity		
	Baseline (MYR/Mt)	Scenario 2 (MYR/Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)
1982	826.11	822.91	-0.39	1.45	1.45	0.02	0.31	0.47	50.85	1.08	1.48	36.71	0.65	0.65	0.00	2.57	3.51	36.71	0.37	0.13	-65.09
1983	708.51	668.97	-5.58	1.52	1.52	0.24	0.31	0.50	58.88	1.14	1.60	40.72	0.65	0.64	0.00	2.72	3.83	40.77	0.39	0.11	-71.36
1984	634.72	630.55	-0.66	1.59	1.59	0.02	0.17	0.37	124.21	1.02	1.54	51.04	0.63	0.63	0.00	2.48	3.75	51.17	0.42	0.10	-75.11
1985	652.19	593.99	-8.92	1.52	1.52	0.35	0.32	0.56	75.99	1.25	1.86	48.67	0.64	0.64	0.00	2.98	4.44	48.76	0.42	0.06	-86.28
1986	613.64	476.56	-22.34	1.52	1.52	0.45	0.18	0.44	152.73	1.17	1.84	58.30	0.64	0.64	0.00	2.79	4.42	58.48	0.21	0.00	-100.00
1987	528.60	390.52	-26.12	1.35	1.36	0.93	0.11	0.40	261.41	1.09	1.82	66.80	0.63	0.63	0.00	2.67	4.46	67.47	0.19	0.00	-100.00
1988	770.73	601.62	-21.94	1.43	1.45	1.07	0.11	0.43	300.42	1.14	1.97	72.02	0.65	0.65	0.00	2.70	4.65	72.48	0.29	0.00	-100.00
1989	938.60	799.09	-14.86	1.51	1.52	0.84	0.13	0.47	249.59	1.17	2.01	72.23	0.62	0.62	0.00	2.88	4.98	72.72	0.36	0.00	-100.00
1990	971.35	623.88	-35.77	1.48	1.51	2.13	0.23	0.61	168.16	1.28	2.24	75.20	0.65	0.65	0.00	3.03	5.31	75.63	0.30	0.00	-100.00
1991	878.41	670.86	-23.63	1.53	1.55	1.23	0.23	0.64	178.43	1.16	2.19	89.01	0.66	0.65	0.00	2.72	5.17	89.94	0.36	0.00	-100.00
1992	809.85	570.33	-29.58	1.58	1.60	1.37	0.30	0.73	145.81	1.19	2.28	92.68	0.66	0.65	0.00	2.77	5.37	93.42	0.47	0.00	-100.00
1993	731.66	523.50	-28.45	1.65	1.67	1.14	0.34	0.81	136.45	1.30	2.48	90.34	0.67	0.67	0.00	2.99	5.72	91.08	0.39	0.00	-100.00
1994	861.88	653.08	-24.23	1.71	1.73	1.11	0.28	0.77	174.38	1.34	2.57	92.28	0.67	0.67	0.00	3.07	5.92	92.96	0.31	0.00	-100.00
1995	827.65	618.98	-25.21	1.72	1.73	1.10	0.30	0.80	170.95	1.34	2.62	95.49	0.67	0.67	0.00	3.09	6.05	96.18	0.40	0.00	-100.00
1996	968.64	688.30	-28.94	1.70	1.73	1.49	0.46	0.99	114.77	1.31	2.65	102.39	0.66	0.66	0.00	3.03	6.15	103.11	0.56	0.00	-100.00
1997	1052.74	783.60	-25.57	1.84	1.86	1.33	0.53	1.09	104.62	1.29	2.70	109.43	0.66	0.66	0.00	3.01	6.32	110.36	0.63	0.00	-100.00
1998	1386.58	1116.43	-19.48	1.94	1.96	1.26	0.48	1.05	120.54	1.26	2.71	115.29	0.64	0.64	0.00	3.02	6.53	116.30	0.63	0.00	-100.00
1999	1266.45	923.05	-27.12	1.95	1.98	1.60	0.42	1.04	147.53	1.28	2.85	122.59	0.65	0.65	0.00	3.01	6.72	123.62	0.62	0.00	-100.00
2000	1180.51	908.73	-23.02	1.95	1.97	1.27	0.49	1.16	137.93	1.42	3.12	119.97	0.67	0.66	0.00	3.26	7.21	121.14	0.59	0.00	-100.00
2001	1034.91	762.29	-26.34	2.01	2.03	1.23	0.45	1.14	153.58	1.36	3.11	128.13	0.65	0.65	0.00	3.23	7.40	129.24	0.61	0.00	-100.00
2002	1122.04	674.37	-39.90	2.01	2.05	2.02	0.32	1.07	234.60	1.41	3.29	134.18	0.66	0.66	0.00	3.27	7.70	135.28	0.48	0.00	-100.00
2003	1107.12	825.03	-25.48	2.03	2.06	1.26	0.26	1.06	313.14	1.49	3.52	136.75	0.68	0.68	0.00	3.37	8.02	138.26	0.48	0.00	-100.00
2004	1062.47	771.32	-27.40	2.05	2.08	1.29	0.32	1.15	254.40	1.44	3.52	144.91	0.66	0.66	0.00	3.34	8.22	146.17	0.69	0.00	-100.00
2005	1173.01	885.82	-24.48	2.15	2.18	1.21	0.36	1.21	238.85	1.44	3.59	149.29	0.66	0.66	0.00	3.36	8.41	150.54	0.75	0.00	-100.00
2006	1217.52	846.06	-30.51	2.17	2.20	1.56	0.45	1.33	194.70	1.40	3.62	159.40	0.65	0.65	0.00	3.30	8.61	160.69	0.87	0.00	-100.00
2007	1334.89	991.10	-25.75	2.35	2.38	1.33	0.61	1.52	149.86	1.47	3.77	156.36	0.65	0.64	0.00	3.49	9.01	157.94	1.04	0.00	-100.00
2008	2465.68	1922.72	-22.02	2.50	2.55	1.97	0.73	1.69	131.86	1.54	3.97	158.31	0.66	0.66	0.00	3.58	9.30	159.83	1.08	0.00	-100.00
2009	1786.37	1418.50	-20.59	2.55	2.58	1.31	0.71	1.74	144.91	1.63	4.24	159.43	0.68	0.68	0.00	3.72	9.73	161.47	0.90	0.00	-100.00
Mean	**1032.60**	**791.51**	**-23.35**	**1.81**	**1.83**	**1.20**	**0.35**	**0.90**	**155.19**	**1.30**	**2.69**	**106.57**	**0.65**	**0.65**	**0.00**	**3.05**	**6.32**	**107.09**	**0.53**	**0.01**	**-97.29**
S.D	**393.68**	**302.90**	**9.22**	**0.33**	**0.34**	**0.54**	**0.16**	**0.39**	**67.30**	**0.15**	**0.79**	**38.65**	**0.01**	**0.01**	**0.00**	**0.31**	**1.80**	**39.14**	**0.23**	**0.04**	**9.57**
C.V.	**0.38**	**0.38**	**-0.39**	**0.18**	**0.19**	**0.45**	**0.47**	**0.44**	**0.43**	**0.12**	**0.29**	**0.36**	**0.02**	**0.02**	**-0.64**	**0.10**	**0.29**	**0.37**	**0.44**	**2.59**	**-0.10**

Table B.2 (continued)

(b) Thailand																					
Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
	Baseline (THB/Mt)	Scenario 2 (THB/Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)
1982	6750.90	6719.41	-0.47	8.12	8.12	0.01	1.34	1.34	0.00	11.14	11.14	0.00	8.94	8.94	0.00	1.89	1.89	0.00	3.69	3.69	-0.02
1983	6339.84	6303.73	-0.57	8.27	8.27	0.01	1.44	1.44	-0.01	12.93	12.93	0.00	9.63	9.63	0.00	2.04	2.04	0.00	4.55	4.55	-0.03
1984	5969.29	5927.28	-0.70	8.49	8.50	0.01	2.08	2.08	-0.01	13.12	13.12	-0.01	9.61	9.61	0.00	2.07	2.07	0.00	3.98	3.97	-0.04
1985	5891.61	5836.01	-0.94	8.62	8.63	0.01	2.50	2.50	-0.01	13.37	13.37	-0.01	9.83	9.83	0.00	2.06	2.06	0.00	4.33	4.33	-0.05
1986	5102.45	5050.68	-1.01	8.34	8.35	0.01	2.27	2.27	-0.01	12.45	12.45	-0.01	9.66	9.65	0.00	1.95	1.95	0.00	4.34	4.28	-1.34
1987	5240.60	5178.49	-1.19	8.50	8.50	0.02	1.14	1.14	-0.02	12.17	12.17	-0.01	9.15	9.15	0.00	2.01	2.01	0.00	4.79	4.79	-0.05
1988	6952.80	6884.21	-0.99	8.25	8.25	0.02	0.90	0.90	-0.04	14.07	14.07	-0.01	9.93	9.93	0.00	2.15	2.15	0.00	6.06	6.06	-0.05
1989	7691.03	7619.76	-0.93	8.57	8.57	0.02	1.98	1.98	-0.02	13.58	13.58	-0.01	9.87	9.87	0.00	2.09	2.09	0.00	3.93	3.92	-0.08
1990	6908.66	6830.53	-1.13	8.40	8.40	0.02	0.94	0.94	-0.04	11.36	11.36	-0.02	8.81	8.80	0.00	1.96	1.96	0.00	4.90	4.89	-0.32
1991	7460.79	7375.84	-1.14	8.40	8.40	0.02	1.14	1.14	-0.04	13.54	13.54	-0.02	9.10	9.10	0.00	2.25	2.25	0.00	4.94	4.93	-0.08
1992	6777.41	6688.09	-1.32	8.50	8.50	0.02	0.81	0.81	-0.06	13.16	13.16	-0.02	9.17	9.17	0.00	2.17	2.17	0.00	4.98	4.98	-0.08
1993	6006.15	5910.18	-1.60	8.50	8.50	0.03	0.25	0.25	-0.20	12.64	12.64	-0.02	8.65	8.65	0.00	2.21	2.21	0.00	6.55	6.54	-0.06
1994	6743.43	6643.72	-1.48	8.25	8.25	0.03	0.20	0.20	-0.28	14.18	14.18	-0.02	9.23	9.23	0.00	2.33	2.33	0.00	5.99	5.98	-0.08
1995	7953.53	7851.28	-1.29	8.44	8.45	0.03	0.87	0.87	-0.07	14.52	14.51	-0.02	9.11	9.11	0.00	2.41	2.41	0.00	5.38	5.38	-0.09
1996	8546.68	8438.91	-1.26	8.59	8.59	0.03	0.70	0.70	-0.08	13.65	13.65	-0.02	9.26	9.26	0.00	2.23	2.23	0.00	8.89	8.86	-0.26
1997	9474.55	9334.78	-1.48	8.80	8.80	0.04	1.04	1.04	-0.06	15.46	15.46	-0.02	9.91	9.90	0.00	2.36	2.36	0.00	6.33	6.32	-0.09
1998	12639.43	12456.64	-1.45	8.90	8.90	0.05	1.08	1.08	-0.07	15.69	15.69	-0.03	9.97	9.96	0.00	2.39	2.39	0.00	6.76	6.76	-0.11
1999	9434.38	9254.32	-1.91	9.05	9.05	0.04	1.94	1.94	-0.06	16.41	16.40	-0.03	9.91	9.91	0.00	2.51	2.51	0.00	9.64	9.60	-0.41
2000	8228.25	8020.49	-2.52	9.25	9.25	0.05	2.23	2.23	-0.05	16.96	16.96	-0.04	9.84	9.83	0.00	2.61	2.61	0.00	7.45	7.44	-0.13
2001	7681.87	7449.07	-3.03	9.40	9.41	0.06	3.12	3.12	-0.04	17.52	17.52	-0.04	10.14	10.14	0.00	2.62	2.62	0.00	7.25	7.24	-0.15
2002	8175.30	7935.22	-2.94	9.46	9.47	0.06	3.32	3.32	-0.04	17.31	17.31	-0.04	10.23	10.22	0.00	2.57	2.57	0.00	7.64	7.63	-0.15
2003	8193.03	7938.86	-3.10	9.47	9.48	0.06	1.70	1.70	-0.09	18.00	17.99	-0.05	10.31	10.31	0.00	2.65	2.65	0.00	10.13	10.12	-0.12
2004	9837.92	9587.26	-2.55	9.48	9.49	0.06	2.31	2.30	-0.07	17.33	17.32	-0.05	9.98	9.97	0.00	2.63	2.63	0.00	11.57	11.44	-1.17
2005	11497.08	11239.89	-2.24	9.55	9.55	0.06	3.63	3.62	-0.05	18.37	18.36	-0.05	10.31	10.31	0.00	2.70	2.70	0.00	10.49	10.40	-0.92
2006	11456.12	11207.42	-2.17	9.78	9.79	0.06	2.51	2.51	-0.07	18.24	18.23	-0.05	10.26	10.26	-0.01	2.69	2.69	0.00	12.72	12.65	-0.54
2007	11456.25	11222.43	-2.04	9.60	9.61	0.05	2.70	2.70	-0.07	19.76	19.75	-0.05	10.81	10.80	0.00	2.77	2.77	0.00	13.99	13.83	-1.17
2008	23245.70	22992.77	-1.09	9.50	9.51	0.06	4.81	4.81	-0.04	19.96	19.95	-0.04	10.86	10.85	0.00	2.78	2.78	0.00	12.68	12.68	0.01
2009	16974.67	16710.87	-1.55	10.20	10.21	0.06	6.13	6.13	-0.03	20.41	20.40	-0.04	11.02	11.02	0.00	2.81	2.81	0.00	10.67	10.46	-1.94
Mean	**8879.63**	**8736.00**	**-1.62**	**8.88**	**8.89**	**0.04**	**1.97**	**1.97**	**-0.04**	**15.26**	**15.26**	**-0.03**	**9.77**	**9.77**	**0.00**	**2.35**	**2.35**	**0.00**	**7.31**	**7.28**	**-0.44**
S.D	**3828.28**	**3772.00**	**0.74**	**0.57**	**0.58**	**0.02**	**1.35**	**1.35**	**0.06**	**2.71**	**2.71**	**0.02**	**0.62**	**0.62**	**0.00**	**0.29**	**0.29**	**0.00**	**3.05**	**3.02**	**0.50**
C.V.	**0.43**	**0.43**	**-0.46**	**0.06**	**0.06**	**0.52**	**0.68**	**0.68**	**-1.36**	**0.18**	**0.18**	**-0.56**	**0.06**	**0.06**	**-0.64**	**0.12**	**0.12**	**4.58**	**0.42**	**0.41**	**-1.13**

Table B.2 (continued)

