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Economic and Policy Evaluations and Impacts of the National Rice Development Policy Strategies in Malaysia: Self-Sufficiency, International Trade, and Food Security

Roslina Binti Ali
University of Arkansas, Fayetteville

Economic and Policy Evaluations and Impacts of the National Rice Development Policy Strategies in Malaysia: Self-Sufficiency, International Trade, and Food Security

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by

Roslina Binti Ali
MARA University of Technology, Malaysia
Bachelor of Business Administration, 1999
University of Arkansas
Master of Science in Agricultural Economics, 2008

December 2017
University of Arkansas

This dissertation is approved for recommendation to the Graduate Council.

Dr. Eric J. Wailes
Dissertation Director

Dr. Alvaro Durand-Morat
Committee Member

Dr. Jeff Luckstead
Committee Member

Dr. Valerie H. Hunt-Whiteside
Committee Member

Abstract

Despite the fact that the recent rice policy has been moving to a strategy of self-sufficiency while the status quo of the national rice economy remains ambiguous, Malaysia has made an extreme policy decision to pursue an autarky economy in its rice sector, thus closing borders from the international markets in the future. The goal of this dissertation research is to comprehensively evaluate a deep-rooted rice policy in Malaysia and analyze the holistic impacts of the self-sufficiency and international trade policies at the national and farm-household levels, utilizing economic frameworks. The protectionist policy measures using a Policy Analysis Matrix reveals that Malaysia is not a competitive rice producer since domestic production is unprofitable at the comparable world price level which leads to significant losses without providing subsidies and producer price support by the government. Since a comparable world price is lower, Malaysia has no comparative advantage in rice production, hence the ongoing interventionist policy approach causes inefficient market outcomes as a result of policy distortions. The analysis of spatial, partial equilibrium model indicates pursuing self-sufficiency would effectively punish consumers due to tremendous increase in prices, thus reducing demand for consumption. The government suffers from the self-sufficiency due to substantial requirements on additional subsidies, land inputs, and technological inefficiency which leads to economic losses. With affordability is a key pillar of food security, self-sufficiency policy strategy does not guarantee food security, instead, free trade allows a more food secure economy. These findings are supported by a farm-household model that shows free trade decreases poverty rates by allowing greater rice consumption. Rice farmers would benefit from self-sufficiency, yet losing from the international free trade, without subsidies. The impacts of protectionist, self-sufficiency, and free trade policies are often misconstrued to focus only on the production side protecting rice farmers' livelihoods and welfare. The government must consider the policy

effects on the economy as a whole, including farmers' and consumers' welfare, and agricultural economic efficiency. While political economy dominates policy outcomes relative to the goal of economic efficiency, this study provides key insights and empirical measures for non-distortionary policy options and future policy directions.

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Dedication

This dissertation work is dedicated to the most precious, important, and very special persons in my life– my loving father and late mother, Ali Salleh and Fatimah Hussin for their taught the value of tireless efforts and persistent hard work, and a very supportive husband and daughter, Sazuki Taib and Sabrina Sazuki for their patience, tolerance, and emotional supports throughout this study.

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Abbreviations

AANZFTA	ASEAN-Australia-New Zealand Free Trade Agreement
ACFTA	ASEAN-China Free Trade Agreement
AGRM	Arkansas Global Rice Model
AIC	Akaike Information Criterion
AIFTA	ASEAN-India Free Trade Agreement
AJCEP	ASEAN-Japan Comprehensive Economic Partnership
AKFTA	ASEAN-Korea Free Trade Agreement
AoA	Agreement of Agriculture
ASEAN	The Association of Southeast Asian Nation
ATIGA	ASEAN Trade in Good Agreement
BERNAS	Padiberas Nasional Bhd.
CES	Constant Elasticity of Substitution
CIF	Cost, Insurance, and Freight
DOA	Department of Agriculture, Malaysia
DOSM	Department of Statistics, Malaysia
DWL	Dead-Weight Loss
EPU	Economic Planning Unit, Malaysia
FAO	Food and Agriculture Organization
FOB	Free on Board
FOC	First Order Condition
FTA	Free Trade Agreement
GDP	Gross Domestic Product
HIES	Household Income and Expenditure Survey
HIS	Household Income Survey
IADA	Integrated Agricultural Development Area
IFPRI	The International Food Policy Research Institute
IMF	International Monetary Fund