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
(c) Vietnam																					
	Baseline (VND/Mt)	Scenario 2 (VND/Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)
1982	524.19	522.04	-0.41	9.65	9.65	0.00	0.15	0.15	0.00	9.75	9.75	0.00	5.70	5.70	0.00	2.59	2.59	0.00	2.62	2.62	-0.03
1983	448.16	445.65	-0.56	10.23	10.23	0.00	0.16	0.16	0.00	10.01	10.00	-0.14	5.74	5.74	0.00	2.64	2.64	-0.14	0.53	0.52	-2.99
1984	3423.37	3400.45	-0.67	10.74	10.75	0.00	0.16	0.16	0.00	10.49	10.49	0.00	5.85	5.85	0.00	2.72	2.72	0.00	1.09	1.09	-0.31
1985	5599.16	5550.85	-0.86	10.57	10.57	0.00	0.16	0.16	0.00	10.22	10.22	0.00	5.83	5.83	0.00	2.65	2.65	0.00	3.56	3.55	-0.38
1986	3688.28	3643.50	-1.21	9.54	9.54	0.00	0.15	0.15	0.00	9.55	9.55	0.08	5.69	5.69	0.00	2.54	2.54	0.08	0.02	0.02	-1.25
1987	11069.84	10880.80	-1.71	11.25	11.25	0.00	0.17	0.17	0.00	11.43	11.43	0.00	5.77	5.77	0.00	3.00	3.00	0.00	0.16	0.16	-0.04
1988	168601.30	166956.39	-0.98	10.50	10.50	0.00	0.16	0.16	0.00	11.95	11.95	0.00	6.02	6.02	0.00	3.01	3.01	0.00	6.98	6.93	-0.78
1989	909421.73	897043.26	-1.36	10.93	10.94	0.03	0.17	0.17	0.00	12.66	12.66	0.00	6.08	6.08	0.00	3.16	3.16	0.00	1.71	1.71	-0.22
1990	1211896.55	1192100.67	-1.63	11.18	11.18	0.05	0.17	0.17	-0.01	12.27	12.27	0.00	6.30	6.30	0.00	2.95	2.95	0.00	1.09	1.08	-0.58
1991	2265479.50	2232062.84	-1.48	12.54	12.55	0.08	0.19	0.19	-0.02	14.49	14.48	-0.01	6.50	6.50	0.00	3.38	3.38	0.00	1.93	1.92	-0.57
1992	2395569.83	2356175.02	-1.64	12.86	12.87	0.09	0.20	0.20	-0.03	14.44	14.44	-0.01	6.62	6.62	0.00	3.31	3.31	0.00	1.58	1.56	-0.87
1993	2242739.22	2202405.60	-1.80	13.58	13.59	0.09	0.21	0.21	-0.05	15.83	15.82	-0.02	6.63	6.63	0.00	3.62	3.62	0.00	2.24	2.22	-0.68
1994	2335602.24	2292128.63	-1.86	13.74	13.75	0.10	0.21	0.21	-0.06	16.03	16.02	-0.03	6.80	6.80	0.00	3.57	3.57	0.00	2.29	2.27	-0.75
1995	2925380.40	2880082.49	-1.55	14.40	14.41	0.09	0.25	0.25	-0.07	17.44	17.43	-0.03	7.11	7.11	0.00	3.72	3.72	0.00	3.00	2.98	-0.63
1996	3132102.74	3085187.62	-1.50	14.48	14.49	0.10	0.45	0.45	-0.05	17.90	17.90	-0.04	7.00	7.00	0.00	3.87	3.87	0.00	3.23	3.21	-0.64
1997	2841745.11	2789679.90	-1.83	15.00	15.02	0.10	0.77	0.77	-0.03	19.03	19.02	-0.04	7.35	7.35	0.00	3.92	3.92	0.00	3.71	3.69	-0.63
1998	3629661.37	3571023.05	-1.62	15.50	15.52	0.11	0.88	0.88	-0.03	19.98	19.97	-0.05	7.53	7.52	0.00	4.02	4.02	0.00	4.37	4.34	-0.62
1999	3177771.61	3111379.50	-2.09	17.55	17.57	0.11	0.92	0.92	-0.04	20.75	20.74	-0.05	7.60	7.59	0.00	4.14	4.14	0.00	3.17	3.13	-0.98
2000	2736866.82	2663486.98	-2.68	16.93	16.95	0.13	0.97	0.97	-0.04	20.30	20.28	-0.06	7.43	7.42	0.00	4.14	4.14	0.00	3.32	3.29	-1.04
2001	2469305.95	2392152.14	-3.12	17.97	17.99	0.13	0.84	0.84	-0.05	20.91	20.90	-0.07	7.43	7.42	-0.01	4.27	4.27	0.00	3.09	3.05	-1.22
2002	3397235.81	3311845.18	-2.51	17.45	17.48	0.15	1.16	1.16	-0.05	21.42	21.40	-0.08	7.43	7.42	-0.01	4.37	4.37	0.00	8.54	8.43	-1.35
2003	2897806.40	2802781.21	-3.28	18.24	18.27	0.16	1.02	1.02	-0.06	21.98	21.96	-0.09	7.43	7.43	-0.01	4.48	4.48	0.00	3.89	3.84	-1.23
2004	3664086.62	3565959.56	-2.68	17.60	17.63	0.17	1.29	1.29	-0.05	22.62	22.60	-0.10	7.42	7.41	-0.01	4.62	4.62	0.00	4.76	4.71	-1.08
2005	4219860.53	4118449.25	-2.40	18.40	18.43	0.17	1.31	1.31	-0.06	22.69	22.67	-0.11	7.29	7.28	-0.01	4.72	4.72	0.00	4.27	4.22	-1.29
2006	4378584.39	4273582.22	-2.40	18.78	18.81	0.17	1.39	1.39	-0.06	22.90	22.87	-0.12	7.19	7.19	-0.01	4.82	4.82	0.00	4.04	3.98	-1.46
2007	5256509.90	5147416.24	-2.08	19.40	19.44	0.17	2.02	2.02	-0.05	24.40	24.37	-0.13	7.42	7.41	-0.01	4.98	4.98	0.00	4.37	4.30	-1.46
2008	9930875.48	9807101.23	-1.25	19.01	19.05	0.20	1.96	1.96	-0.05	24.37	24.33	-0.14	7.33	7.32	-0.01	5.04	5.04	0.00	5.41	5.34	-1.31
2009	7606237.04	7474935.29	-1.73	19.15	19.19	0.21	1.47	1.47	-0.08	25.01	24.97	-0.15	7.42	7.41	-0.01	5.11	5.11	0.00	6.34	6.27	-1.20
Mean	**2636360.48**	**2584227.77**	**-1.98**	**14.54**	**14.56**	**0.11**	**0.68**	**0.68**	**-0.05**	**17.17**	**17.16**	**-0.06**	**6.78**	**6.78**	**0.00**	**3.76**	**3.76**	**0.00**	**3.26**	**3.23**	**-0.97**
S.D	**2331940.89**	**2293802.59**	**0.73**	**3.41**	**3.43**	**0.07**	**0.59**	**0.59**	**0.03**	**5.19**	**5.18**	**0.06**	**0.69**	**0.69**	**0.00**	**0.82**	**0.82**	**0.03**	**2.01**	**1.99**	**0.58**
C.V.	**0.88**	**0.89**	**-0.37**	**0.23**	**0.24**	**0.62**	**0.88**	**0.88**	**-0.54**	**0.30**	**0.30**	**-0.89**	**0.10**	**0.10**	**-1.04**	**0.22**	**0.22**	**-18.16**	**0.62**	**0.62**	**-0.60**

Table B.2 (continued)

(d) Pakistan

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
	Baseline (PAK/Mt)	Scenario 2 (PAK/Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)
1982	4086.92	4070.70	-0.40	2.25	2.25	0.01	0.48	0.48	0.00	3.41	3.41	0.00	1.96	1.96	0.00	2.64	2.64	0.00	3.36	3.36	0.00
1983	3601.90	3581.31	-0.57	2.12	2.12	0.01	0.53	0.53	-0.01	3.31	3.31	-0.01	1.98	1.98	0.00	2.53	2.53	0.00	1.15	1.15	-0.03
1984	4677.45	4652.49	-0.53	2.20	2.20	0.01	0.81	0.81	0.00	3.29	3.29	-0.01	1.98	1.98	0.00	2.51	2.51	0.00	3.01	3.01	-0.01
1985	4877.55	4844.94	-0.67	1.86	1.86	0.02	0.58	0.58	-0.01	2.90	2.90	-0.01	1.85	1.85	0.00	2.37	2.37	0.00	2.90	2.90	-0.01
1986	4307.54	4274.76	-0.76	2.05	2.07	0.82	0.72	0.72	-0.01	3.52	3.52	-0.01	2.08	2.08	0.00	2.56	2.55	-0.14	1.33	1.30	-1.85
1987	4070.22	4028.21	-1.03	2.14	2.14	0.02	0.81	0.81	-0.01	3.22	3.21	-0.01	1.95	1.95	0.00	2.50	2.50	-0.01	1.13	1.13	-0.07
1988	5387.93	5339.10	-0.91	2.10	2.10	0.03	1.13	1.13	-0.01	3.21	3.21	-0.01	2.05	2.05	0.00	2.37	2.37	0.00	0.80	0.80	-0.37
1989	7449.50	7392.54	-0.76	2.25	2.25	0.03	1.35	1.35	-0.01	3.22	3.22	-0.02	2.10	2.10	0.00	2.32	2.32	0.00	0.75	0.74	-0.14
1990	7040.86	6974.58	-0.94	2.10	2.10	0.04	1.24	1.24	-0.01	3.25	3.25	-0.02	2.11	2.10	0.00	2.34	2.34	0.00	1.26	1.26	-0.10
1991	6790.93	6711.69	-1.17	2.15	2.15	0.04	0.91	0.91	-0.01	3.24	3.24	-0.02	2.09	2.09	0.00	2.34	2.34	0.00	1.41	1.41	-0.10
1992	6819.01	6730.80	-1.29	2.25	2.25	0.04	0.86	0.86	-0.02	3.12	3.12	-0.03	1.98	1.98	0.00	2.39	2.39	0.00	0.92	0.92	-0.18
1993	8722.55	8616.01	-1.22	2.30	2.30	0.05	1.33	1.33	-0.01	4.06	4.05	-0.03	2.22	2.22	0.00	2.77	2.77	0.00	1.28	1.28	-0.16
1994	7459.46	7338.28	-1.62	2.40	2.40	0.06	0.71	0.71	-0.03	3.44	3.44	-0.03	2.12	2.12	0.00	2.46	2.46	0.00	3.39	3.39	-0.03
1995	7856.95	7727.10	-1.65	2.53	2.53	0.06	0.52	0.52	-0.05	3.99	3.99	-0.04	2.18	2.18	0.00	2.78	2.78	0.00	1.65	1.65	-0.16
1996	11562.12	11408.70	-1.33	2.55	2.55	0.07	0.44	0.44	-0.06	4.33	4.33	-0.04	2.26	2.26	0.00	2.90	2.90	0.00	1.85	1.85	-0.17
1997	11145.34	10962.13	-1.64	2.55	2.55	0.08	0.12	0.12	-0.27	4.33	4.33	-0.04	2.32	2.31	0.00	2.83	2.83	0.00	2.10	2.09	-0.17
1998	12978.26	12779.18	-1.53	2.57	2.58	0.09	0.38	0.38	-0.10	4.67	4.66	-0.05	2.42	2.42	0.00	2.92	2.92	0.00	2.48	2.40	-2.89
1999	16362.05	16126.34	-1.44	2.60	2.60	0.10	0.83	0.83	-0.06	5.11	5.11	-0.05	2.49	2.49	0.00	3.11	3.11	0.00	2.07	2.06	-0.24
2000	14267.38	13989.52	-1.95	2.61	2.62	0.12	0.58	0.58	-0.09	4.74	4.74	-0.07	2.34	2.34	0.00	3.06	3.06	0.00	2.38	2.37	-0.24
2001	13318.16	12993.68	-2.44	2.54	2.54	0.14	0.31	0.31	-0.19	3.89	3.89	-0.09	2.12	2.12	0.00	2.78	2.78	0.00	1.64	1.63	-0.39
2002	15107.67	14773.90	-2.21	2.56	2.56	0.15	0.27	0.27	-0.27	4.60	4.59	-0.09	2.28	2.28	0.00	3.05	3.05	0.00	2.08	2.07	-0.32
2003	16637.91	16284.08	-2.13	2.61	2.61	0.15	0.65	0.65	-0.12	4.91	4.91	-0.09	2.49	2.49	0.00	2.98	2.98	0.00	1.91	1.90	-0.40
2004	19172.25	18809.20	-1.89	2.56	2.56	0.16	0.31	0.31	-0.26	5.01	5.01	-0.09	2.51	2.51	0.00	3.02	3.02	0.00	2.78	2.77	-0.29
2005	19041.85	18661.28	-2.00	1.90	1.90	0.23	0.29	0.29	-0.30	5.53	5.52	-0.09	2.61	2.61	0.00	3.21	3.21	0.00	3.65	3.64	-0.23
2006	18725.60	18329.92	-2.11	2.21	2.21	0.20	0.69	0.69	-0.13	5.42	5.41	-0.10	2.56	2.56	0.00	3.21	3.21	0.00	2.81	2.80	-0.32
2007	21938.54	21527.10	-1.88	2.72	2.72	0.17	0.70	0.70	-0.14	5.70	5.69	-0.10	2.55	2.55	0.00	3.39	3.39	0.00	2.98	2.97	-0.32
2008	43383.11	42848.54	-1.23	3.49	3.50	0.17	1.20	1.20	-0.09	6.92	6.91	-0.09	2.92	2.92	0.00	3.59	3.59	0.00	2.92	2.91	-0.39
2009	35090.85	34462.13	-1.79	3.03	3.04	0.23	1.08	1.08	-0.13	6.67	6.66	-0.13	2.74	2.74	0.00	3.68	3.68	0.00	3.76	3.75	-0.38
Mean	**12567.14**	**12365.65**	**-1.60**	**2.40**	**2.40**	**0.12**	**0.71**	**0.71**	**-0.06**	**4.25**	**4.25**	**-0.06**	**2.26**	**2.26**	**0.00**	**2.81**	**2.81**	**-0.01**	**2.13**	**2.13**	**-0.35**
S.D	**9357.39**	**9197.91**	**0.57**	**0.34**	**0.34**	**0.15**	**0.34**	**0.34**	**0.09**	**1.10**	**1.10**	**0.04**	**0.27**	**0.27**	**0.00**	**0.39**	**0.39**	**0.03**	**0.91**	**0.90**	**0.60**
C.V.	**0.74**	**0.74**	**-0.36**	**0.14**	**0.14**	**1.29**	**0.48**	**0.48**	**-1.62**	**0.26**	**0.26**	**-0.67**	**0.12**	**0.12**	**-0.87**	**0.14**	**0.14**	**-5.41**	**0.42**	**0.43**	**-1.70**

Table B.2 (continued)

(e) Indonesia

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Import Quantity		
	Baseline (IND/Mt)	Scenario 2 (IND/Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)
1982	220417.92	219512.44	-0.41	24.68	24.68	0.00	3.47	3.47	0.00	24.01	24.01	0.00	9.16	9.16	0.00	4.03	4.03	0.00	1.16	1.18	1.18
1983	297698.81	296271.12	-0.48	25.46	25.46	0.00	4.36	4.36	0.00	25.94	25.94	0.00	9.76	9.76	0.00	4.09	4.09	0.00	0.42	0.42	0.29
1984	327226.01	325403.08	-0.56	26.09	26.09	0.01	4.48	4.48	0.00	26.54	26.54	0.00	9.90	9.90	0.00	4.12	4.12	0.00	0.05	0.06	5.56
1985	285640.63	283366.93	-0.80	26.74	26.74	0.01	4.56	4.56	0.00	27.02	27.02	0.00	9.90	9.90	0.00	4.20	4.20	0.00	0.02	0.03	7.07
1986	272459.00	269933.88	-0.93	27.32	27.40	0.26	3.20	3.20	0.00	26.05	26.05	0.02	9.80	9.80	0.00	4.09	4.10	0.33	0.13	0.13	0.30
1987	366959.22	362990.19	-1.08	28.05	28.06	0.01	2.29	2.29	0.00	27.09	27.09	0.00	9.80	9.80	0.00	4.25	4.25	0.00	0.05	0.05	5.74
1988	485431.49	480859.76	-0.94	28.69	28.70	0.01	2.92	2.92	0.00	29.07	29.07	0.00	10.53	10.53	0.00	4.25	4.25	0.00	0.25	0.25	1.89
1989	498474.64	493566.29	-0.98	29.41	29.41	0.01	2.95	2.95	0.00	29.37	29.37	-0.01	10.50	10.50	0.00	4.30	4.30	0.00	0.07	0.08	7.36
1990	535047.95	529420.73	-1.05	30.12	30.13	0.01	2.06	2.06	-0.01	29.05	29.04	-0.01	10.28	10.28	0.00	4.35	4.35	0.00	0.19	0.20	3.32
1991	603404.60	596911.34	-1.08	30.84	30.85	0.02	3.12	3.12	-0.01	31.35	31.35	-0.01	11.10	11.10	0.00	4.34	4.34	0.00	0.54	0.54	1.37
1992	572123.80	564985.17	-1.25	31.38	31.38	0.02	2.61	2.61	-0.01	31.32	31.32	-0.01	11.01	11.01	0.00	4.38	4.38	0.00	0.02	0.02	4.68
1993	807834.76	799923.78	-0.98	32.10	32.10	0.02	1.72	1.72	-0.02	30.32	30.32	-0.01	10.74	10.74	0.00	4.34	4.34	0.00	0.89	0.90	1.05
1994	551955.19	543388.84	-1.55	32.92	32.93	0.02	4.22	4.22	-0.01	32.34	32.33	-0.01	11.44	11.44	0.00	4.35	4.35	0.00	3.08	3.09	0.34
1995	640674.52	631446.86	-1.44	33.46	33.47	0.02	5.05	5.05	-0.01	33.22	33.21	-0.01	11.57	11.57	0.00	4.42	4.42	0.00	1.08	1.09	1.06
1996	837383.94	827423.53	-1.19	33.91	33.92	0.02	4.06	4.06	-0.01	32.09	32.08	-0.02	11.14	11.14	0.00	4.43	4.43	0.00	0.84	0.85	1.51
1997	1420080.96	1407115.69	-0.91	34.67	34.68	0.03	6.28	6.28	-0.01	31.12	31.12	-0.02	11.73	11.73	0.00	4.08	4.08	0.00	5.76	5.78	0.26
1998	2982884.75	2938629.25	-1.48	35.03	35.07	0.10	7.12	7.12	-0.01	32.15	32.15	-0.02	11.97	11.97	0.00	4.13	4.13	0.00	3.72	3.76	1.09
1999	2106093.05	2068689.78	-1.78	35.40	35.43	0.08	6.02	6.02	-0.01	32.81	32.80	-0.03	11.79	11.79	0.00	4.28	4.28	0.00	1.48	1.52	2.65
2000	1978203.24	1934583.86	-2.20	35.87	35.90	0.10	4.61	4.61	-0.02	32.98	32.96	-0.04	11.61	11.61	0.00	4.37	4.37	0.00	1.57	1.58	0.67
2001	2638333.93	2584571.30	-2.04	36.38	36.42	0.12	4.68	4.68	-0.03	32.97	32.96	-0.05	11.60	11.60	0.00	4.37	4.37	0.00	3.27	3.37	3.08
2002	1783108.72	1731072.42	-2.92	36.51	36.55	0.11	4.35	4.34	-0.04	33.43	33.41	-0.07	11.51	11.51	0.00	4.47	4.47	0.00	2.77	2.79	1.05
2003	1776162.22	1723611.25	-2.96	36.01	36.05	0.11	4.02	4.02	-0.05	35.05	35.02	-0.08	11.91	11.91	0.00	4.53	4.53	0.00	0.65	0.67	1.97
2004	2330491.99	2274786.21	-2.39	35.86	35.90	0.12	3.45	3.45	-0.07	34.85	34.82	-0.09	11.66	11.66	0.00	4.60	4.60	0.00	0.44	0.45	3.89
2005	2760119.84	2698061.98	-2.25	35.75	35.80	0.14	3.21	3.21	-0.08	34.98	34.95	-0.10	11.81	11.81	0.00	4.56	4.56	0.00	0.53	0.54	1.76
2006	2934158.00	2874027.13	-2.05	35.91	35.96	0.13	4.61	4.61	-0.06	35.33	35.29	-0.11	11.91	11.91	0.00	4.56	4.56	0.00	1.98	2.06	4.11
2007	3068035.13	3006115.40	-2.02	36.35	36.40	0.13	5.61	5.60	-0.06	37.00	36.96	-0.11	11.90	11.90	0.00	4.78	4.78	0.00	0.35	0.37	4.72
2008	4497103.28	4450881.51	-1.03	36.87	36.88	0.02	7.06	7.05	-0.05	38.32	38.28	-0.12	12.17	12.17	0.00	4.84	4.84	0.00	0.26	0.26	1.13
2009	4476461.60	4396519.60	-1.79	38.01	38.07	0.17	6.59	6.58	-0.04	36.48	36.44	-0.09	12.13	12.13	0.00	4.62	4.62	0.00	1.06	1.15	8.68
Mean	**1501927.47**	**1475502.47**	**-1.76**	**32.49**	**32.52**	**0.07**	**4.24**	**4.24**	**-0.02**	**31.51**	**31.50**	**-0.04**	**11.08**	**11.08**	**0.00**	**4.36**	**4.36**	**0.01**	**1.17**	**1.19**	**1.71**
S.D	**1288063.58**	**1264803.38**	**0.69**	**4.04**	**4.05**	**0.07**	**1.46**	**1.46**	**0.03**	**3.68**	**3.67**	**0.04**	**0.88**	**0.88**	**0.00**	**0.21**	**0.21**	**0.06**	**1.39**	**1.40**	**2.39**
C.V.	**0.86**	**0.86**	**-0.39**	**0.12**	**0.12**	**0.96**	**0.35**	**0.35**	**-1.05**	**0.12**	**0.12**	**-1.05**	**0.08**	**0.08**	**-1.62**	**0.05**	**0.05**	**5.52**	**1.19**	**1.18**	**1.39**

Table B.2 (continued)

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Import Quantity		
	Baseline (USD/Mt)	Scenario 2 (USD/Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)	Baseline (Mt)	Scenario 2 (Mt)	Change (%)
	(f) Rest of the world																				
1982	406.31	404.94	-0.34	231.67	231.90	0.10	51.18	51.18	0.00	234.84	234.84	0.00	113.77	113.77	0.00	3.08	3.08	0.00	3.46	3.70	6.88
1983	372.71	371.14	-0.42	245.22	245.48	0.11	64.77	64.76	-0.01	254.29	254.28	0.00	117.16	117.16	0.00	3.24	3.24	0.00	4.67	4.93	5.57
1984	359.20	357.42	-0.49	249.12	249.43	0.12	79.70	79.69	-0.01	261.87	261.86	0.00	115.89	115.89	-0.01	3.37	3.37	0.00	4.45	4.76	6.98
1985	312.30	310.25	-0.66	257.56	257.92	0.14	90.59	90.57	-0.01	263.16	263.14	-0.01	116.64	116.63	-0.01	3.37	3.37	0.00	5.03	5.39	7.10
1986	298.28	296.31	-0.66	259.51	259.85	0.13	98.77	98.75	-0.01	263.16	263.14	-0.01	116.87	116.86	-0.01	3.36	3.36	0.00	5.56	5.90	6.19
1987	296.35	293.93	-0.81	260.86	261.28	0.16	101.45	101.44	-0.01	259.83	259.82	-0.01	114.03	114.01	-0.01	3.40	3.40	0.00	5.68	6.11	7.42
1988	353.97	351.25	-0.77	272.77	273.24	0.17	109.39	109.37	-0.02	273.66	273.64	-0.01	117.84	117.83	-0.01	3.47	3.47	0.00	7.78	8.26	6.09
1989	363.65	360.88	-0.76	282.80	283.29	0.17	114.53	114.51	-0.02	284.91	284.89	-0.01	118.49	118.48	-0.01	3.59	3.59	0.00	5.95	6.43	8.15
1990	365.62	362.57	-0.84	290.65	291.18	0.18	122.74	122.72	-0.02	293.46	293.43	-0.01	118.55	118.54	-0.01	3.69	3.69	0.00	5.87	6.40	9.10
1991	379.65	376.32	-0.88	295.57	296.15	0.20	122.71	122.68	-0.02	288.88	288.85	-0.01	117.83	117.82	-0.01	3.66	3.66	0.00	7.38	7.96	7.88
1992	379.85	376.34	-0.93	299.16	299.77	0.20	119.94	119.91	-0.02	290.52	290.49	-0.01	116.96	116.95	-0.01	3.71	3.71	0.00	7.47	8.08	8.23
1993	351.75	347.96	-1.08	301.12	301.78	0.22	115.10	115.07	-0.02	290.86	290.83	-0.01	116.55	116.54	-0.01	3.72	3.72	0.00	6.93	7.60	9.55
1994	366.50	362.54	-1.08	305.07	305.76	0.23	114.15	114.12	-0.03	297.57	297.54	-0.01	117.40	117.39	-0.01	3.78	3.78	0.00	6.54	7.23	10.60
1995	369.36	365.25	-1.11	306.31	307.02	0.23	113.09	113.06	-0.03	298.86	298.83	-0.01	117.99	117.98	-0.01	3.78	3.78	0.00	8.56	9.28	8.38
1996	412.79	408.53	-1.03	315.68	316.42	0.23	116.64	116.60	-0.03	312.29	312.26	-0.01	119.85	119.83	-0.01	3.89	3.89	0.00	8.89	9.63	8.36
1997	399.08	394.63	-1.12	314.74	315.51	0.25	120.75	120.72	-0.03	315.59	315.55	-0.01	119.52	119.50	-0.01	3.94	3.94	0.00	8.03	9.11	13.35
1998	373.44	369.02	-1.18	324.25	325.02	0.24	124.19	124.15	-0.03	320.84	320.80	-0.01	120.50	120.49	-0.02	3.97	3.97	0.00	8.61	9.38	8.97
1999	356.67	351.91	-1.34	331.02	331.85	0.25	134.66	134.62	-0.03	331.98	331.93	-0.01	123.04	123.02	-0.02	4.03	4.03	0.00	9.61	10.44	8.66
2000	326.25	321.07	-1.59	327.00	327.90	0.28	137.90	137.86	-0.03	320.94	320.89	-0.01	119.76	119.74	-0.02	4.00	4.00	0.00	11.08	11.99	8.17
2001	281.35	276.11	-1.86	344.41	345.32	0.26	123.86	123.81	-0.03	322.59	322.55	-0.01	119.27	119.25	-0.02	4.04	4.04	0.00	7.87	8.79	11.63
2002	262.40	256.81	-2.13	338.48	339.46	0.29	95.68	95.64	-0.04	300.57	300.52	-0.02	114.94	114.92	-0.02	3.90	3.90	0.00	10.14	11.11	9.64
2003	297.39	291.26	-2.06	343.52	344.59	0.31	78.17	78.12	-0.06	313.34	313.29	-0.02	117.36	117.34	-0.02	3.99	3.99	0.00	14.81	15.88	7.23
2004	336.01	329.78	-1.85	339.25	340.34	0.32	69.74	69.69	-0.07	321.43	321.37	-0.02	120.16	120.14	-0.02	3.99	3.99	0.00	13.67	14.76	7.97
2005	362.04	355.64	-1.77	344.96	346.07	0.32	71.13	71.07	-0.08	335.65	335.59	-0.02	121.35	121.33	-0.02	4.13	4.13	0.00	14.14	15.26	7.91
2006	384.25	377.69	-1.71	349.81	350.95	0.33	67.98	67.93	-0.08	336.40	336.34	-0.02	121.90	121.88	-0.02	4.12	4.12	0.00	13.55	14.70	8.47
2007	452.50	445.73	-1.50	355.70	356.88	0.33	69.47	69.42	-0.08	343.80	343.74	-0.02	121.80	121.78	-0.02	4.21	4.21	0.00	15.93	17.11	7.44
2008	708.15	700.56	-1.07	363.01	364.33	0.36	77.09	77.02	-0.08	356.17	356.10	-0.02	123.88	123.85	-0.02	4.29	4.29	0.00	15.61	16.93	8.51
2009	580.83	573.14	-1.32	361.93	363.27	0.37	79.75	79.69	-0.08	348.88	348.81	-0.02	121.70	121.68	-0.03	4.28	4.28	0.00	17.01	18.36	7.91
Mean	**375.31**	**371.04**	**-1.14**	**307.54**	**308.28**	**0.24**	**99.47**	**99.44**	**-0.03**	**301.30**	**301.26**	**-0.01**	**118.61**	**118.59**	**-0.01**	**3.79**	**3.79**	**0.00**	**9.08**	**9.84**	**8.34**
S.D	**88.59**	**87.78**	**0.50**	**38.44**	**38.75**	**0.08**	**24.41**	**24.41**	**0.03**	**31.53**	**31.51**	**0.01**	**2.59**	**2.59**	**0.01**	**0.33**	**0.33**	**0.00**	**3.90**	**4.21**	**1.63**
C.V.	**0.24**	**0.24**	**-0.44**	**0.12**	**0.13**	**0.32**	**0.25**	**0.25**	**-0.79**	**0.10**	**0.10**	**-0.45**	**0.02**	**0.02**	**-0.47**	**0.09**	**0.09**	**4.76**	**0.43**	**0.43**	**0.20**

Table B.3: Baseline versus Scenario 3 (Removal of BERNAS-Removal of import quota and imposed ad-valorem tariffs)

(a) Malaysia

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Import Quantity		
	Baseline (MYR/Mt)	Scenario 3 (MYR/Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)
1982	826.11	991.49	20.02	1.45	1.43	-1.03	0.31	0.31	0.00	1.08	1.08	0.00	0.65	0.65	0.00	2.57	2.57	0.00	0.37	0.35	-4.07
1983	708.51	807.30	13.94	1.52	1.51	-0.59	0.31	0.31	0.27	1.14	1.14	0.19	0.65	0.65	0.00	2.72	2.72	0.02	0.39	0.38	-2.64
1984	634.72	762.26	20.09	1.59	1.56	-1.60	0.17	0.17	0.37	1.02	1.02	0.15	0.63	0.63	0.00	2.48	2.48	0.02	0.42	0.44	4.33
1985	652.19	719.05	10.25	1.52	1.51	-0.40	0.32	0.32	0.27	1.25	1.25	0.17	0.64	0.65	0.00	2.98	2.98	0.02	0.42	0.41	-1.76
1986	613.64	737.16	20.13	1.52	1.49	-2.14	0.18	0.18	0.29	1.17	1.17	0.12	0.64	0.64	0.00	2.79	2.79	0.03	0.21	0.18	-17.00
1987	528.60	634.39	20.01	1.35	1.34	-0.71	0.11	0.11	0.64	1.09	1.10	0.16	0.63	0.63	0.00	2.67	2.67	0.25	0.19	0.18	-5.50
1988	770.73	889.01	15.35	1.43	1.42	-0.75	0.11	0.11	0.62	1.14	1.15	0.15	0.65	0.65	0.00	2.70	2.70	0.07	0.29	0.28	-4.07
1989	938.60	1126.44	20.01	1.51	1.49	-1.13	0.13	0.13	0.58	1.17	1.17	0.17	0.62	0.62	0.00	2.88	2.88	0.03	0.36	0.35	-5.00
1990	971.35	996.97	2.64	1.48	1.48	-0.16	0.23	0.23	0.54	1.28	1.28	0.24	0.65	0.65	0.00	3.03	3.03	0.02	0.30	0.29	-1.41
1991	878.41	1054.21	20.01	1.53	1.51	-1.04	0.23	0.23	0.15	1.16	1.16	0.08	0.66	0.66	0.00	2.72	2.72	0.03	0.36	0.34	-4.57
1992	809.85	933.39	15.26	1.58	1.57	-0.71	0.30	0.30	0.33	1.19	1.19	0.21	0.66	0.66	0.00	2.77	2.77	0.03	0.47	0.46	-2.70
1993	731.66	878.09	20.01	1.65	1.64	-0.80	0.34	0.34	0.26	1.30	1.31	0.17	0.67	0.67	0.00	2.99	3.00	0.03	0.39	0.37	-3.79
1994	861.88	1034.37	20.01	1.71	1.69	-0.92	0.28	0.28	0.36	1.34	1.34	0.19	0.67	0.67	0.00	3.07	3.07	0.03	0.31	0.29	-5.53
1995	827.65	992.22	19.88	1.72	1.63	-4.69	0.30	0.30	0.40	1.34	1.34	0.23	0.67	0.67	0.00	3.09	3.09	0.03	0.40	0.31	-20.79
1996	968.64	1120.28	15.66	1.70	1.69	-0.81	0.46	0.46	0.25	1.31	1.31	0.23	0.66	0.67	0.00	3.03	3.03	0.03	0.56	0.55	-2.76
1997	1052.74	1263.42	20.01	1.84	1.82	-1.04	0.53	0.53	0.20	1.29	1.29	0.21	0.66	0.66	0.00	3.01	3.01	0.04	0.63	0.61	-3.28
1998	1386.58	1663.89	20.00	1.94	1.91	-1.30	0.48	0.48	0.29	1.26	1.26	0.28	0.64	0.64	0.00	3.02	3.02	0.04	0.63	0.60	-4.34
1999	1266.45	1430.93	12.99	1.95	1.94	-0.76	0.42	0.42	0.44	1.28	1.28	0.36	0.65	0.66	0.00	3.01	3.01	0.04	0.62	0.60	-2.87
2000	1180.51	1416.63	20.00	1.95	1.92	-1.10	0.49	0.49	0.29	1.42	1.42	0.25	0.67	0.67	0.00	3.26	3.26	0.04	0.59	0.57	-3.98
2001	1034.91	1241.90	20.00	2.01	1.99	-0.93	0.45	0.45	0.38	1.36	1.37	0.32	0.65	0.65	0.00	3.23	3.23	0.04	0.61	0.59	-3.49
2002	1122.04	1159.02	3.30	2.01	2.00	-0.68	0.32	0.32	0.51	1.41	1.41	0.29	0.66	0.66	0.00	3.27	3.27	0.04	0.48	0.46	-3.36
2003	1107.12	1328.59	20.00	2.03	2.01	-0.99	0.26	0.26	0.22	1.49	1.49	0.10	0.68	0.68	0.00	3.37	3.37	0.04	0.48	0.46	-4.40
2004	1062.47	1274.98	20.00	2.05	2.03	-0.94	0.32	0.33	0.46	1.44	1.44	0.26	0.66	0.66	0.00	3.34	3.34	0.04	0.69	0.66	-3.14
2005	1173.01	1407.64	20.00	2.15	2.13	-0.99	0.36	0.36	0.46	1.44	1.45	0.29	0.66	0.66	0.00	3.36	3.36	0.05	0.75	0.73	-3.17
2006	1217.52	1461.07	20.00	2.17	2.14	-1.02	0.45	0.45	0.39	1.40	1.40	0.32	0.65	0.65	0.00	3.30	3.31	0.05	0.87	0.84	-2.86
2007	1334.89	1600.58	19.90	2.35	2.33	-1.03	0.61	0.61	0.32	1.47	1.48	0.34	0.65	0.65	0.00	3.49	3.49	0.06	1.04	1.01	-2.61
2008	2465.68	2958.96	20.01	2.50	2.46	-1.79	0.73	0.73	0.30	1.54	1.54	0.36	0.66	0.66	0.00	3.58	3.58	0.06	1.08	1.04	-4.43
2009	1786.37	2143.69	20.00	2.55	2.52	-1.27	0.71	0.72	0.54	1.63	1.64	0.60	0.68	0.68	0.00	3.72	3.72	0.05	0.90	0.86	-4.27
Mean	**1032.60**	**1215.28**	**17.69**	**1.81**	**1.79**	**-1.13**	**0.35**	**0.35**	**0.35**	**1.30**	**1.30**	**0.24**	**0.65**	**0.66**	**0.00**	**3.05**	**3.05**	**0.04**	**0.53**	**0.51**	**-3.96**
S.D	**393.68**	**477.87**	**4.90**	**0.33**	**0.33**	**0.80**	**0.16**	**0.16**	**0.15**	**0.15**	**0.15**	**0.11**	**0.01**	**0.01**	**0.00**	**0.31**	**0.31**	**0.04**	**0.23**	**0.23**	**4.50**
C.V.	**0.38**	**0.39**	**0.28**	**0.18**	**0.18**	**-0.71**	**0.47**	**0.47**	**0.43**	**0.12**	**0.12**	**0.47**	**0.02**	**0.02**	**0.64**	**0.10**	**0.10**	**0.92**	**0.44**	**0.45**	**-1.14**

Table B.3 (continued)