IRRI	The International Rice Research Institute
KADA	Kemubu Agricultural Development Area
LPP	Farmers' Organization Authority
MADA	Muda Agricultural Development Area
MAFTA	Malaysia-Australia Free Trade Agreement
MARDI	Malaysia Agricultural Research and Development Institute
MCFTA	Malaysia-Chile Free Trade Agreement
MFN	Most-Favored Nation
MICECA	Malaysia-India Comprehensive Economic Cooperation Agreement
MJEPA	Malaysia-Japan Economic Partnership Agreement
MLE	Maximum Likelihood Estimation
MNZFTA	Malaysia-New Zealand Free Trade Agreement
MOA	Ministry of Agriculture and Agro-based Industry, Malaysia
MPCEPA	Malaysia-Pakistan Closer Economic Partnership Agreement
MTFTA	Malaysia-Turkey Free Trade Agreement
OECD	The Organization of Economic Co-operation Development
PAC	Public Account Corporation
PAM	Policy Analysis Matrix
PDF	Probability Density Function
PSD	Production, Supply, and Distribution
SSR	Self-sufficiency Rate Ratio
TN 50	National Transformation 2050
TPP	Trans-Pacific Partnership
USDA	United States Department of Agriculture
UN	United Nation
WTO	World Trade Organization

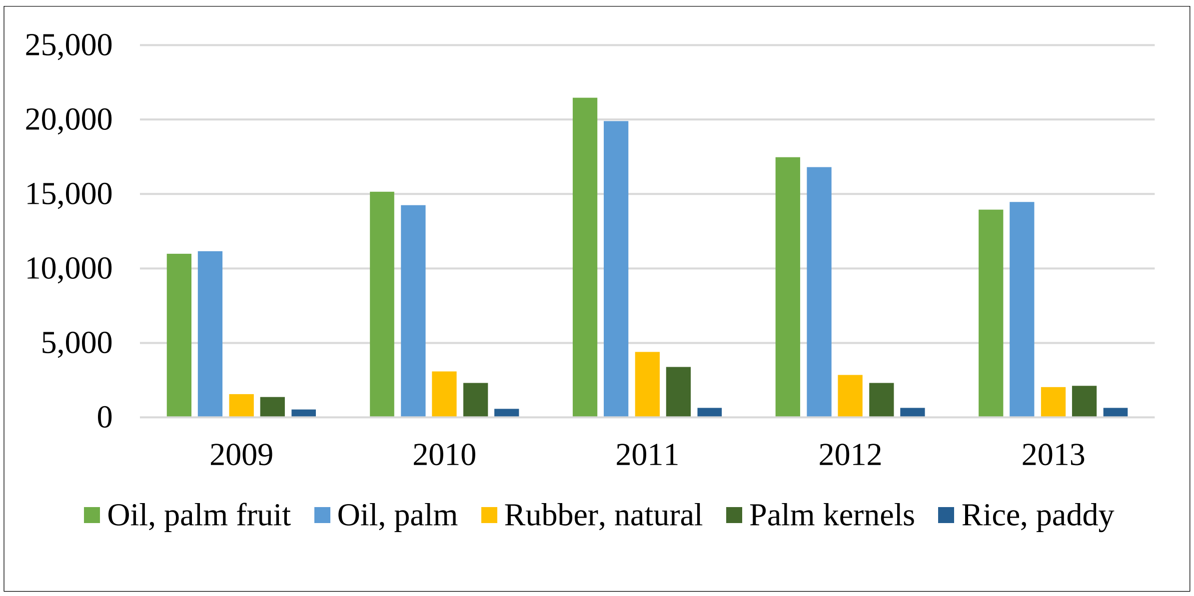
Chapter I
Introduction

1. Rice Policy Outlook

The severe aftermath of the 2007/08 food crisis has strained many rice-deficit regions, primarily in Asia where rice is the basic food staple. These countries have moved towards a self-sufficiency approach, primarily due to food security concerns. Having relied on rice imports for many years due to inadequate domestic rice production, and now having become one of the largest rice importers globally, Malaysia has made the same move. The food crisis in 2007/08 caused a food supply crunch due to spiraling high rice prices in the global markets, reflected in a tremendous cost increase of rice imports to Malaysia. This placed financial strains on both the government and consumers. In addition, the rice exporting countries imposed more shipment restrictions and even stopped supplying rice due to pressure from their domestic demands (Dawe and Slayton, 2010). The Malaysian government tightened security on the national food reserve by tremendously increasing the national rice buffer stocks. This essentially worsened the situation of the world market price for rice[1](Dawe, 2010). Subsequently, in the most recent policy goal reformulation, the government has decided to pursue and aim to achieve total rice self-sufficiency by the year 2020. This target date has been recently extended to 2050 under the new masterplan, the National Transformation 2050 (2020-2050), thus the government seeks to eliminate rice imports in the future (The Sun Daily, 2016; News Straits Times, 2014). The self-sufficiency strategy not only concerns food security, but also rice farmers' welfare, since poverty mitigation among poor farmers has been the goal since the origins of this national rice policy.

[1] The Malaysian government decided to immediately expand the national rice buffer stocks by six-fold which was administered by BERNAS, an import monopoly (Dawe, 2010).

Despite having contributed a relatively marginal share to the national income, rice remains a crucial agricultural food crop in Malaysia which holds a stake in Malaysian economics due to not only being a primary food staple for the nation, but also providing livelihood to local farmers. Relative to the major agricultural cash or plantation crops, palm oil and rubber, rice has made an essentially minor contribution to the national gross domestic production (GDP) value, ranging between US$ 737 and US$ 625 million in 2009 – 2013 (Food and Agriculture Organization, 2014) (Figure 1.1) from the total GDP of US$ 323.3 to US$ 202.3 billion in the same period (Department of Statistics, Malaysia).

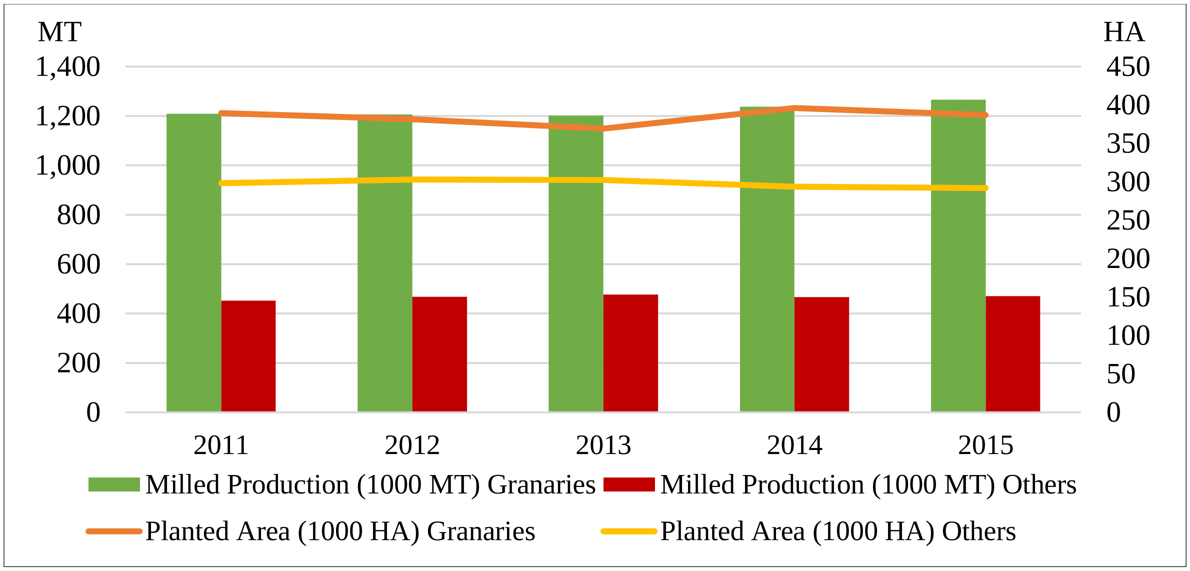


Source: Food and Agriculture Organization.

Figure 1.1: Gross production value of major agricultural crops (US$ Million).

The Malaysian rice industry largely exists in rural economies, subject to small-scale production, and unattractive returns for farmers which is characterized by the majority of rice farmers living in poor households. The biased development approach to encourage the cash plantation commodities, practiced by British colonials during the pre-independence era has highly shaped and influenced the current national rice development policy. Intended or not, this colonial plantation policy neglected small agricultural industries, leaving local and rural smallholders to grow food crops such as rice, vegetables, and fruits living in poor households. Consequently, rice receives special attention by the government in Malaysia, although it has no clear comparative advantage and competitiveness (Abu, 2012; Mohamed Arshad et al., 2011).

The interventionist rice policy regime has taken a deep root in Malaysia to guarantee that the self-sufficiency goal is achieved. Massive public investment and expenditures have occurred to realize the self-sufficiency goal primarily through input subsidies, followed by output subsidy and price support programs at the production level that consist of distorted prices of rice seeds, fertilizers, pesticides, chemicals, wages subsidies, output and paddy yield improvement incentives, and producer price support (the details of these subsidies are provided in Appendix Table 1.1). For instance, the Malaysian Department of Agriculture (DOA) reported that the government spent around RM 839 million (US$ 246.76 Million) for only input subsidies to boost domestic rice production in 2010 (DOA, 2010). In addition, the government has implicitly subsidized infrastructural requirements and the maintenance of irrigation, drainage, and water system facilities and supplies, especially for the designated regions (also known as Malaysian granaries). Thus, rice production in Malaysia has been highly subsidized (Rajamoorthy, 2015; Abu, 2012; Abdullah et al., 2010; Nee, 2008; Dano and Samonte, 2005) and regulated by the government. The designated rice production regions and their granaries play an important role in the Malaysian rice industry, and the country is highly dependent on these areas to achieve self-sufficiency goals. The granary regions produce 72.9% of domestic rice from 57% of the total planted area in 2015/16 (Figure 1.2).