(b) Thailand																					
Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
	Baseline (THB/Mt)	Scenario 3 (THB/Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)
1982	6750.90	6748.93	-0.03	8.12	8.12	0.00	1.34	1.34	0.00	11.14	11.14	0.00	8.94	8.94	0.00	1.89	1.89	0.00	3.69	3.69	0.00
1983	6339.84	6338.51	-0.02	8.27	8.27	0.00	1.44	1.44	0.00	12.93	12.93	0.00	9.63	9.63	0.00	2.04	2.04	0.00	4.55	4.55	0.00
1984	5969.29	5971.74	0.04	8.49	8.49	0.00	2.08	2.08	0.00	13.12	13.12	0.00	9.61	9.61	0.00	2.07	2.07	0.00	3.98	3.98	0.00
1985	5891.61	5890.46	-0.02	8.62	8.62	0.00	2.50	2.50	0.00	13.37	13.37	0.00	9.83	9.83	0.00	2.06	2.06	0.00	4.33	4.33	0.00
1986	5102.45	5106.65	0.08	8.34	8.34	0.00	2.27	2.27	0.00	12.45	12.45	0.00	9.66	9.66	0.00	1.95	1.95	0.00	4.34	4.34	0.00
1987	5240.60	5239.01	-0.03	8.50	8.50	0.00	1.14	1.14	0.00	12.17	12.17	0.00	9.15	9.15	0.00	2.01	2.01	0.00	4.79	4.80	0.00
1988	6952.80	6951.12	-0.02	8.25	8.25	0.00	0.90	0.90	0.00	14.07	14.07	0.00	9.93	9.93	0.00	2.15	2.15	0.00	6.06	6.06	0.00
1989	7691.03	7688.40	-0.03	8.57	8.57	0.00	1.98	1.98	0.00	13.58	13.58	0.00	9.87	9.87	0.00	2.09	2.09	0.00	3.93	3.93	0.00
1990	6908.66	6908.08	-0.01	8.40	8.40	0.00	0.94	0.94	0.00	11.36	11.36	0.00	8.81	8.81	0.00	1.96	1.96	0.00	4.90	4.90	0.00
1991	7460.79	7458.46	-0.03	8.40	8.40	0.00	1.14	1.14	0.00	13.54	13.54	0.00	9.10	9.10	0.00	2.25	2.25	0.00	4.94	4.94	0.00
1992	6777.41	6775.65	-0.03	8.50	8.50	0.00	0.81	0.81	0.00	13.16	13.16	0.00	9.17	9.17	0.00	2.17	2.17	0.00	4.98	4.98	0.00
1993	6006.15	6004.12	-0.03	8.50	8.50	0.00	0.25	0.25	0.00	12.64	12.64	0.00	8.65	8.65	0.00	2.21	2.21	0.00	6.55	6.56	0.22
1994	6743.43	6741.06	-0.04	8.25	8.25	0.00	0.20	0.20	-0.01	14.18	14.18	0.00	9.23	9.23	0.00	2.33	2.33	0.00	5.99	5.99	0.00
1995	7953.53	7942.20	-0.14	8.44	8.44	0.00	0.87	0.87	0.00	14.52	14.52	0.00	9.11	9.11	0.00	2.41	2.41	0.00	5.38	5.38	-0.01
1996	8546.68	8544.65	-0.02	8.59	8.59	0.00	0.70	0.70	-0.01	13.65	13.65	0.00	9.26	9.26	0.00	2.23	2.23	0.00	8.89	8.90	0.16
1997	9474.55	9471.07	-0.04	8.80	8.80	0.00	1.04	1.04	0.00	15.46	15.46	0.00	9.91	9.91	0.00	2.36	2.36	0.00	6.33	6.33	0.00
1998	12639.43	12633.56	-0.05	8.90	8.90	0.00	1.08	1.08	0.00	15.69	15.69	0.00	9.97	9.97	0.00	2.39	2.39	0.00	6.76	6.76	0.00
1999	9434.38	9430.98	-0.04	9.05	9.05	0.00	1.94	1.94	0.00	16.41	16.41	0.00	9.91	9.91	0.00	2.51	2.51	0.00	9.64	9.64	-0.01
2000	8228.25	8223.39	-0.06	9.25	9.25	0.00	2.23	2.23	0.00	16.96	16.96	0.00	9.84	9.84	0.00	2.61	2.61	0.00	7.45	7.45	0.00
2001	7681.87	7677.10	-0.06	9.40	9.40	0.00	3.12	3.12	0.00	17.52	17.52	0.00	10.14	10.14	0.00	2.62	2.62	0.00	7.25	7.25	0.00
2002	8175.30	8171.90	-0.04	9.46	9.46	0.00	3.32	3.32	0.00	17.31	17.31	0.00	10.23	10.23	0.00	2.57	2.57	0.00	7.64	7.64	0.00
2003	8193.03	8188.67	-0.05	9.47	9.47	0.00	1.70	1.70	0.00	18.00	18.00	0.00	10.31	10.31	0.00	2.65	2.65	0.00	10.13	10.13	0.00
2004	9837.92	9833.59	-0.04	9.48	9.48	0.00	2.31	2.31	0.00	17.33	17.33	0.00	9.98	9.98	0.00	2.63	2.63	0.00	11.57	11.57	-0.02
2005	11497.08	11492.31	-0.04	9.55	9.55	0.00	3.63	3.63	0.00	18.37	18.36	0.00	10.31	10.31	0.00	2.70	2.70	0.00	10.49	10.51	0.20
2006	11456.12	11451.44	-0.04	9.78	9.78	0.00	2.51	2.51	0.00	18.24	18.24	0.00	10.26	10.26	0.00	2.69	2.69	0.00	12.72	12.74	0.18
2007	11456.25	11451.59	-0.04	9.60	9.60	0.00	2.70	2.70	0.00	19.76	19.76	0.00	10.81	10.81	0.00	2.77	2.77	0.00	13.99	13.99	-0.02
2008	23245.70	23237.02	-0.04	9.50	9.50	0.00	4.81	4.81	0.00	19.96	19.96	0.00	10.86	10.86	0.00	2.78	2.78	0.00	12.68	12.73	0.36
2009	16974.67	16968.10	-0.04	10.20	10.20	0.00	6.13	6.13	0.00	20.41	20.41	0.00	11.02	11.02	0.00	2.81	2.81	0.00	10.67	10.70	0.33
Mean	**8879.63**	**8876.42**	**-0.04**	**8.88**	**8.88**	**0.00**	**1.97**	**1.97**	**0.00**	**15.26**	**15.26**	**0.00**	**9.77**	**9.77**	**0.00**	**2.35**	**2.35**	**0.00**	**7.31**	**7.31**	**0.07**
S.D	**3828.28**	**3826.35**	**0.04**	**0.57**	**0.57**	**0.00**	**1.35**	**1.35**	**0.00**	**2.71**	**2.71**	**0.00**	**0.62**	**0.62**	**0.00**	**0.29**	**0.29**	**0.00**	**3.05**	**3.06**	**0.11**
C.V.	**0.43**	**0.43**	**-0.99**	**0.06**	**0.06**	**0.93**	**0.68**	**0.68**	**-1.84**	**0.18**	**0.18**	**-0.79**	**0.06**	**0.06**	**-0.67**	**0.12**	**0.12**	**-14.75**	**0.42**	**0.42**	**1.54**

Table B.3 (continued)

(c) Vietnam																					
Year	**Demand Price**			**Consumption Demand**			**Stocks Demand**			**Supply**			**Area Harvested**			**Yield**			**Export Quantity**		
	Baseline (VND/Mt)	**Scenario 3** (VND/Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)
1982	524.19	524.06	-0.03	9.65	9.65	0.00	0.15	0.15	0.00	9.75	9.75	0.00	5.70	5.70	0.00	2.59	2.59	0.00	2.62	2.60	-0.57
1983	448.16	448.06	-0.02	10.23	10.23	0.00	0.16	0.16	0.00	10.01	10.00	-0.14	5.74	5.74	0.00	2.64	2.64	-0.14	0.53	0.53	-0.71
1984	3423.37	3424.71	0.04	10.74	10.74	0.00	0.16	0.16	0.00	10.49	10.49	0.00	5.85	5.85	0.00	2.72	2.72	0.00	1.09	1.07	-1.65
1985	5599.16	5598.16	-0.02	10.57	10.58	0.09	0.16	0.16	0.00	10.22	10.22	0.00	5.83	5.83	0.00	2.65	2.65	0.00	3.56	3.56	-0.07
1986	3688.28	3691.91	0.10	9.54	9.54	0.00	0.15	0.15	0.00	9.55	9.55	0.00	5.69	5.69	0.00	2.54	2.54	0.00	0.02	0.02	-0.47
1987	11069.84	11065.01	-0.04	11.25	11.25	0.00	0.17	0.17	0.00	11.43	11.43	0.00	5.77	5.77	0.00	3.00	3.00	0.00	0.16	0.16	0.00
1988	168601.30	168560.92	-0.02	10.50	10.50	0.00	0.16	0.16	0.00	11.95	11.95	0.00	6.02	6.02	0.00	3.01	3.01	0.00	6.98	6.99	0.17
1989	909421.73	908965.71	-0.05	10.93	10.93	0.00	0.17	0.17	0.00	12.66	12.66	0.00	6.08	6.08	0.00	3.16	3.16	0.00	1.71	1.71	-0.01
1990	1211896.55	1211750.25	-0.01	11.18	11.18	0.00	0.17	0.17	0.00	12.27	12.27	0.00	6.30	6.30	0.00	2.95	2.95	0.00	1.09	1.09	-0.01
1991	2265479.50	2264563.26	-0.04	12.54	12.54	0.00	0.19	0.19	0.00	14.49	14.49	0.00	6.50	6.50	0.00	3.38	3.38	0.00	1.93	1.93	-0.02
1992	2395569.83	2394791.79	-0.03	12.86	12.86	0.00	0.20	0.20	0.00	14.44	14.44	0.00	6.62	6.62	0.00	3.31	3.31	0.00	1.58	1.58	-0.02
1993	2242739.22	2241885.44	-0.04	13.58	13.58	0.00	0.21	0.21	0.00	15.83	15.83	0.00	6.63	6.63	0.00	3.62	3.62	0.00	2.24	2.24	-0.01
1994	2335602.24	2334570.97	-0.04	13.74	13.74	0.00	0.21	0.21	0.00	16.03	16.03	0.00	6.80	6.80	0.00	3.57	3.57	0.00	2.29	2.29	-0.02
1995	2925380.40	2920363.36	-0.17	14.40	14.40	0.01	0.25	0.25	0.00	17.44	17.44	0.00	7.11	7.11	0.00	3.72	3.72	0.00	3.00	3.00	-0.05
1996	3132102.74	3131219.09	-0.03	14.48	14.48	0.00	0.45	0.45	0.00	17.90	17.90	0.00	7.00	7.00	0.00	3.87	3.87	0.00	3.23	3.23	-0.02
1997	2841745.11	2840451.30	-0.05	15.00	15.00	0.00	0.77	0.77	0.00	19.03	19.03	0.00	7.35	7.35	0.00	3.92	3.92	0.00	3.71	3.71	-0.02
1998	3629661.37	3627780.97	-0.05	15.50	15.50	0.00	0.88	0.88	0.00	19.98	19.98	0.00	7.53	7.53	0.00	4.02	4.02	0.00	4.37	4.37	-0.02
1999	3177771.61	3176518.17	-0.04	17.55	17.55	0.00	0.92	0.92	0.00	20.75	20.75	0.00	7.60	7.60	0.00	4.14	4.14	0.00	3.17	3.16	-0.02
2000	2736866.82	2735152.44	-0.06	16.93	16.93	0.00	0.97	0.97	0.00	20.30	20.30	0.00	7.43	7.43	0.00	4.14	4.14	0.00	3.32	3.32	-0.03
2001	2469305.95	2467724.56	-0.06	17.97	17.97	0.00	0.84	0.84	0.00	20.91	20.91	0.00	7.43	7.43	0.00	4.27	4.27	0.00	3.09	3.09	-0.03
2002	3397235.81	3396026.38	-0.04	17.45	17.45	0.00	1.16	1.16	0.00	21.42	21.42	0.00	7.43	7.43	0.00	4.37	4.37	0.00	8.54	8.54	-0.02
2003	2897806.40	2896173.48	-0.06	18.24	18.24	0.00	1.02	1.02	0.00	21.98	21.98	0.00	7.43	7.43	0.00	4.48	4.48	0.00	3.89	3.89	-0.03
2004	3664086.62	3662392.37	-0.05	17.60	17.60	0.00	1.29	1.29	0.00	22.62	22.62	0.00	7.42	7.42	0.00	4.62	4.62	0.00	4.76	4.76	-0.02
2005	4219860.53	4217980.46	-0.04	18.40	18.40	0.00	1.31	1.31	0.00	22.69	22.69	0.00	7.29	7.29	0.00	4.72	4.72	0.00	4.27	4.27	-0.03
2006	4378584.39	4376608.20	-0.05	18.78	18.78	0.00	1.39	1.39	0.00	22.90	22.90	0.00	7.19	7.19	0.00	4.82	4.82	0.00	4.04	4.04	-0.03
2007	5256509.90	5254335.54	-0.04	19.40	19.40	0.00	2.02	2.02	0.00	24.40	24.40	0.00	7.42	7.42	0.00	4.98	4.98	0.00	4.37	4.37	-0.03
2008	9930875.48	9926632.22	-0.04	19.01	19.01	0.01	1.96	1.96	0.00	24.37	24.36	0.00	7.33	7.33	0.00	5.04	5.04	0.00	5.41	5.41	-0.04
2009	7606237.04	7602967.45	-0.04	19.15	19.16	0.01	1.47	1.47	0.00	25.01	25.01	0.00	7.42	7.42	0.00	5.11	5.11	0.00	6.34	6.34	-0.03
Mean	**2636360.48**	**2635077.37**	**-0.05**	**14.54**	**14.54**	**0.01**	**0.68**	**0.68**	**0.00**	**17.17**	**17.17**	**0.00**	**6.78**	**6.78**	**0.00**	**3.76**	**3.76**	**0.00**	**3.26**	**3.26**	**-0.05**
S.D	**2331940.89**	**2330912.71**	**0.04**	**3.41**	**3.41**	**0.02**	**0.59**	**0.59**	**0.00**	**5.19**	**5.19**	**0.03**	**0.69**	**0.69**	**0.00**	**0.82**	**0.82**	**0.03**	**2.01**	**2.01**	**0.35**
C.V.	**0.88**	**0.88**	**-0.85**	**0.23**	**0.23**	**3.44**	**0.88**	**0.88**	**-0.55**	**0.30**	**0.30**	**-5.80**	**0.10**	**0.10**	**-0.98**	**0.22**	**0.22**	**-6.97**	**0.62**	**0.62**	**-6.74**

Table B.3 (continued)

(d) Pakistan

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
	Baseline (PAK/Mt)	Scenario 3 (PAK/Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)
1982	4086.92	4085.90	-0.02	2.25	2.25	0.00	0.48	0.48	0.00	3.41	3.41	0.00	1.96	1.96	0.00	2.64	2.64	0.00	3.36	3.36	0.00
1983	3601.90	3601.15	-0.02	2.12	2.12	0.00	0.53	0.53	0.00	3.31	3.31	0.00	1.98	1.98	0.00	2.53	2.53	0.00	1.15	1.15	0.00
1984	4677.45	4678.91	0.03	2.20	2.20	0.00	0.81	0.81	0.00	3.29	3.29	0.00	1.98	1.98	0.00	2.51	2.51	0.00	3.01	3.01	0.00
1985	4877.55	4876.87	-0.01	1.86	1.86	0.00	0.58	0.58	0.00	2.90	2.90	0.00	1.85	1.85	0.00	2.37	2.37	0.00	2.90	2.90	0.00
1986	4307.54	4310.20	0.06	2.05	2.05	0.00	0.72	0.72	0.00	3.52	3.52	0.00	2.08	2.08	0.00	2.56	2.56	0.00	1.33	1.33	0.00
1987	4070.22	4069.15	-0.03	2.14	2.14	0.00	0.81	0.81	0.00	3.22	3.22	0.00	1.95	1.95	0.00	2.50	2.50	0.00	1.13	1.13	0.00
1988	5387.93	5386.73	-0.02	2.10	2.10	0.00	1.13	1.13	0.00	3.21	3.21	0.00	2.05	2.05	0.00	2.37	2.37	0.00	0.80	0.80	0.00
1989	7449.50	7447.40	-0.03	2.25	2.25	0.00	1.35	1.35	0.00	3.22	3.22	0.00	2.10	2.10	0.00	2.32	2.32	0.00	0.75	0.75	0.00
1990	7040.86	7040.37	-0.01	2.10	2.10	0.00	1.24	1.24	0.00	3.25	3.25	0.00	2.11	2.11	0.00	2.34	2.34	0.00	1.26	1.26	0.00
1991	6790.93	6788.75	-0.03	2.15	2.15	0.00	0.91	0.91	0.00	3.24	3.24	0.00	2.09	2.09	0.00	2.34	2.34	0.00	1.41	1.41	0.00
1992	6819.01	6817.27	-0.03	2.25	2.25	0.00	0.86	0.86	0.00	3.12	3.12	0.00	1.98	1.98	0.00	2.39	2.39	0.00	0.92	0.92	0.00
1993	8722.55	8720.29	-0.03	2.30	2.30	0.00	1.33	1.33	0.00	4.06	4.06	0.00	2.22	2.22	0.00	2.77	2.77	0.00	1.28	1.28	0.00
1994	7459.46	7456.59	-0.04	2.40	2.40	0.00	0.71	0.71	0.00	3.44	3.44	0.00	2.12	2.12	0.00	2.46	2.46	0.00	3.39	3.37	-0.50
1995	7856.95	7842.57	-0.18	2.53	2.53	0.01	0.52	0.52	0.00	3.99	3.99	0.00	2.18	2.18	0.00	2.78	2.78	0.00	1.65	1.65	-0.01
1996	11562.12	11559.23	-0.02	2.55	2.55	0.00	0.44	0.44	-0.01	4.33	4.33	0.00	2.26	2.26	0.00	2.90	2.90	0.00	1.85	1.85	-0.01
1997	11145.34	11140.79	-0.04	2.55	2.55	0.00	0.12	0.12	-0.01	4.33	4.33	0.00	2.32	2.32	0.00	2.83	2.83	0.00	2.10	2.10	0.00
1998	12978.26	12971.88	-0.05	2.57	2.57	0.00	0.38	0.38	0.00	4.67	4.67	0.00	2.42	2.42	0.00	2.92	2.92	0.00	2.48	2.47	-0.09
1999	16362.05	16357.60	-0.03	2.60	2.60	0.00	0.83	0.83	0.00	5.11	5.11	0.00	2.49	2.49	0.00	3.11	3.11	0.00	2.07	2.07	-0.01
2000	14267.38	14260.89	-0.05	2.61	2.61	0.00	0.58	0.58	0.00	4.74	4.74	0.00	2.34	2.34	0.00	3.06	3.06	0.00	2.38	2.38	-0.01
2001	13318.16	13311.50	-0.05	2.54	2.54	0.00	0.31	0.31	0.00	3.89	3.89	0.00	2.12	2.12	0.00	2.78	2.78	0.00	1.64	1.64	-0.01
2002	15107.67	15102.94	-0.03	2.56	2.56	0.00	0.27	0.27	-0.01	4.60	4.60	0.00	2.28	2.28	0.00	3.05	3.05	0.00	2.08	2.08	-0.01
2003	16637.91	16631.83	-0.04	2.61	2.61	0.00	0.65	0.65	0.00	4.91	4.91	0.00	2.49	2.49	0.00	2.98	2.98	0.00	1.91	1.91	-0.01
2004	19172.25	19165.98	-0.03	2.56	2.56	0.00	0.31	0.31	0.00	5.01	5.01	0.00	2.51	2.51	0.00	3.02	3.02	0.00	2.78	2.78	0.00
2005	19041.85	19034.79	-0.04	1.90	1.90	0.00	0.29	0.29	-0.01	5.53	5.53	0.00	2.61	2.61	0.00	3.21	3.21	0.00	3.65	3.65	0.00
2006	18725.60	18718.15	-0.04	2.21	2.21	0.00	0.69	0.69	0.00	5.42	5.42	0.00	2.56	2.56	0.00	3.21	3.21	0.00	2.81	2.81	-0.01
2007	21938.54	21930.33	-0.04	2.72	2.72	0.00	0.70	0.70	0.00	5.70	5.70	0.00	2.55	2.55	0.00	3.39	3.39	0.00	2.98	2.98	-0.01
2008	43383.11	43364.79	-0.04	3.49	3.49	0.01	1.20	1.20	0.00	6.92	6.92	0.00	2.92	2.92	0.00	3.59	3.59	0.00	2.92	2.92	-0.01
2009	35090.85	35075.19	-0.04	3.03	3.03	0.01	1.08	1.08	0.00	6.67	6.66	0.00	2.74	2.74	0.00	3.68	3.68	0.00	3.76	3.76	-0.01
Mean	**12567.14**	**12562.43**	**-0.04**	**2.40**	**2.40**	**0.00**	**0.71**	**0.71**	**0.00**	**4.25**	**4.25**	**0.00**	**2.26**	**2.26**	**0.00**	**2.81**	**2.81**	**0.00**	**2.13**	**2.13**	**-0.04**
S.D	**9357.39**	**9353.20**	**0.04**	**0.34**	**0.34**	**0.00**	**0.34**	**0.34**	**0.00**	**1.10**	**1.10**	**0.00**	**0.27**	**0.27**	**0.00**	**0.39**	**0.39**	**0.00**	**0.91**	**0.91**	**0.09**
C.V.	**0.74**	**0.74**	**-1.01**	**0.14**	**0.14**	**0.87**	**0.48**	**0.48**	**-1.62**	**0.26**	**0.26**	**-0.86**	**0.12**	**0.12**	**-1.14**	**0.14**	**0.14**	**-3.60**	**0.42**	**0.42**	**-2.58**