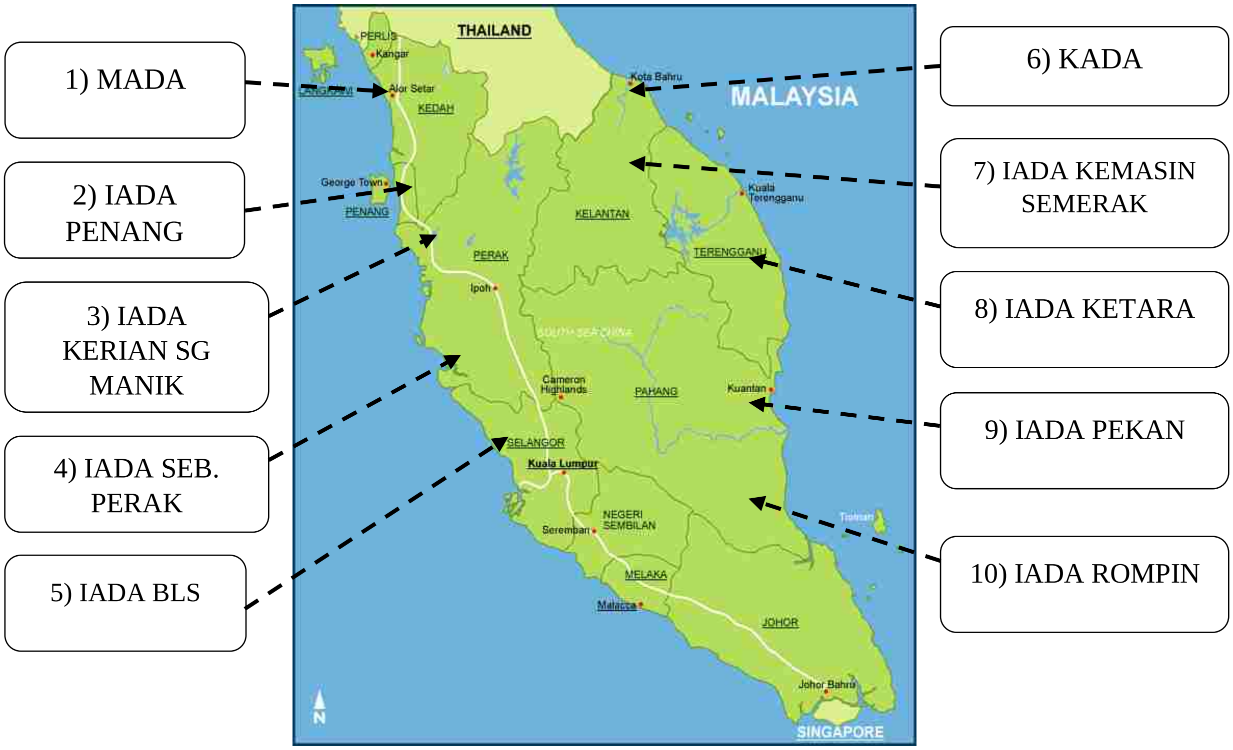


Source: Department of Agriculture (DOA), Malaysia.

Figure 1.2: Planted rice area and production in Malaysia.

Currently, there are 12 designated regions, of which the majority were historically developed in Peninsular Malaysia (Figure 1.3). New areas are extended into Sabah (IADA Kota Belud) and Sarawak (IADA Batang Lupar). The designated regions which can also be referred as a "rice bowl" to the country, are managed and maintained by the government. Rice is mostly grown on irrigated or wetland rain-fed lowland ecosystems. The suitability of the agricultural land is clearly one of the crucial constraints in the rice industry that forces the government to practice multiple cropping methods to achieve the national production goal. The rice cropping intensity now reaches as high as 180% in major areas and 170% in the rest. The high cropping intensity and the limiting soil requirements for irrigated rice gave rise to the development of non-irrigated rice varieties which include hybrid rice and upland rice[2].

[2] Upland (Aerobic) rice is a production system in which especially developed "aerobic rice" varieties are grown in well-drained, non-puddled, and non-saturated soils. The varieties are the combination of both the characteristics of the upland and the high yielding lowland rice varieties (IRRI).