Table B.3 (continued)

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Import Quantity		
(e) Indonesia																					
	Baseline (IND/Mt)	Scenario 3 (IND/Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)	Baseline (Mt)	Scenario 3 (Mt)	Change (%)
1982	220417.92	220361.31	-0.03	24.68	24.68	0.00	3.47	3.47	0.00	24.01	24.01	0.00	9.16	9.16	0.00	4.03	4.03	0.00	1.16	1.18	1.28
1983	297698.81	297646.21	-0.02	25.46	25.46	0.00	4.36	4.36	0.00	25.94	25.94	0.00	9.76	9.76	0.00	4.09	4.09	0.00	0.42	0.42	0.01
1984	327226.01	327332.42	0.03	26.09	26.09	0.00	4.48	4.48	0.00	26.54	26.54	0.00	9.90	9.90	0.00	4.12	4.12	0.00	0.05	0.05	0.23
1985	285640.63	285593.49	-0.02	26.74	26.74	0.00	4.56	4.56	0.00	27.02	27.02	0.00	9.90	9.90	0.00	4.20	4.20	0.00	0.02	0.02	3.30
1986	272459.00	272663.55	0.08	27.32	27.39	0.26	3.20	3.20	0.00	26.05	26.05	0.02	9.80	9.80	0.00	4.09	4.09	0.02	0.13	0.13	0.30
1987	366959.22	366857.84	-0.03	28.05	28.05	0.00	2.29	2.29	0.00	27.09	27.09	0.00	9.80	9.80	0.00	4.25	4.25	0.00	0.05	0.05	0.12
1988	485431.49	485319.28	-0.02	28.69	28.69	0.00	2.92	2.92	0.00	29.07	29.07	0.00	10.53	10.53	0.00	4.25	4.25	0.00	0.25	0.25	0.03
1989	498474.64	498293.82	-0.04	29.41	29.41	0.00	2.95	2.95	0.00	29.37	29.37	0.00	10.50	10.50	0.00	4.30	4.30	0.00	0.07	0.07	0.21
1990	535047.95	535006.36	-0.01	30.12	30.12	0.00	2.06	2.06	0.00	29.05	29.05	0.00	10.28	10.28	0.00	4.35	4.35	0.00	0.19	0.19	0.03
1991	603404.60	603226.57	-0.03	30.84	30.84	0.00	3.12	3.12	0.00	31.35	31.35	0.00	11.10	11.10	0.00	4.34	4.34	0.00	0.54	0.54	0.03
1992	572123.80	571982.81	-0.02	31.38	31.38	0.00	2.61	2.61	0.00	31.32	31.32	0.00	11.01	11.01	0.00	4.38	4.38	0.00	0.02	0.02	2.10
1993	807834.76	807667.30	-0.02	32.10	32.10	0.00	1.72	1.72	0.00	30.32	30.32	0.00	10.74	10.74	0.00	4.34	4.34	0.00	0.89	0.89	0.02
1994	551955.19	551751.98	-0.04	32.92	32.92	0.00	4.22	4.22	0.00	32.34	32.34	0.00	11.44	11.44	0.00	4.35	4.35	0.00	3.08	3.08	0.01
1995	640674.52	639652.50	-0.16	33.46	33.46	0.00	5.05	5.05	0.00	33.22	33.22	0.00	11.57	11.57	0.00	4.42	4.42	0.00	1.08	1.08	0.08
1996	837383.94	837196.34	-0.02	33.91	33.91	0.00	4.06	4.06	0.00	32.09	32.09	0.00	11.14	11.14	0.00	4.43	4.43	0.00	0.84	0.84	0.04
1997	1420080.96	1419758.77	-0.02	34.67	34.67	0.00	6.28	6.28	0.00	31.12	31.12	0.00	11.73	11.73	0.00	4.08	4.08	0.00	5.76	5.76	0.01
1998	2982884.75	2981465.58	-0.05	35.03	35.03	0.00	7.12	7.12	0.00	32.15	32.15	0.00	11.97	11.97	0.00	4.13	4.13	0.00	3.72	3.72	0.03
1999	2106093.05	2105386.91	-0.03	35.40	35.40	0.00	6.02	6.02	0.00	32.81	32.81	0.00	11.79	11.79	0.00	4.28	4.28	0.00	1.48	1.48	0.06
2000	1978203.24	1977184.15	-0.05	35.87	35.87	0.00	4.61	4.61	0.00	32.98	32.98	0.00	11.61	11.61	0.00	4.37	4.37	0.00	1.57	1.59	1.45
2001	2638333.93	2637231.98	-0.04	36.38	36.38	0.00	4.68	4.68	0.00	32.97	32.97	0.00	11.60	11.60	0.00	4.37	4.37	0.00	3.27	3.27	0.19
2002	1783108.72	1782371.70	-0.04	36.51	36.51	0.00	4.35	4.35	0.00	33.43	33.43	0.00	11.51	11.51	0.00	4.47	4.47	0.00	2.77	2.77	0.05
2003	1776162.22	1775259.18	-0.05	36.01	36.01	0.00	4.02	4.02	0.00	35.05	35.05	0.00	11.91	11.91	0.00	4.53	4.53	0.00	0.65	0.67	2.35
2004	2330491.99	2329530.18	-0.04	35.86	35.86	0.00	3.45	3.45	0.00	34.85	34.85	0.00	11.66	11.66	0.00	4.60	4.60	0.00	0.44	0.44	0.31
2005	2760119.84	2758969.34	-0.04	35.75	35.75	0.00	3.21	3.21	0.00	34.98	34.98	0.00	11.81	11.81	0.00	4.56	4.56	0.00	0.53	0.53	0.10
2006	2934158.00	2933026.31	-0.04	35.91	35.91	0.00	4.61	4.61	0.00	35.33	35.33	0.00	11.91	11.91	0.00	4.56	4.56	0.00	1.98	1.98	0.08
2007	3068035.13	3066801.00	-0.04	36.35	36.35	0.00	5.61	5.61	0.00	37.00	37.00	0.00	11.90	11.90	0.00	4.78	4.78	0.00	0.35	0.35	0.50
2008	4497103.28	4498168.42	0.02	36.87	36.87	0.00	7.06	7.06	0.00	38.32	38.32	0.00	12.17	12.17	0.00	4.84	4.84	0.00	0.26	0.26	3.00
2009	4476461.60	4474470.94	-0.04	38.01	38.01	0.00	6.59	6.59	0.00	36.48	36.47	0.00	12.13	12.13	0.00	4.62	4.62	0.00	1.06	1.06	0.20
Mean	**1501927.47**	**1501434.87**	**-0.03**	**32.49**	**32.50**	**0.01**	**4.24**	**4.24**	**0.00**	**31.51**	**31.51**	**0.00**	**11.08**	**11.08**	**0.00**	**4.36**	**4.36**	**0.00**	**1.17**	**1.17**	**0.25**
S.D	**1288063.58**	**1287737.31**	**0.04**	**4.04**	**4.04**	**0.05**	**1.46**	**1.46**	**0.00**	**3.68**	**3.68**	**0.00**	**0.88**	**0.88**	**0.00**	**0.21**	**0.21**	**0.00**	**1.39**	**1.39**	**0.96**
C.V.	**0.86**	**0.86**	**-1.14**	**0.12**	**0.12**	**5.41**	**0.35**	**0.35**	**-1.03**	**0.12**	**0.12**	**-25.64**	**0.08**	**0.08**	**-1.04**	**0.05**	**0.05**	**5.86**	**1.19**	**1.19**	**3.83**

Table B.3 (continued)

(f) Rest of the world																					
Year	**Demand Price**			**Consumption Demand**			**Stocks Demand**			**Supply**			**Area Harvested**			**Yield**			**Import Quantity**		
	Baseline (USD/Mt)	**Scenario 3** (USD/Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)	**Baseline** (Mt)	**Scenario 3** (Mt)	**Change** (%)
1982	406.31	406.23	-0.02	231.67	231.68	0.01	51.18	51.18	0.00	234.84	234.84	0.00	113.77	113.77	0.00	3.08	3.08	0.00	3.46	3.48	0.43
1983	372.71	372.65	-0.02	245.22	245.22	0.00	64.77	64.77	0.00	254.29	254.29	0.00	117.16	117.16	0.00	3.24	3.24	0.00	4.67	4.66	-0.08
1984	359.20	359.30	0.03	249.12	249.10	-0.01	79.70	79.70	0.00	261.87	261.87	0.00	115.89	115.89	0.00	3.37	3.37	0.00	4.45	4.43	-0.41
1985	312.30	312.26	-0.01	257.56	257.56	0.00	90.59	90.59	0.00	263.16	263.16	0.00	116.64	116.64	0.00	3.37	3.37	0.00	5.03	5.04	0.15
1986	298.28	298.44	0.05	259.51	259.48	-0.01	98.77	98.77	0.00	263.16	263.16	0.00	116.87	116.87	0.00	3.36	3.36	0.00	5.56	5.53	-0.50
1987	296.35	296.29	-0.02	260.86	260.87	0.00	101.45	101.45	0.00	259.83	259.83	0.00	114.03	114.02	0.00	3.40	3.40	0.00	5.68	5.69	0.19
1988	353.97	353.90	-0.02	272.77	272.78	0.00	109.39	109.39	0.00	273.66	273.66	0.00	117.84	117.84	0.00	3.47	3.47	0.00	7.78	7.79	0.15
1989	363.65	363.55	-0.03	282.80	282.82	0.01	114.53	114.53	0.00	284.91	284.91	0.00	118.49	118.49	0.00	3.59	3.59	0.00	5.95	5.97	0.30
1990	365.62	365.60	-0.01	290.65	290.65	0.00	122.74	122.74	0.00	293.46	293.45	0.00	118.55	118.55	0.00	3.69	3.69	0.00	5.87	5.87	0.07
1991	379.65	379.56	-0.02	295.57	295.58	0.01	122.71	122.71	0.00	288.88	288.88	0.00	117.83	117.83	0.00	3.66	3.66	0.00	7.38	7.39	0.22
1992	379.85	379.78	-0.02	299.16	299.17	0.00	119.94	119.94	0.00	290.52	290.52	0.00	116.96	116.96	0.00	3.71	3.71	0.00	7.47	7.48	0.16
1993	351.75	351.67	-0.02	301.12	301.13	0.00	115.10	115.10	0.00	290.86	290.86	0.00	116.55	116.55	0.00	3.72	3.72	0.00	6.93	6.95	0.20
1994	366.50	366.41	-0.03	305.07	305.08	0.01	114.15	114.15	0.00	297.57	297.57	0.00	117.40	117.40	0.00	3.78	3.78	0.00	6.54	6.55	0.25
1995	369.36	368.90	-0.12	306.31	306.39	0.03	113.09	113.09	0.00	298.86	298.86	0.00	117.99	117.99	0.00	3.78	3.78	0.00	8.56	8.64	0.92
1996	412.79	412.71	-0.02	315.68	315.69	0.00	116.64	116.63	0.00	312.29	312.29	0.00	119.85	119.85	0.00	3.89	3.89	0.00	8.89	8.90	0.16
1997	399.08	398.97	-0.03	314.74	314.75	0.01	120.75	120.75	0.00	315.59	315.59	0.00	119.52	119.52	0.00	3.94	3.94	0.00	8.03	8.08	0.54
1998	373.44	373.30	-0.04	324.25	324.27	0.01	124.19	124.19	0.00	320.84	320.84	0.00	120.50	120.50	0.00	3.97	3.97	0.00	8.61	8.64	0.29
1999	356.67	356.58	-0.03	331.02	331.04	0.00	134.66	134.65	0.00	331.98	331.97	0.00	123.04	123.04	0.00	4.03	4.03	0.00	9.61	9.63	0.16
2000	326.25	326.13	-0.04	327.00	327.02	0.01	137.90	137.90	0.00	320.94	320.93	0.00	119.76	119.76	0.00	4.00	4.00	0.00	11.08	11.10	0.19
2001	281.35	281.24	-0.04	344.41	344.43	0.01	123.86	123.86	0.00	322.59	322.59	0.00	119.27	119.27	0.00	4.04	4.04	0.00	7.87	7.89	0.24
2002	262.40	262.32	-0.03	338.48	338.50	0.00	95.68	95.68	0.00	300.57	300.57	0.00	114.94	114.94	0.00	3.90	3.90	0.00	10.14	10.15	0.14
2003	297.39	297.28	-0.04	343.52	343.54	0.01	78.17	78.17	0.00	313.34	313.34	0.00	117.36	117.36	0.00	3.99	3.99	0.00	14.81	14.83	0.12
2004	336.01	335.90	-0.03	339.25	339.27	0.01	69.74	69.74	0.00	321.43	321.43	0.00	120.16	120.16	0.00	3.99	3.99	0.00	13.67	13.69	0.14
2005	362.04	361.92	-0.03	344.96	344.98	0.01	71.13	71.13	0.00	335.65	335.65	0.00	121.35	121.35	0.00	4.13	4.13	0.00	14.14	14.16	0.15
2006	384.25	384.13	-0.03	349.81	349.83	0.01	67.98	67.98	0.00	336.40	336.39	0.00	121.90	121.90	0.00	4.12	4.12	0.00	13.55	13.57	0.16
2007	452.50	452.37	-0.03	355.70	355.72	0.01	69.47	69.47	0.00	343.80	343.80	0.00	121.80	121.80	0.00	4.21	4.21	0.00	15.93	15.95	0.15
2008	708.15	707.89	-0.04	363.01	363.06	0.01	77.09	77.08	0.00	356.17	356.17	0.00	123.88	123.88	0.00	4.29	4.29	0.00	15.61	15.65	0.29
2009	580.83	580.64	-0.03	361.93	361.97	0.01	79.75	79.75	0.00	348.88	348.88	0.00	121.70	121.70	0.00	4.28	4.28	0.00	17.01	17.04	0.20
Mean	**375.31**	**375.21**	**-0.03**	**307.54**	**307.56**	**0.01**	**99.47**	**99.47**	**0.00**	**301.30**	**301.30**	**0.00**	**118.61**	**118.61**	**0.00**	**3.79**	**3.79**	**0.00**	**9.08**	**9.10**	**0.19**
S.D	**88.59**	**88.55**	**0.03**	**38.44**	**38.45**	**0.01**	**24.41**	**24.41**	**0.00**	**31.53**	**31.52**	**0.00**	**2.59**	**2.59**	**0.00**	**0.33**	**0.33**	**0.00**	**3.90**	**3.91**	**0.25**
C.V.	**0.24**	**0.24**	**-1.06**	**0.12**	**0.13**	**1.17**	**0.25**	**0.25**	**-1.02**	**0.10**	**0.10**	**-0.93**	**0.02**	**0.02**	**-0.61**	**0.09**	**0.09**	**-38.05**	**0.43**	**0.43**	**1.30**

Table B.4: Baseline versus Scenario 4 (Free Trade)

(a) Malaysia																					
Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Import Quantity		
	Baseline (MYR/Mt)	Scenario 4 (MYR/Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)
1982	826.11	826.62	0.06	1.45	1.45	0.00	0.31	0.28	-8.17	1.08	1.02	-5.90	0.65	0.61	-5.90	2.57	2.57	0.00	0.37	0.41	10.46
1983	708.51	673.33	-4.97	1.52	1.52	0.21	0.31	0.28	-10.60	1.14	1.06	-7.33	0.65	0.60	-0.05	2.72	2.72	0.00	0.39	0.44	13.84
1984	634.72	635.35	0.10	1.59	1.59	-0.02	0.17	0.13	-19.02	1.02	0.94	-7.82	0.63	0.58	-0.05	2.48	2.48	0.00	0.42	0.47	11.44
1985	652.19	599.95	-8.01	1.52	1.52	0.31	0.32	0.28	-12.00	1.25	1.15	-7.68	0.64	0.60	-0.05	2.98	2.98	0.00	0.42	0.48	14.95
1986	613.64	615.14	0.25	1.52	1.51	-0.84	0.18	0.14	-20.35	1.17	1.07	-7.76	0.64	0.59	-0.05	2.79	2.79	0.01	0.21	0.25	18.52
1987	528.60	529.33	0.14	1.35	1.35	0.00	0.11	0.08	-30.86	1.09	1.01	-7.89	0.63	0.58	-0.05	2.67	2.67	0.18	0.19	0.25	26.79
1988	770.73	741.58	-3.78	1.43	1.43	-0.27	0.11	0.07	-31.70	1.14	1.06	-7.60	0.65	0.60	-0.05	2.70	2.70	0.04	0.29	0.34	16.82
1989	938.60	939.45	0.09	1.51	1.51	-0.01	0.13	0.10	-27.59	1.17	1.08	-7.98	0.62	0.57	-0.05	2.88	2.88	0.00	0.36	0.42	15.46
1990	971.35	831.96	-14.35	1.48	1.49	0.86	0.23	0.17	-23.66	1.28	1.15	-10.58	0.65	0.58	-0.07	3.03	3.03	0.00	0.30	0.39	31.72
1991	878.41	879.61	0.14	1.53	1.53	-0.01	0.23	0.18	-22.75	1.16	1.03	-11.35	0.66	0.58	-0.07	2.72	2.72	0.00	0.36	0.44	22.00
1992	809.85	778.86	-3.83	1.58	1.59	0.18	0.30	0.25	-17.83	1.19	1.05	-11.33	0.66	0.58	-0.07	2.77	2.77	0.00	0.47	0.55	17.87
1993	731.66	732.89	0.17	1.65	1.65	-0.01	0.34	0.28	-16.85	1.30	1.16	-11.15	0.67	0.60	-0.07	2.99	2.99	0.00	0.39	0.48	22.68
1994	861.88	863.16	0.15	1.71	1.71	-0.01	0.28	0.22	-20.99	1.34	1.19	-11.11	0.67	0.60	-0.07	3.07	3.07	0.00	0.31	0.40	28.82
1995	827.65	828.88	0.15	1.72	1.72	-0.01	0.30	0.24	-19.96	1.34	1.19	-11.15	0.67	0.59	-0.07	3.09	3.09	0.00	0.40	0.49	22.83
1996	968.64	934.65	-3.51	1.70	1.71	0.18	0.46	0.40	-12.57	1.31	1.16	-11.22	0.66	0.59	-0.07	3.03	3.03	0.00	0.56	0.65	16.31
1997	1052.74	1054.07	0.13	1.84	1.84	-0.01	0.53	0.47	-10.90	1.29	1.14	-11.40	0.66	0.58	-0.08	3.01	3.01	0.00	0.63	0.72	14.01
1998	1386.58	1388.38	0.13	1.94	1.94	-0.01	0.48	0.42	-12.26	1.26	1.11	-11.72	0.64	0.57	-0.08	3.02	3.02	0.00	0.63	0.72	14.15
1999	1266.45	1194.18	-5.71	1.95	1.96	0.34	0.42	0.36	-13.83	1.28	1.13	-11.49	0.65	0.58	-0.08	3.01	3.01	0.00	0.62	0.71	15.45
2000	1180.51	1182.40	0.16	1.95	1.95	-0.01	0.49	0.42	-13.02	1.42	1.26	-11.33	0.67	0.59	-0.08	3.26	3.26	0.00	0.59	0.69	16.37
2001	1034.91	1036.74	0.18	2.01	2.01	-0.01	0.45	0.39	-13.91	1.36	1.20	-11.60	0.65	0.57	-0.08	3.23	3.23	0.00	0.61	0.71	15.55
2002	1122.04	967.90	-13.74	2.01	2.03	0.69	0.32	0.26	-19.87	1.41	1.25	-11.37	0.66	0.59	-0.08	3.27	3.27	0.00	0.48	0.59	23.03
2003	1107.12	1109.04	0.17	2.03	2.03	-0.01	0.26	0.19	-25.71	1.49	1.32	-11.23	0.68	0.60	-0.08	3.37	3.37	0.00	0.48	0.58	21.14
2004	1062.47	1064.34	0.18	2.05	2.05	-0.01	0.32	0.26	-19.99	1.44	1.27	-11.38	0.66	0.59	-0.08	3.34	3.34	0.00	0.69	0.78	14.40
2005	1173.01	1174.87	0.16	2.15	2.15	-0.01	0.36	0.29	-18.25	1.44	1.28	-11.41	0.66	0.59	-0.08	3.36	3.36	0.00	0.75	0.85	13.21
2006	1217.52	1219.40	0.15	2.17	2.17	0.26	0.45	0.39	-14.15	1.40	1.23	-11.59	0.65	0.57	-0.08	3.30	3.30	0.00	0.87	0.97	11.91
2007	1334.89	1335.52	0.05	2.35	2.35	0.00	0.61	0.54	-11.25	1.47	1.30	-11.74	0.65	0.57	-0.08	3.49	3.49	0.00	1.04	1.14	10.03
2008	2465.68	2467.57	0.08	2.50	2.50	-0.01	0.73	0.66	-9.57	1.54	1.36	-11.49	0.66	0.59	-0.08	3.58	3.58	0.00	1.08	1.19	9.83
2009	1786.37	1788.30	0.11	2.55	2.55	-0.01	0.71	0.64	-10.20	1.63	1.45	-11.22	0.68	0.60	-0.08	3.72	3.72	0.00	0.90	1.01	12.33
Mean	**1032.60**	**1014.05**	**-1.80**	**1.81**	**1.81**	**0.07**	**0.35**	**0.30**	**-15.13**	**1.30**	**1.17**	**-10.39**	**0.65**	**0.59**	**-0.07**	**3.05**	**3.05**	**0.01**	**0.53**	**0.61**	**15.64**
S.D	**393.68**	**398.57**	**4.08**	**0.33**	**0.33**	**0.29**	**0.16**	**0.16**	**6.47**	**0.15**	**0.12**	**1.82**	**0.01**	**0.01**	**1.10**	**0.31**	**0.31**	**0.03**	**0.23**	**0.25**	**5.71**
C.V.	**0.38**	**0.39**	**-2.27**	**0.18**	**0.18**	**4.42**	**0.47**	**0.52**	**-0.43**	**0.12**	**0.10**	**-0.17**	**0.02**	**0.02**	**-16.38**	**0.10**	**0.10**	**4.78**	**0.44**	**0.41**	**0.37**

Table B.4 (continued)

(b) Thailand																					
Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
	Baseline (THB/Mt)	Scenario 4 (THB/Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)
1982	6750.90	6755.96	0.07	8.12	8.12	0.00	1.34	1.34	0.00	11.14	11.14	0.00	8.94	8.94	0.00	1.89	1.89	0.00	3.69	3.69	0.00
1983	6339.84	6346.85	0.11	8.27	8.27	0.00	1.44	1.44	0.00	12.93	12.93	0.00	9.63	9.63	0.00	2.04	2.04	0.00	4.55	4.55	0.01
1984	5969.29	5975.67	0.11	8.49	8.49	0.00	2.08	2.08	0.00	13.12	13.16	0.37	9.61	9.61	0.00	2.07	2.07	0.36	3.98	4.02	1.21
1985	5891.61	5901.25	0.16	8.62	8.62	0.00	2.50	2.50	0.00	13.37	13.44	0.53	9.83	9.83	0.00	2.06	2.07	0.53	4.33	4.40	1.65
1986	5102.45	5117.77	0.30	8.34	8.34	0.00	2.27	2.27	0.00	12.45	12.45	0.00	9.66	9.66	0.00	1.95	1.95	0.00	4.34	4.34	0.01
1987	5240.60	5248.07	0.14	8.50	8.50	0.00	1.14	1.14	0.01	12.17	12.17	0.00	9.15	9.15	0.00	2.01	2.01	0.00	4.79	4.80	0.01
1988	6952.80	6961.11	0.12	8.25	8.25	0.00	0.90	0.90	0.01	14.07	14.14	0.49	9.93	9.93	0.00	2.15	2.16	0.49	6.06	6.13	1.15
1989	7691.03	7699.08	0.10	8.57	8.57	0.00	1.98	1.98	0.00	13.58	13.58	0.00	9.87	9.87	0.00	2.09	2.09	0.00	3.93	3.93	0.01
1990	6908.66	6922.11	0.19	8.40	8.40	0.00	0.94	0.94	0.00	11.36	11.36	0.00	8.81	8.81	0.00	1.96	1.96	0.00	4.90	4.90	0.05
1991	7460.79	7471.91	0.15	8.40	8.40	0.00	1.14	1.14	0.01	13.54	13.54	0.00	9.10	9.10	0.00	2.25	2.25	0.00	4.94	4.94	0.01
1992	6777.41	6789.08	0.17	8.50	8.50	0.00	0.81	0.81	0.01	13.16	13.16	0.00	9.17	9.17	0.00	2.17	2.17	0.00	4.98	4.98	0.01
1993	6006.15	6018.29	0.20	8.50	8.50	0.00	0.25	0.25	0.03	12.64	12.64	0.00	8.65	8.65	0.00	2.21	2.21	0.00	6.55	6.56	0.20
1994	6743.43	6755.71	0.18	8.25	8.25	0.00	0.20	0.20	0.04	14.18	14.18	0.00	9.23	9.23	0.00	2.33	2.33	0.00	5.99	5.99	0.01
1995	7953.53	7965.73	0.15	8.44	8.44	0.00	0.87	0.88	0.01	14.52	14.52	0.00	9.11	9.11	0.00	2.41	2.41	0.00	5.38	5.38	0.01
1996	8546.68	8559.27	0.15	8.59	8.59	0.00	0.70	0.70	0.01	13.65	13.65	0.00	9.26	9.26	0.00	2.23	2.23	0.00	8.89	8.89	0.01
1997	9474.55	9489.46	0.16	8.80	8.80	0.00	1.04	1.04	0.01	15.46	15.46	0.01	9.91	9.91	0.00	2.36	2.37	0.01	6.33	6.33	0.04
1998	12639.43	12658.45	0.15	8.90	8.90	0.00	1.08	1.08	0.01	15.69	15.70	0.00	9.97	9.97	0.00	2.39	2.39	0.00	6.76	6.76	0.01
1999	9434.38	9453.06	0.20	9.05	9.05	0.00	1.94	1.94	0.01	16.41	16.41	0.00	9.91	9.92	0.00	2.51	2.51	0.00	9.64	9.65	0.04
2000	8228.25	8248.20	0.24	9.25	9.25	0.00	2.23	2.23	0.01	16.96	16.97	0.00	9.84	9.84	0.00	2.61	2.61	0.00	7.45	7.45	0.01
2001	7681.87	7703.29	0.28	9.40	9.40	-0.01	3.12	3.12	0.00	17.52	17.52	0.00	10.14	10.14	0.00	2.62	2.62	0.00	7.25	7.25	0.01
2002	8175.30	8199.43	0.30	9.46	9.46	-0.01	3.32	3.32	0.00	17.31	17.31	0.00	10.23	10.23	0.00	2.57	2.57	0.00	7.64	7.64	0.01
2003	8193.03	8214.06	0.26	9.47	9.47	0.00	1.70	1.70	0.01	18.00	18.00	0.00	10.31	10.31	0.00	2.65	2.65	0.00	10.13	10.13	0.01
2004	9837.92	9857.77	0.20	9.48	9.48	0.00	2.31	2.31	0.01	17.33	17.33	0.00	9.98	9.98	0.00	2.63	2.63	0.00	11.57	11.58	0.10
2005	11497.08	11516.87	0.17	9.55	9.55	0.00	3.63	3.63	0.00	18.37	18.45	0.48	10.31	10.31	0.00	2.70	2.71	0.48	10.49	10.49	0.01
2006	11456.12	11475.55	0.17	9.78	9.78	0.00	2.51	2.41	-3.98	18.24	18.24	0.00	10.26	10.27	0.00	2.69	2.69	0.00	12.72	12.72	0.02
2007	11456.25	11474.02	0.16	9.60	9.60	0.00	2.70	2.70	0.01	19.76	19.76	0.00	10.81	10.81	0.00	2.77	2.77	0.00	13.99	14.00	0.10
2008	23245.70	23264.56	0.08	9.50	9.50	0.00	4.81	4.81	0.00	19.96	19.96	0.00	10.86	10.86	0.00	2.78	2.78	0.00	12.68	12.69	0.08
2009	16974.67	16993.41	0.11	10.20	10.20	0.00	6.13	6.13	0.00	20.41	20.41	0.00	11.02	11.02	0.00	2.81	2.81	0.00	10.67	10.68	0.10
Mean	**8879.63**	**8894.14**	**0.16**	**8.88**	**8.88**	**0.00**	**1.97**	**1.96**	**-0.18**	**15.26**	**15.27**	**0.07**	**9.77**	**9.77**	**0.00**	**2.35**	**2.36**	**0.06**	**7.31**	**7.32**	**0.13**
S.D	**3828.28**	**3831.00**	**0.06**	**0.57**	**0.57**	**0.00**	**1.35**	**1.34**	**0.75**	**2.71**	**2.71**	**0.17**	**0.62**	**0.62**	**0.00**	**0.29**	**0.29**	**0.17**	**3.05**	**3.05**	**0.42**
C.V.	**0.43**	**0.43**	**0.37**	**0.06**	**0.06**	**-0.32**	**0.68**	**0.68**	**-4.25**	**0.18**	**0.18**	**2.47**	**0.06**	**0.06**	**0.55**	**0.12**	**0.12**	**2.61**	**0.42**	**0.42**	**3.15**

Table B.4 (continued)

(c) Vietnam																					
Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
	Baseline (VND/Mt)	Scenario 4 (VND/Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)
1982	524.19	524.54	0.07	9.65	9.64	0.00	0.15	0.15	0.00	9.75	9.75	0.00	5.70	5.70	0.00	2.59	2.59	0.00	2.62	2.66	1.47
1983	448.16	448.64	0.11	10.23	10.23	0.00	0.16	0.16	0.00	10.01	10.01	0.02	5.74	5.74	0.00	2.64	2.64	0.02	0.53	0.54	0.43
1984	3423.37	3426.86	0.10	10.74	10.74	0.00	0.16	0.16	0.00	10.49	10.49	0.00	5.85	5.85	0.00	2.72	2.72	0.00	1.09	1.09	0.03
1985	5599.16	5607.54	0.15	10.57	10.57	0.00	0.16	0.16	0.00	10.22	10.22	0.00	5.83	5.83	0.00	2.65	2.65	0.00	3.56	3.57	0.25
1986	3688.28	3701.53	0.36	9.54	9.54	0.00	0.15	0.15	0.00	9.55	9.55	0.00	5.69	5.69	0.00	2.54	2.54	0.00	0.02	0.02	0.28
1987	11069.84	11092.57	0.21	11.25	11.25	0.00	0.17	0.17	0.00	11.43	11.43	0.00	5.77	5.77	0.00	3.00	3.00	0.00	0.16	0.16	0.00
1988	168601.30	168800.47	0.12	10.50	10.50	0.00	0.16	0.16	0.00	11.95	11.95	0.00	6.02	6.02	0.00	3.01	3.01	0.00	6.98	7.00	0.31
1989	909421.73	910819.70	0.15	10.93	10.93	0.00	0.17	0.17	0.00	12.66	12.66	0.00	6.08	6.08	0.00	3.16	3.16	0.00	1.71	1.72	0.02
1990	1211896.55	1215306.00	0.28	11.18	11.18	-0.01	0.17	0.17	0.00	12.27	12.27	0.00	6.30	6.30	0.00	2.95	2.95	0.00	1.09	1.09	0.10
1991	2265479.50	2269854.68	0.19	12.54	12.54	-0.01	0.19	0.19	0.00	14.49	14.49	0.00	6.50	6.50	0.00	3.38	3.38	0.00	1.93	1.93	0.08
1992	2395569.83	2400717.47	0.21	12.86	12.85	-0.01	0.20	0.20	0.00	14.44	14.44	0.00	6.62	6.62	0.00	3.31	3.31	0.00	1.58	1.58	0.11
1993	2242739.22	2247842.04	0.23	13.58	13.58	-0.01	0.21	0.21	0.01	15.83	16.02	1.25	6.63	6.63	0.00	3.62	3.66	1.24	2.24	2.44	8.89
1994	2335602.24	2340956.01	0.23	13.74	13.74	-0.01	0.21	0.21	0.01	16.03	16.03	0.00	6.80	6.80	0.00	3.57	3.57	0.00	2.29	2.29	0.09
1995	2925380.40	2930785.09	0.18	14.40	14.40	-0.01	0.25	0.25	0.01	17.44	17.44	0.00	7.11	7.11	0.00	3.72	3.72	0.00	3.00	3.00	0.08
1996	3132102.74	3137582.34	0.17	14.48	14.48	-0.01	0.45	0.45	0.01	17.90	17.99	0.50	7.00	7.00	0.00	3.87	3.89	0.49	3.23	3.32	2.81
1997	2841745.11	2847301.54	0.20	15.00	15.00	-0.01	0.77	0.77	0.00	19.03	19.03	0.01	7.35	7.35	0.00	3.92	3.92	0.00	3.71	3.72	0.07
1998	3629661.37	3635762.83	0.17	15.50	15.50	-0.01	0.88	0.88	0.00	19.98	19.98	0.01	7.53	7.53	0.00	4.02	4.02	0.00	4.37	4.37	0.07
1999	3177771.61	3184661.92	0.22	17.55	17.55	-0.01	0.92	0.92	0.00	20.75	20.76	0.01	7.60	7.60	0.00	4.14	4.14	0.00	3.17	3.17	0.11
2000	2736866.82	2743914.19	0.26	16.93	16.92	-0.01	0.97	0.97	0.00	20.30	20.30	0.01	7.43	7.43	0.00	4.14	4.14	0.00	3.32	3.33	0.11
2001	2469305.95	2476404.25	0.29	17.97	17.96	-0.01	0.84	0.84	0.01	20.91	20.91	0.01	7.43	7.43	0.00	4.27	4.27	0.00	3.09	3.09	0.12
2002	3397235.81	3405816.60	0.25	17.45	17.45	-0.01	1.16	1.16	0.00	21.42	21.42	0.01	7.43	7.43	0.00	4.37	4.37	0.00	8.54	8.55	0.14
2003	2897806.40	2905666.81	0.27	18.24	18.24	-0.01	1.02	1.02	0.01	21.98	21.98	0.01	7.43	7.44	0.00	4.48	4.48	0.00	3.89	3.89	0.11
2004	3664086.62	3671856.59	0.21	17.60	17.60	-0.01	1.29	1.29	0.01	22.62	22.63	0.01	7.42	7.42	0.00	4.62	4.62	0.00	4.76	4.76	0.10
2005	4219860.53	4227663.66	0.18	18.40	18.40	-0.01	1.31	1.31	0.01	22.69	22.70	0.01	7.29	7.29	0.00	4.72	4.72	0.00	4.27	4.28	0.11
2006	4378584.39	4386788.56	0.19	18.78	18.78	-0.01	1.39	1.39	0.01	22.90	22.90	0.01	7.19	7.20	0.00	4.82	4.82	0.00	4.04	4.05	0.13
2007	5256509.90	5264800.55	0.16	19.40	19.40	-0.01	2.02	2.02	0.00	24.40	24.40	0.01	7.42	7.42	0.00	4.98	4.98	0.00	4.37	4.37	0.12
2008	9930875.48	9940106.90	0.09	19.01	19.01	-0.01	1.96	1.96	0.00	24.37	24.37	0.01	7.33	7.33	0.00	5.04	5.04	0.00	5.41	5.42	0.11
2009	7606237.04	7615564.03	0.12	19.15	19.15	-0.01	1.47	1.47	0.01	25.01	25.01	0.01	7.42	7.42	0.00	5.11	5.11	0.00	6.34	6.35	0.10
Mean	**2636360.48**	**2641206.21**	**0.18**	**14.54**	**14.54**	**-0.01**	**0.68**	**0.68**	**0.00**	**17.17**	**17.18**	**0.07**	**6.78**	**6.78**	**0.00**	**3.76**	**3.76**	**0.06**	**3.26**	**3.28**	**0.48**
S.D	**2331940.89**	**2334784.43**	**0.07**	**3.41**	**3.41**	**0.01**	**0.59**	**0.59**	**0.00**	**5.19**	**5.19**	**0.25**	**0.69**	**0.69**	**0.00**	**0.82**	**0.82**	**0.25**	**2.01**	**2.01**	**1.72**
C.V.	**0.88**	**0.88**	**0.36**	**0.23**	**0.23**	**-0.55**	**0.88**	**0.88**	**0.58**	**0.30**	**0.30**	**3.77**	**0.10**	**0.10**	**0.95**	**0.22**	**0.22**	**4.07**	**0.62**	**0.61**	**3.62**