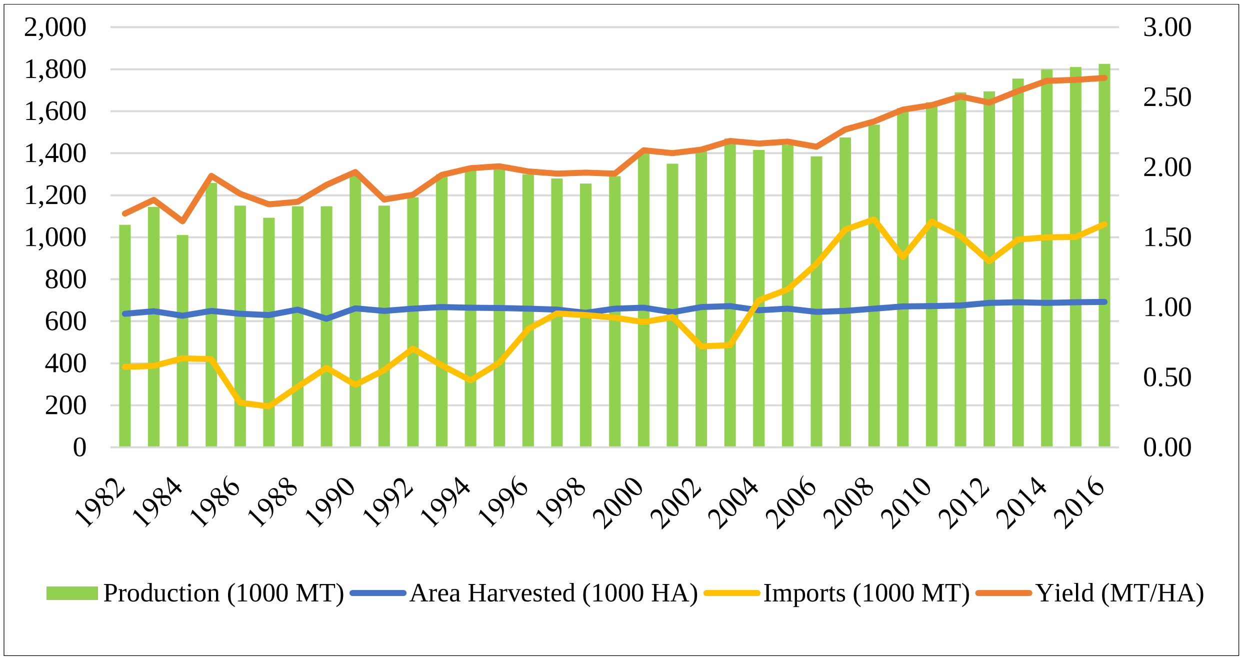


Source: Ministry of Agriculture and Agro-based Industry (MOA), Malaysia.

Figure 1.3: Designated national rice producing areas in Peninsular Malaysia.

2. Significance of the Study

A twofold and long-standing rice policy goal in Malaysia is 1) to improve food security and 2) to alleviate poverty among rice farmers. This largely dictates why the Malaysian government constantly mandates rice self-sufficiency as a crucial national policy measure (Ibrahim and Siwar, 2012; Tobias et al., 2012; Tey, 2010; Mohd Arshad and Abdel Hameed, 2010; Dano and Samonte, 2005). With limited agricultural land and high production costs, the government intervenes heavily into the domestic rice industry through substantially providing subsidies and price support programs to increase domestic production. These efforts are not only to attain a high degree of self-sufficiency, but also to ensure economic welfare of both rice farmers and consumers (Tey, 2010; Athukorala and Wai-Heng, 2007; Najim et al., 2007; Dano and Samonte, 2005; Mustapha, 1998). Despite these supports, rice productivity has improved slowly, and the nation has only produced between 65% to 70% of domestic requirements over many years. Rice production grew slightly as the total production marginally increased by 0.87%, which comes from a yield improvement of 0.52% and an increase in area harvested of 0.32% in 2015/16 (Figure 1.4).



Source: Production, Supply, and Distribution (PS&D), USDA.

Figure 1.4: Rice production, area harvested, imports and yield in Malaysia.

Many studies have concluded that this marginal production growth has resulted from inefficient policy strategies, which critically threatens overall food security[3] (Siwar et al., 2014; Abu, 2012; Vengedasalam et al., 2011; Mohamed Arshad et al., 2011; Mohamed Arshad and Abdel Hameed, 2010; Tey, 2010; Athukorala and Wai-Heng, 2007; Dano and Samonte, 2005;

[3] Food security refers to when all people at all times have physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life. Food security has three dimensions: availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports; access by households and individuals to adequate resources to acquire appropriate foods for a nutritious diet; and utilization of food through adequate diet, water, sanitation, and health care (Timmer, 2012).