Table B.4 (continued)

(d) Pakistan																					
Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Export Quantity		
	Baseline (PAK/Mt)	Scenario 4 (PAK/Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)
1982	4086.92	4089.52	0.06	2.25	2.25	0.00	0.48	0.48	0.00	3.41	3.41	0.00	1.96	1.96	0.00	2.64	2.64	0.00	3.36	3.36	0.00
1983	3601.90	3605.90	0.11	2.12	2.12	0.00	0.53	0.53	0.00	3.31	3.36	1.64	1.98	1.98	0.00	2.53	2.57	1.64	1.15	1.16	1.09
1984	4677.45	4681.24	0.08	2.20	2.20	0.00	0.81	0.81	0.00	3.29	3.29	0.00	1.98	1.98	0.00	2.51	2.51	0.00	3.01	3.01	0.00
1985	4877.55	4883.20	0.12	1.86	1.86	0.00	0.58	0.58	0.00	2.90	2.90	0.00	1.85	1.85	0.00	2.37	2.37	0.00	2.90	2.90	0.00
1986	4307.54	4317.24	0.23	2.05	2.05	-0.01	0.72	0.72	0.00	3.52	3.52	0.00	2.08	2.08	0.00	2.56	2.56	0.00	1.33	1.33	0.01
1987	4070.22	4075.27	0.12	2.14	2.14	0.00	0.81	0.81	0.00	3.22	3.22	0.00	1.95	1.95	0.00	2.50	2.50	-0.01	1.13	1.13	0.01
1988	5387.93	5393.84	0.11	2.10	2.10	0.00	1.13	1.13	0.00	3.21	3.21	0.00	2.05	2.05	0.00	2.37	2.37	0.00	0.80	0.80	0.01
1989	7449.50	7455.93	0.09	2.25	2.25	0.00	1.35	1.35	0.00	3.22	3.22	0.00	2.10	2.10	0.00	2.32	2.32	0.00	0.75	0.75	0.02
1990	7040.86	7052.28	0.16	2.10	2.10	-0.01	1.24	1.24	0.00	3.25	3.25	0.00	2.11	2.11	0.00	2.34	2.34	0.00	1.26	1.26	0.01
1991	6790.93	6801.30	0.15	2.15	2.15	-0.01	0.91	0.91	0.00	3.24	3.24	0.00	2.09	2.09	0.00	2.34	2.34	0.00	1.41	1.42	0.01
1992	6819.01	6830.53	0.17	2.25	2.25	-0.01	0.86	0.86	0.00	3.12	3.12	0.00	1.98	1.98	0.00	2.39	2.39	0.00	0.92	0.92	0.02
1993	8722.55	8736.03	0.15	2.30	2.30	-0.01	1.33	1.33	0.00	4.06	4.06	0.00	2.22	2.22	0.00	2.77	2.77	0.00	1.28	1.28	0.02
1994	7459.46	7474.39	0.20	2.40	2.40	-0.01	0.71	0.71	0.00	3.44	3.44	0.00	2.12	2.12	0.00	2.46	2.46	0.00	3.39	3.44	1.45
1995	7856.95	7872.44	0.20	2.53	2.53	-0.01	0.52	0.52	0.01	3.99	4.00	0.00	2.18	2.18	0.00	2.78	2.78	0.00	1.65	1.65	0.02
1996	11562.12	11580.04	0.15	2.55	2.55	-0.01	0.44	0.44	0.01	4.33	4.33	0.00	2.26	2.26	0.00	2.90	2.90	0.00	1.85	1.85	0.02
1997	11145.34	11164.89	0.18	2.55	2.55	-0.01	0.12	0.12	0.03	4.33	4.33	0.01	2.32	2.32	0.00	2.83	2.83	0.00	2.10	2.10	0.02
1998	12978.26	12998.98	0.16	2.57	2.57	-0.01	0.38	0.38	0.01	4.67	4.67	0.01	2.42	2.42	0.00	2.92	2.92	0.00	2.48	2.48	0.31
1999	16362.05	16386.51	0.15	2.60	2.60	-0.01	0.83	0.83	0.01	5.11	5.11	0.01	2.49	2.49	0.00	3.11	3.11	0.00	2.07	2.07	0.02
2000	14267.38	14294.07	0.19	2.61	2.61	-0.01	0.58	0.58	0.01	4.74	4.74	0.01	2.34	2.35	0.00	3.06	3.06	0.00	2.38	2.38	0.02
2001	13318.16	13348.01	0.22	2.54	2.54	-0.01	0.31	0.31	0.02	3.89	3.89	0.01	2.12	2.12	0.00	2.78	2.78	0.00	1.64	1.64	0.04
2002	15107.67	15141.21	0.22	2.56	2.56	-0.01	0.27	0.27	0.03	4.60	4.60	0.01	2.28	2.28	0.00	3.05	3.05	0.00	2.08	2.08	0.03
2003	16637.91	16667.18	0.18	2.61	2.61	-0.01	0.65	0.65	0.01	4.91	4.91	0.01	2.49	2.49	0.00	2.98	2.98	0.00	1.91	1.91	0.04
2004	19172.25	19201.00	0.15	2.56	2.56	-0.01	0.31	0.31	0.02	5.01	5.01	0.01	2.51	2.51	0.00	3.02	3.02	0.00	2.78	2.78	0.02
2005	19041.85	19071.13	0.15	1.90	1.90	-0.02	0.29	0.29	0.02	5.53	5.53	0.01	2.61	2.61	0.00	3.21	3.21	0.00	3.65	3.65	0.02
2006	18725.60	18756.52	0.17	2.21	2.21	-0.02	0.69	0.69	0.01	5.42	5.42	0.01	2.56	2.56	0.00	3.21	3.21	0.00	2.81	2.81	0.02
2007	21938.54	21969.80	0.14	2.72	2.72	-0.01	0.70	0.70	0.01	5.70	5.70	0.01	2.55	2.55	0.00	3.39	3.39	0.00	2.98	2.98	0.02
2008	43383.11	43422.98	0.09	3.49	3.49	-0.01	1.20	1.20	0.01	6.92	6.92	0.01	2.92	2.92	0.00	3.59	3.59	0.00	2.92	2.92	0.03
2009	35090.85	35135.51	0.13	3.03	3.00	-1.01	1.08	1.08	0.01	6.67	6.75	1.24	2.74	2.74	0.00	3.68	3.72	1.23	3.76	3.87	3.01
Mean	**12567.14**	**12585.96**	**0.15**	**2.40**	**2.40**	**-0.05**	**0.71**	**0.71**	**0.01**	**4.25**	**4.25**	**0.12**	**2.26**	**2.26**	**0.00**	**2.81**	**2.81**	**0.11**	**2.13**	**2.14**	**0.32**
S.D	**9357.39**	**9368.10**	**0.04**	**0.34**	**0.34**	**0.19**	**0.34**	**0.34**	**0.01**	**1.10**	**1.10**	**0.38**	**0.27**	**0.27**	**0.00**	**0.39**	**0.39**	**0.38**	**0.91**	**0.92**	**0.64**
C.V.	**0.74**	**0.74**	**0.29**	**0.14**	**0.14**	**-3.53**	**0.48**	**0.48**	**1.56**	**0.26**	**0.26**	**3.17**	**0.12**	**0.12**	**0.65**	**0.14**	**0.14**	**3.46**	**0.42**	**0.43**	**1.99**

Table B.4 (continued)

(e) Indonesia

Year	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Import Quantity		
	Baseline (IND/Mt)	Scenario 4 (IND/Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)
1982	220417.92	220563.42	0.07	24.68	24.68	0.00	3.47	3.47	0.00	24.01	24.01	0.00	9.16	9.16	0.00	4.03	4.03	0.00	1.16	1.13	-3.30
1983	297698.81	297975.90	0.09	25.46	25.46	0.00	4.36	4.36	0.00	25.94	25.94	0.00	9.76	9.76	0.00	4.09	4.09	0.00	0.42	0.42	-0.06
1984	327226.01	327503.23	0.08	26.09	26.14	0.18	4.48	4.48	0.00	26.54	26.54	0.00	9.90	9.90	0.00	4.12	4.12	0.00	0.05	0.05	-1.46
1985	285640.63	286034.75	0.14	26.74	26.74	0.01	4.56	4.56	0.00	27.02	27.02	0.00	9.90	9.90	0.00	4.20	4.20	0.00	0.02	0.02	-1.71
1986	272459.00	273206.13	0.27	27.32	27.35	0.09	3.20	3.20	0.00	26.05	26.05	0.02	9.80	9.80	0.00	4.09	4.09	0.02	0.13	0.13	-0.71
1987	366959.22	367436.50	0.13	28.05	28.05	0.00	2.29	2.29	0.00	27.09	27.09	0.00	9.80	9.80	0.00	4.25	4.25	0.00	0.05	0.05	-0.21
1988	485431.49	485985.04	0.11	28.69	28.69	0.00	2.92	2.92	0.00	29.07	29.07	0.00	10.53	10.53	0.00	4.25	4.25	0.00	0.25	0.25	-0.25
1989	498474.64	499028.97	0.11	29.41	29.41	0.00	2.95	2.95	0.00	29.37	29.37	0.00	10.50	10.50	0.00	4.30	4.30	0.00	0.07	0.07	-0.93
1990	535047.95	536017.12	0.18	30.12	30.12	0.00	2.06	2.06	0.00	29.05	29.05	0.00	10.28	10.28	0.00	4.35	4.35	0.00	0.19	0.19	-0.55
1991	603404.60	604254.75	0.14	30.84	30.84	0.00	3.12	3.12	0.00	31.35	31.35	0.00	11.10	11.10	0.00	4.34	4.34	0.00	0.54	0.54	-0.19
1992	572123.80	573056.59	0.16	31.38	31.38	0.00	2.61	2.61	0.00	31.32	31.32	0.00	11.01	11.01	0.00	4.38	4.38	0.00	0.02	0.02	-0.08
1993	807834.76	808835.62	0.12	32.10	32.10	0.00	1.72	1.72	0.00	30.32	30.32	0.00	10.74	10.74	0.00	4.34	4.34	0.00	0.89	0.89	-0.14
1994	551955.19	553010.14	0.19	32.92	32.92	0.00	4.22	4.22	0.00	32.34	32.34	0.00	11.44	11.44	0.00	4.35	4.35	0.00	3.08	3.08	-0.04
1995	640674.52	641775.52	0.17	33.46	33.46	0.00	5.05	5.05	0.00	33.22	33.22	0.00	11.57	11.57	0.00	4.42	4.42	0.00	1.08	1.08	-0.13
1996	837383.94	838547.30	0.14	33.91	33.91	0.00	4.06	4.06	0.00	32.09	32.09	0.00	11.14	11.14	0.00	4.43	4.43	0.00	0.84	0.83	-0.18
1997	1420080.96	1421464.62	0.10	34.67	34.67	0.00	6.28	6.28	0.00	31.12	31.12	0.00	11.73	11.73	0.00	4.08	4.08	0.00	5.76	5.76	-0.03
1998	2982884.75	2987489.65	0.15	35.03	35.03	-0.01	7.12	7.12	0.00	32.15	32.15	0.00	11.97	11.97	0.00	4.13	4.13	0.00	3.72	3.72	-0.12
1999	2106093.05	2109974.84	0.18	35.40	35.39	-0.01	6.02	6.02	0.00	32.81	32.82	0.00	11.79	11.80	0.00	4.28	4.28	0.00	1.48	1.48	-0.28
2000	1978203.24	1982392.42	0.21	35.87	35.86	-0.01	4.61	4.61	0.00	32.98	32.98	0.00	11.61	11.61	0.00	4.37	4.37	0.00	1.57	1.56	-0.61
2001	2638333.93	2643280.19	0.19	36.38	36.38	-0.01	4.68	4.68	0.00	32.97	32.98	0.01	11.60	11.61	0.00	4.37	4.37	0.00	3.27	3.26	-0.02
2002	1783108.72	1788337.77	0.29	36.51	36.51	-0.01	4.35	4.35	0.00	33.43	33.43	0.01	11.51	11.51	0.00	4.47	4.47	0.00	2.77	2.76	-0.14
2003	1776162.22	1780509.19	0.24	36.01	36.01	-0.01	4.02	4.02	0.01	35.05	35.05	0.01	11.91	11.91	0.00	4.53	4.53	0.00	0.65	0.65	-0.02
2004	2330491.99	2334902.93	0.19	35.86	35.85	-0.01	3.45	3.45	0.01	34.85	34.86	0.01	11.66	11.66	0.00	4.60	4.60	0.00	0.44	0.43	-1.42
2005	2760119.84	2764894.90	0.17	35.75	35.75	-0.01	3.21	3.21	0.01	34.98	34.99	0.01	11.81	11.81	0.00	4.56	4.56	0.00	0.53	0.53	-0.20
2006	2934158.00	2938856.23	0.16	35.91	35.90	-0.01	4.61	4.61	0.01	35.33	35.33	0.01	11.91	11.91	0.00	4.56	4.56	0.00	1.98	1.98	-0.34
2007	3068035.13	3072740.76	0.15	36.35	36.35	-0.01	5.61	5.61	0.01	37.00	37.01	0.01	11.90	11.90	0.00	4.78	4.78	0.00	0.35	0.34	-2.04
2008	4497103.28	4492479.73	-0.10	36.87	36.87	0.01	7.06	7.06	0.00	38.32	38.33	0.01	12.17	12.18	0.00	4.84	4.84	0.00	0.26	0.26	-0.40
2009	4476461.60	4482140.26	0.13	38.01	38.00	-0.01	6.59	6.59	0.00	36.48	36.48	0.01	12.13	12.14	0.00	4.62	4.62	0.00	1.06	1.05	-0.66
Mean	**1501927.47**	**1504024.80**	**0.14**	**32.49**	**32.49**	**0.00**	**4.24**	**4.24**	**0.00**	**31.51**	**31.51**	**0.00**	**11.08**	**11.08**	**0.00**	**4.36**	**4.36**	**0.00**	**1.17**	**1.16**	**-0.32**
S.D	**1288063.58**	**1289107.50**	**0.07**	**4.04**	**4.03**	**0.04**	**1.46**	**1.46**	**0.00**	**3.68**	**3.68**	**0.01**	**0.88**	**0.88**	**0.00**	**0.21**	**0.21**	**0.00**	**1.39**	**1.39**	**0.77**
C.V.	**0.86**	**0.86**	**0.52**	**0.12**	**0.12**	**12.41**	**0.35**	**0.35**	**0.95**	**0.12**	**0.12**	**1.10**	**0.08**	**0.08**	**1.09**	**0.05**	**0.05**	**4.31**	**1.19**	**1.20**	**-2.42**

Table B.4 (continued)