Mustapha, 1996). A simulation study by Md. Amin (1989) found that the fertilizer subsidy programs provide a significant positive impact to improve rice yield, and thus increase the rice production output, yet the input subsidy programs have failed to reduce cost of production due to an upward trend in input market prices. With Malaysian farmers not likely to spend on additional fertilizer if the subsidies are eliminated (Ramli et al., 2012), the removal of these subsidies might negatively affect domestic rice production. It has also been argued that input subsidies are capitalized into the cost of production, raising the value of fixed inputs such as land, and paradoxically augmenting the cost of production. In addition, the price support policy was discovered as an ineffective and a non-sustainable approach to increase rice production (Mustapha, 1998; Baharumshah, 1991).

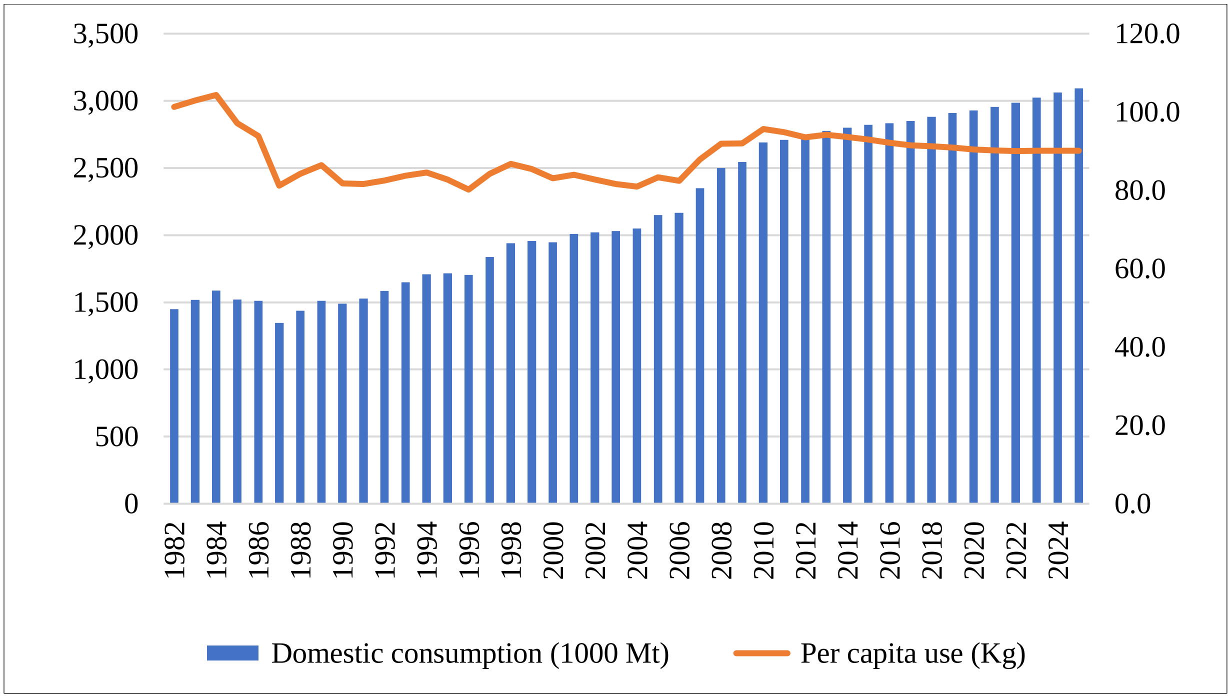
With these negative outcomes of the policy programs, the current sectoral performance shows that the national rice self-sufficiency goal is still unachieved (Table 1.1).

Table 1.1: Discrepancy between target and achieved rice self-sufficiency in Malaysia, 1966 – 2016.

National Development Plan	**Period**	**Targeted Self-sufficiency (%)**	**Achieved Self-sufficiency (%)**
First Malaysia Plan	1966 – 1970	n.a	80.0
Second Malaysia Plan	1971 – 1975	n.a	87.0
Third Malaysia Plan	1976 – 1980	90.0	92.0
Fourth Malaysia Plan	1981 – 1985	65.0	76.5
Fifth Malaysia Plan	1986 – 1990	65.0	75.0
Sixth Malaysia Plan	1991 – 1995	65.0	76.3
Seventh Malaysia Plan	1996 – 2000	65.0	71.0
Eighth Malaysia Plan	2001 – 2005	65.0	71.0
Ninth Malaysia Plan	2006 – 2010	90.0	72.0
Tenth Malaysia Plan	2011 – 2015	90.0	65.0
Eleventh Malaysia Plan	2016 – 2020	100.0	65.0*

Source: Economic Planning Unit (EPU), and MOA, Malaysia.
*Projection.

The policy goal to attain rice self-sufficiency has failed, hence the stimulative policy measures have not achieved the desired goals (Siwar et al., 2014; Abu, 2012; Vengedasalam et al., 2011; Mohamed Arshad et al., 2011; Mohamed Arshad and Abdel Hameed, 2010; Tey, 2010; Athukorala and Wai-Heng, 2007; Dano and Samonte, 2005; Mustapha, 1996). Despite the government's failed efforts, if the country attempts to achieve rice self-sufficiency, it would come at a high cost both in terms of financial as well as societal costs (Mohamed Arshad et al., 1983 and Abdullah et al, 2010). The interventionist instruments have also been debated in terms of long-term sustainability which have resulted in a high budgetary burden to the government, misallocation of resources, and demands for market liberalization. With the domestic consumption continuing to grow in the future, rice remains significant for the entire Malaysian population (Figure 1.5).



Source: International Rice Outlook (Wailes and Chavez, 2016).

Figure 1.5: Projections on domestic rice production and per capita use, 1982-2025.

Self-sufficiency is not a new strategy in Malaysian rice policy history. In fact, it has been emphasized since the 1930s, when the government began subsidizing domestic production to attain a high self-sufficiency level in order to prevent rapidly escalating food import bills and consequently release the country from the vulnerability of depending on external rice supplies. The self-sufficiency strategy was not only continued to address food security, but also has been used to measure national food security level (Ibrahim and Siwar, 2012; Tobias et al., 2012; Tey, 2010; Mohd Arshad and Abdel Hameed, 2010; Dano and Samonte, 2005). While self-sufficiency and food security are somewhat separate concerns, the government and policy makers have often misinterpreted food security to self-sufficiency. The perception of food security in Malaysia is narrowly interpreted as the ability of the country to provide adequate food entirely through domestic production, which implies the government's stance on food security is largely referred to as complete dependence on domestic production without supplement from external sources. Thus, this misconstrued standpoint calls to redefine food security to not only rely on self-sufficiency through subsidizing and regulating with various policy programs, but also requires the integration of capital, energy, technology, and experienced management into sustained efforts to heighten the efficiency of rice production (Alavi et. al, 2012). Self-sufficiency has been revealed as an inefficient, a costly, and a counterproductive path to food security (Alavi et al., 2012), while also proving to be a large challenge to policymakers. Even if a self-sufficiency strategy is technically feasible, it would require for massive efforts and expenditure (Overton, 1999). In addition, the drive for food self-sufficiency may not be an appropriate or an efficient policy strategy for the rice sector in Malaysia (Overton, 1999). From a household perspective, rural households may be forced into food self-sufficiency by lack of market access. With the market accessibility as a key concept of food security, encouraging households into self-sufficiency is not a useful strategy to either achieve food security objectives or to reduce poverty (Galero et. al., 2014). Because of this, self-sufficiency in rice is more likely to be more a political strategy rather than a poverty-reducing rational (Timmer, 2010).

Having limited competitive rice production (Najim et al., 2007), Malaysia struggles to achieve a rice self-sufficiency level, due to food security issues, financial burden, trade agreements, and competition with industrial crops throughout the years. Malaysia embarked on an ambitious goal to achieve self-sufficiency in the rice sector (Goldman, 1975) through heavy government interventions. Tey (2010) suggested that the country certainly needs to reexamine the current policy approach due to costly intervention, particularly on subsidy programs. Furthermore, food self-sufficiency approach has been widely criticized as a misguided policy decision and furthermore that it seeks to achieve food security that reflects political priorities over economic efficiency (Clapp, 2017). The goal of self-sufficiency which means to food security is a political goal while economically is distorted, costly, and inefficient, and thus the Malaysian rice policy has become a political delusion (Dano and Samonte, 2005).

Future Malaysian rice production and supply are going to be more uncertain and may result in more volatile prices (Ibrahim and Siwar, 2012; MOA, 2011). Even compared to the widely accepted standard of sustainable agriculture[4], the recent agricultural policies in Malaysia are not supportive to sustainable agricultural practices (Murad et al., 2008). According to the

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[4] (1) Improved farm-level social and economic sustainability enhances farmer's quality of life, (2) increases farmers self-reliance, (3) sustains the viability/profitability of the farm, (4) improved wider social and economic sustainability improves equity socially supportive and meets society's needs for food and fiber, (5) increased yields and reduced losses while minimizing off-farm inputs, (6) minimizing inputs from non-renewable sources, (6) maximizing use of (knowledge of) natural biological processes and promoting local biodiversity/environmental quality (U.S Farm Bill, 1990; Pretty, 1995; Ikerd, 1993; Hodge, 1993; Swedish Society for Nature Conservation, 1999).