Year	(f) Rest of the world																				
	Demand Price			Consumption Demand			Stocks Demand			Supply			Area Harvested			Yield			Import Quantity		
	Baseline (USD/Mt)	Scenario 4 (USD/Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)	Baseline (Mt)	Scenario 4 (Mt)	Change (%)
1982	406.31	406.53	0.05	231.67	231.63	-0.02	51.18	51.18	0.00	234.84	234.84	0.00	113.77	113.77	0.00	3.08	3.08	0.00	3.46	3.42	-1.11
1983	372.71	373.02	0.08	245.22	245.22	0.00	64.77	64.77	0.00	254.29	254.29	0.00	117.16	117.16	0.00	3.24	3.24	0.00	4.67	4.67	0.06
1984	359.20	359.47	0.08	249.12	249.08	-0.02	79.70	79.71	0.00	261.87	261.88	0.00	115.89	115.89	0.00	3.37	3.37	0.00	4.45	4.40	-1.06
1985	312.30	312.65	0.11	257.56	257.57	0.00	90.59	90.59	0.00	263.16	263.16	0.00	116.64	116.64	0.00	3.37	3.37	0.00	5.03	5.04	0.15
1986	298.28	298.86	0.20	259.51	259.45	-0.02	98.77	98.77	0.00	263.16	263.16	0.00	116.87	116.87	0.00	3.36	3.36	0.00	5.56	5.50	-1.03
1987	296.35	296.64	0.10	260.86	260.81	-0.02	101.45	101.45	0.00	259.83	259.83	0.00	114.03	114.02	0.00	3.40	3.40	0.00	5.68	5.63	-0.90
1988	353.97	354.29	0.09	272.77	272.79	0.01	109.39	109.39	0.00	273.66	273.66	0.00	117.84	117.84	0.00	3.47	3.47	0.00	7.78	7.80	0.28
1989	363.65	363.97	0.09	282.80	282.75	-0.02	114.53	114.53	0.00	284.91	284.91	0.00	118.49	118.50	0.00	3.59	3.59	0.00	5.95	5.89	-0.92
1990	365.62	366.15	0.14	290.65	290.55	-0.03	122.74	122.74	0.00	293.46	293.46	0.00	118.55	118.55	0.00	3.69	3.69	0.00	5.87	5.77	-1.56
1991	379.65	380.09	0.11	295.57	295.49	-0.03	122.71	122.71	0.00	288.88	288.88	0.00	117.83	117.83	0.00	3.66	3.66	0.00	7.38	7.30	-1.03
1992	379.85	380.31	0.12	299.16	299.08	-0.03	119.94	119.94	0.00	290.52	290.52	0.00	116.96	116.96	0.00	3.71	3.71	0.00	7.47	7.39	-1.08
1993	351.75	352.23	0.14	301.12	301.23	0.04	115.10	115.10	0.00	290.86	290.87	0.00	116.55	116.55	0.00	3.72	3.72	0.00	6.93	7.05	1.63
1994	366.50	366.99	0.13	305.07	304.98	-0.03	114.15	114.15	0.00	297.57	297.57	0.00	117.40	117.40	0.00	3.78	3.78	0.00	6.54	6.45	-1.31
1995	369.36	369.85	0.13	306.31	306.22	-0.03	113.09	113.10	0.00	298.86	298.87	0.00	117.99	117.99	0.00	3.78	3.78	0.00	8.56	8.48	-1.00
1996	412.79	413.28	0.12	315.68	315.68	0.00	116.64	116.64	0.00	312.29	312.30	0.00	119.85	119.85	0.00	3.89	3.89	0.00	8.89	8.89	0.01
1997	399.08	399.56	0.12	314.74	314.61	-0.04	120.75	120.76	0.00	315.59	315.55	-0.01	119.52	119.52	0.00	3.94	3.94	-0.02	8.03	8.02	-0.15
1998	373.44	373.90	0.12	324.25	324.17	-0.02	124.19	124.19	0.00	320.84	320.84	0.00	120.50	120.51	0.00	3.97	3.97	0.00	8.61	8.53	-0.93
1999	356.67	357.16	0.14	331.02	330.93	-0.03	134.66	134.66	0.00	331.98	331.98	0.00	123.04	123.04	0.00	4.03	4.03	0.00	9.61	9.52	-0.90
2000	326.25	326.75	0.15	327.00	326.91	-0.03	137.90	137.91	0.00	320.94	320.94	0.00	119.76	119.76	0.00	4.00	4.00	0.00	11.08	10.99	-0.78
2001	281.35	281.83	0.17	344.41	344.32	-0.02	123.86	123.86	0.00	322.59	322.60	0.00	119.27	119.27	0.00	4.04	4.04	0.00	7.87	7.79	-1.07
2002	262.40	262.96	0.21	338.48	338.39	-0.03	95.68	95.68	0.00	300.57	300.57	0.00	114.94	114.94	0.00	3.90	3.90	0.00	10.14	10.04	-0.97
2003	297.39	297.89	0.17	343.52	343.43	-0.03	78.17	78.18	0.01	313.34	313.35	0.00	117.36	117.36	0.00	3.99	3.99	0.00	14.81	14.72	-0.60
2004	336.01	336.50	0.15	339.25	339.17	-0.03	69.74	69.74	0.01	321.43	321.43	0.00	120.16	120.17	0.00	3.99	3.99	0.00	13.67	13.58	-0.63
2005	362.04	362.53	0.14	344.96	344.96	0.00	71.13	71.13	0.01	335.65	335.66	0.00	121.35	121.36	0.00	4.13	4.13	0.00	14.14	14.14	0.01
2006	384.25	384.76	0.13	349.81	349.82	0.00	67.98	67.99	0.01	336.40	336.40	0.00	121.90	121.90	0.00	4.12	4.12	0.00	13.55	13.56	0.08
2007	452.50	453.01	0.11	355.70	355.61	-0.03	69.47	69.48	0.01	343.80	343.80	0.00	121.80	121.81	0.00	4.21	4.21	0.00	15.93	15.84	-0.57
2008	708.15	708.72	0.08	363.01	362.91	-0.03	77.09	77.09	0.01	356.17	356.17	0.00	123.88	123.88	0.00	4.29	4.29	0.00	15.61	15.51	-0.63
2009	580.83	581.38	0.09	361.93	361.95	0.00	79.75	79.76	0.01	348.88	348.89	0.00	121.70	121.70	0.00	4.28	4.28	0.00	17.01	17.03	0.10
Mean	**375.31**	**375.76**	**0.12**	**307.54**	**307.49**	**-0.02**	**99.47**	**99.47**	**0.00**	**301.30**	**301.30**	**0.00**	**118.61**	**118.61**	**0.00**	**3.79**	**3.79**	**0.00**	**9.08**	**9.03**	**-0.51**
S.D	**88.59**	**88.61**	**0.04**	**38.44**	**38.43**	**0.02**	**24.41**	**24.41**	**0.00**	**31.53**	**31.53**	**0.00**	**2.59**	**2.59**	**0.00**	**0.33**	**0.33**	**0.00**	**3.90**	**3.90**	**0.67**
C.V.	**0.24**	**0.24**	**0.30**	**0.12**	**0.12**	**-1.04**	**0.25**	**0.25**	**0.48**	**0.10**	**0.10**	**4.22**	**0.02**	**0.02**	**0.74**	**0.09**	**0.09**	**-7.43**	**0.43**	**0.43**	**-1.30**

Appendix C: Consumer Expenditure, Producer Revenue and Net Revenue

Table C.1. Consumer Expenditure, Producer Revenue and Net Revenue for Malaysia, 1982-2009

Baseline

Year	Demand Price (MYR/MT)	Consumption Demand (mil. MT)	Consumer Expenditure (mil. MYR)	Supply Price (MYR/MT)	Quantity Supplied (mil. MT)	Producer Revenue (mil. MYR)	Net Revenue (mil. MYR)
1982	826.11	1.45	1197.83	991.11	1.08	1073.18	124.66
1983	708.51	1.52	1074.10	873.51	1.14	995.83	-78.27
1984	634.72	1.59	1006.63	799.72	1.02	815.40	-191.23
1985	652.19	1.52	988.26	817.19	1.25	1021.66	33.40
1986	613.64	1.52	931.47	778.64	1.17	907.13	-24.33
1987	528.60	1.35	712.11	693.60	1.09	758.46	46.34
1988	770.73	1.43	1105.88	935.73	1.14	1070.88	-35.00
1989	938.60	1.51	1417.41	1103.60	1.17	1290.81	-126.60
1990	971.35	1.48	1435.05	1219.35	1.28	1562.13	127.08
1991	878.41	1.53	1341.61	1126.41	1.16	1307.03	-34.58
1992	809.85	1.58	1281.40	1057.85	1.19	1254.07	-27.33
1993	731.66	1.65	1207.24	979.66	1.30	1278.13	70.88
1994	861.88	1.71	1473.23	1109.88	1.34	1485.47	12.24
1995	827.65	1.72	1419.72	1075.65	1.34	1443.15	23.42
1996	968.64	1.70	1648.61	1261.64	1.31	1651.84	3.23
1997	1052.74	1.84	1933.98	1373.48	1.29	1768.56	-165.42
1998	1386.58	1.94	2689.88	1702.58	1.26	2141.36	-548.52
1999	1266.45	1.95	2469.70	1580.40	1.28	2020.64	-449.06
2000	1180.51	1.95	2296.70	1495.65	1.42	2119.05	-177.64
2001	1034.91	2.01	2080.10	1350.80	1.36	1839.40	-240.70
2002	1122.04	2.01	2258.51	1448.44	1.41	2036.77	-221.73
2003	1107.12	2.03	2248.20	1430.63	1.49	2129.09	-119.10
2004	1062.47	2.05	2178.50	1396.80	1.44	2009.34	-169.16
2005	1173.01	2.15	2522.76	1501.73	1.44	2164.77	-357.99
2006	1217.52	2.17	2637.60	1651.75	1.40	2304.91	-332.69
2007	1334.89	2.35	3137.06	1734.09	1.47	2549.33	-587.73
2008	2465.68	2.50	6166.00	2854.22	1.54	4390.67	-1775.33
2009	1786.37	2.55	4555.79	2212.32	1.63	3616.63	-939.17
Mean	**1032.60**	**1.81**	**1979.12**	**1305.59**	**1.30**	**1750.20**	**-220.01**

Scenario 1

Year	Demand Price (MYR/MT)	Consumption Demand (mil. MT)	Consumer Expenditure (mil. MYR)	Supply Price (MYR/MT)	Quantity Supplied (mil. MT)	Producer Revenue (mil. MYR)	Net Revenue (mil. MYR)
1982	824.80	1.45	1196.04	973.30	1.24	1211.76	15.72
1983	671.05	1.52	1019.59	819.55	1.34	1100.70	81.12
1984	633.02	1.59	1004.04	781.52	1.23	962.31	-41.73
1985	597.05	1.52	907.68	745.55	1.50	1116.66	208.97
1986	483.49	1.52	735.56	631.99	1.44	910.62	175.05
1987	526.07	1.35	708.82	674.57	1.39	937.15	228.33
1988	737.78	1.44	1060.81	886.28	1.48	1311.66	250.86
1989	935.47	1.51	1412.94	1083.97	1.51	1640.77	227.83
1990	827.18	1.49	1232.87	1050.38	1.67	1757.82	524.94
1991	874.57	1.53	1336.05	1097.77	1.58	1735.48	399.43
1992	773.96	1.59	1227.13	997.16	1.63	1629.43	402.30
1993	727.57	1.65	1200.77	950.77	1.79	1697.60	496.83
1994	857.53	1.71	1466.13	1080.73	1.84	1990.94	524.81
1995	823.36	1.72	1412.69	1046.56	1.86	1950.75	538.06
1996	928.94	1.71	1584.40	1192.65	1.86	2213.68	629.28
1997	1047.47	1.84	1924.81	1336.14	1.86	2489.45	564.64
1998	1379.31	1.94	2676.68	1663.71	1.85	3077.44	400.77
1999	1184.80	1.96	2319.25	1467.35	1.92	2816.17	496.92
2000	1172.28	1.95	2281.55	1455.90	2.11	3074.76	793.21
2001	1026.57	2.01	2064.12	1310.87	2.08	2721.77	657.65
2002	957.01	2.03	1940.65	1250.77	2.18	2728.60	787.95
2003	812.42	2.06	1671.48	1103.58	2.32	2561.79	890.31
2004	1052.60	2.05	2159.20	1353.50	2.29	3099.21	940.01
2005	1162.90	2.15	2502.08	1458.74	2.32	3388.93	886.85
2006	1207.32	2.17	2616.61	1598.13	2.31	3699.24	1082.63
2007	1323.96	2.35	3112.70	1683.25	2.42	4065.88	953.18
2008	2454.98	2.50	6141.62	2804.66	2.53	7106.93	965.30
2009	1774.97	2.55	4528.55	2158.32	2.71	5846.23	1317.68
Mean	**992.09**	**1.82**	**1908.74**	**1237.77**	**1.87**	**2458.70**	**549.96**

Scenario 2

Year	Demand Price (MYR/MT)	Consumption Demand (mil. Mt)	Consumer Expenditure (mil. MYR)	Supply Price (MYR/MT)	Quantity Supplied (mil. MT)	Producer Revenue (mil. MYR)	Net Revenue (mil. MYR)
1982	822.91	1.45	1193.44	954.91	1.48	1413.60	220.16
1983	668.97	1.52	1016.56	800.97	1.60	1284.92	268.36
1984	630.55	1.59	1000.26	762.55	1.54	1174.32	174.06
1985	593.99	1.52	903.20	725.99	1.86	1349.40	446.20
1986	476.56	1.52	726.66	608.56	1.84	1122.34	395.67
1987	390.52	1.36	530.98	522.52	1.82	953.07	422.08
1988	601.62	1.45	872.46	733.62	1.97	1444.24	571.79
1989	799.09	1.52	1216.84	931.09	2.01	1875.61	658.77
1990	623.88	1.51	941.37	822.28	2.24	1845.60	904.23
1991	670.86	1.55	1037.24	869.26	2.19	1906.46	869.22
1992	570.33	1.60	914.82	768.73	2.28	1755.95	841.13
1993	523.50	1.67	873.66	721.90	2.48	1792.67	919.00
1994	653.08	1.73	1128.68	851.48	2.57	2191.21	1062.53
1995	618.98	1.73	1073.48	817.38	2.62	2143.81	1070.33
1996	688.30	1.73	1188.97	922.70	2.65	2445.06	1256.09
1997	783.60	1.86	1458.68	1040.20	2.70	2805.11	1346.43
1998	1116.43	1.96	2193.17	1369.23	2.71	3707.50	1514.34
1999	923.05	1.98	1828.79	1174.21	2.85	3341.74	1512.95
2000	908.73	1.97	1790.33	1160.83	3.12	3617.75	1827.42
2001	762.29	2.03	1551.00	1015.00	3.11	3153.07	1602.08
2002	674.37	2.05	1384.79	935.49	3.29	3080.64	1695.84
2003	825.03	2.06	1696.48	1083.84	3.52	3818.71	2122.23
2004	771.32	2.08	1601.90	1038.79	3.52	3659.81	2057.91
2005	885.82	2.18	1928.18	1148.79	3.59	4128.29	2200.11
2006	846.06	2.20	1861.37	1193.44	3.62	4319.92	2458.55
2007	991.10	2.38	2360.05	1310.46	3.77	4938.90	2578.86
2008	1922.72	2.55	4902.90	2233.55	3.97	8875.17	3972.27
2009	1418.50	2.58	3664.94	1759.25	4.24	7461.11	3796.17
Mean	**791.51**	**1.83**	**1530.04**	**1009.89**	**2.69**	**2914.50**	**1384.46**

Scenario 3

Year	Demand Price (MYR/MT)	Consumption Demand (mil. MT)	Consumer Expenditure (mil. MYR)	Supply Price (MYR/MT)	Quantity Supplied (mil. MT)	Producer Revenue (mil. MYR)	Net Revenue (mil. MYR)
1982	991.49	1.43	1422.75	1156.49	1.08	1252.25	-170.51
1983	807.30	1.51	1216.64	972.30	1.14	1110.51	-106.13
1984	762.26	1.56	1189.50	927.26	1.02	946.88	-242.63
1985	719.05	1.51	1085.21	884.05	1.25	1107.16	21.95
1986	737.16	1.49	1100.38	902.16	1.17	1052.28	-48.10
1987	634.39	1.34	848.54	799.39	1.10	875.58	27.04
1988	889.01	1.42	1266.06	1054.01	1.15	1208.04	-58.01
1989	1126.44	1.49	1681.88	1291.44	1.17	1513.06	-168.82
1990	996.97	1.48	1470.59	1244.97	1.28	1598.81	128.22
1991	1054.21	1.51	1593.31	1302.21	1.16	1512.19	-81.12
1992	933.39	1.57	1466.42	1181.39	1.19	1403.46	-62.97
1993	878.09	1.64	1437.20	1126.09	1.31	1471.75	34.55
1994	1034.37	1.69	1751.89	1282.37	1.34	1719.65	-32.24
1995	992.22	1.63	1622.26	1240.22	1.34	1667.69	45.43
1996	1120.28	1.69	1891.30	1413.29	1.31	1854.56	-36.75
1997	1263.42	1.82	2296.88	1584.16	1.29	2044.17	-252.70
1998	1663.89	1.91	3186.00	1979.90	1.26	2497.16	-688.84
1999	1430.93	1.94	2769.09	1744.87	1.28	2239.02	-530.07
2000	1416.63	1.92	2725.72	1731.76	1.42	2459.73	-266.00
2001	1241.90	1.99	2472.82	1557.79	1.37	2127.95	-344.87
2002	1159.02	2.00	2317.10	1485.42	1.41	2094.81	-222.29
2003	1328.59	2.01	2671.26	1652.10	1.49	2461.07	-210.18
2004	1274.98	2.03	2589.66	1609.31	1.44	2321.10	-268.56
2005	1407.64	2.13	2997.41	1736.35	1.45	2510.14	-487.27
2006	1461.07	2.14	3132.93	1895.30	1.40	2653.23	-479.70
2007	1600.58	2.33	3722.88	1999.78	1.48	2949.84	-773.04
2008	2958.96	2.46	7267.17	3347.50	1.54	5167.91	-2099.26
2009	2143.69	2.52	5397.60	2569.64	1.64	4225.91	-1171.69
Mean	**1215.28**	**1.79**	**2306.80**	**1488.27**	**1.30**	**2001.64**	**-305.16**

Scenario 4

Year	Demand Price (MYR/MT)	Consumption Demand (mil. MT)	Consumer Expenditure (mil. MYR)	Supply Price (MYR/MT)	Quantity Supplied (mil. MT)	Producer Revenue (mil. MYR)	Net Revenue (mil. MYR)
1982	826.11	1.45	1199.02	826.11	1.08	894.51	-304.50
1983	672.68	1.52	1023.24	672.68	1.14	765.32	-257.92
1984	634.74	1.59	1007.90	634.74	1.02	645.27	-362.62
1985	599.17	1.52	912.02	599.17	1.25	747.08	-164.94
1986	614.38	1.51	930.39	614.38	1.16	713.50	-216.89
1987	528.62	1.35	713.19	528.62	1.09	576.42	-136.77
1988	740.79	1.44	1066.65	740.79	1.14	845.55	-221.10
1989	938.63	1.51	1419.91	938.63	1.17	1094.43	-325.48
1990	830.76	1.49	1240.10	830.76	1.28	1061.36	-178.74
1991	878.46	1.53	1344.66	878.46	1.15	1014.06	-330.60
1992	777.77	1.59	1235.62	777.77	1.18	918.18	-317.44
1993	731.70	1.65	1210.19	731.70	1.30	950.55	-259.65
1994	861.92	1.71	1476.51	861.92	1.33	1148.98	-327.53
1995	827.69	1.72	1423.03	827.69	1.34	1106.09	-316.94
1996	933.48	1.71	1595.37	933.48	1.30	1217.33	-378.04
1997	1052.79	1.84	1938.95	1052.79	1.28	1348.99	-589.96
1998	1386.65	1.95	2698.34	1386.65	1.25	1734.91	-963.42
1999	1192.51	1.96	2340.71	1192.51	1.27	1516.67	-824.03
2000	1180.60	1.95	2304.06	1180.60	1.41	1662.71	-641.36
2001	1034.98	2.02	2086.15	1034.98	1.35	1401.57	-684.58
2002	966.12	2.03	1964.31	966.12	1.40	1351.42	-612.89
2003	1107.22	2.04	2256.33	1107.22	1.48	1636.44	-619.89
2004	1062.54	2.06	2186.44	1062.54	1.43	1519.59	-666.85
2005	1173.08	2.16	2531.28	1173.08	1.43	1681.33	-849.95
2006	1217.70	2.17	2645.70	1217.60	1.39	1689.37	-956.32
2007	1333.83	2.36	3142.90	1333.84	1.46	1947.59	-1195.32
2008	2465.77	2.51	6182.61	2465.77	1.53	3768.57	-2414.05
2009	1786.46	2.56	4567.04	1786.46	1.62	2902.27	-1664.77
Mean	**1012.75**	**1.82**	**1951.52**	**1012.75**	**1.29**	**1352.15**	**-599.38**