International Rice Research Institute (IRRI), "the global rice market, which is relatively small compared with that of other major food crops such as wheat, maize, and soybeans, is likely to become even smaller if rice-consuming countries vigorously pursue self-sufficiency strategy. A consequence of a smaller market is greater price volatility and, the smaller the market size is, the more prices have to move in response to any supply and demand shock" (IRRI, 2016).

The typical policy responses by the net rice importing countries after the food crisis generally involved the reduction of import duties, the building up of extra reserves, the reduction of import restrictions, price controls through subsidies, and more importantly, the promotion of self-sufficiency (Chandra and Lontoh, 2010). To a large extent, policy responses at the national level have not only contributed to further global food price volatility (Slayton, 2009), but also have undermined the food security situation in the region (Chandra and Lontoh, 2010). An ex-post analysis of the 2008-food crisis found that government policies and panicky responses were the key factors behind soaring rice prices (Alavi et al., 2012). There were also arguments that the recent food crisis could have stemmed from a shift in policy towards heavy governmental intervention to boost food production, control food prices, and provide more reliable access for poor households, since the interventions involved significant costs (Timmer, 2010; Dawe, 2010). The catastrophe of the crisis revealed the urgent need to reexamine and reform policies that trigger not only the immediate catastrophe, but also the potential for recurrence. Unfortunately, "The government interventions seem simply like attempts to recycle the past, harking back to self-sufficiency[5], while also reconsidering internal market emphasis during the 1960s and 1970s, which fostered large productivity gains, improved crop yields, disease-resistant seeds, food

[5] In the context of food security, the self-sufficiency ratio is indicated by the ratio of a country's own production relative to domestic consumption, i.e. the higher the ratio the greater the self-sufficiency.

supply chain revolution, and so forth" (Alavi et al., 2012). Instead of needing to be developed for the next phase of competitive capability, the rice sector has been pulled backwards, focusing on a self-sufficiency strategy and pushing local rice production. While Malaysia often associates food security with complete self-sufficiency as well as its dependency on government programs, food security cannot easily be achieved through domestic production.

With the domestic production having been stagnant for many years, the elimination of subsidies could potentially increase net welfare and government revenues (Vengedasalam et al., 2011), but with changing the current import policies. Some research hypothesized that the price support policy might have been justified on grounds of income distribution or the government's favor for political interests (Dano and Samonte, 2005; Baharumshah, 1991). In addition, the authorization of BERNAS as a sole importer and distributor in the Malaysian rice sector would not hide political reasons behind the sound of economic rationale (Dano and Samonte, 2005). A "single-desk" import policy instrument can also threaten food security as the domestic support price is staked above the world price under a monopsony market structure and the failure of the government to control market price instability, resulting in severe inflation (Vengedasalam et al., 2011). Thus, the policy decision of authorizing a sole importer has trade-distorting effects as the government provides a privilege to be a monopsony rice buyer (Abu, 2012; Vengedesalam et al., 2011).

Malaysia has been a net rice importer for many years and is expected to remain dependent on rice imports in the future to support a domestic shortage supply. The baseline projections using the Arkansas Global Rice Model (AGRM) indicate that Malaysia is likely to import around 1.6 million tons in 2025 (Wailes and Chavez, 2016). Despite the call for a more liberalized market by the World Trade Organization[6] (WTO) since the 1960s, the importation of rice reflects a trade-off of self-sufficiency for financial sustainability as imports are considered to be cost saving (Mohamed Arshad et al., 2011; Tey, 2010; Mustapha, 1996). Malaysia's participation in free trade agreements (FTAs) suggests that opening to freer trade and elimination of tariffs on rice is a key strategy going forward but also in conflict with the rice self-sufficiency goal.

Alternatively, trade openness improves each dimension of food security, increasing food availability through enabling products to flow from surplus to deficit regions (OECD, 2014). A previous study projected that Malaysia would be able to sustain the maximum of 70% of self-sufficiency in the long-term due to complying with trade agreements (Mohamed Arshad et. al, 2011). In theory, trade expands rice markets, and thus opens access to additional sources that could be a remedial approach to domestic production scarcity, so that rice supply and demand would be met. In fact, trade balances the deficits of net food importers with the surpluses of rice exporting countries. In the absence of trade, food prices would be higher in net importing countries in order to bring national supply and demand into equilibrium, potentially worsening the food security status quo in those countries. In addition, rice imports may help lower food prices for poor, low-income, and undernourished groups, which is crucial in times of disruptions to and uncertainty of domestic production, from climate change, crop diseases, and so forth. According to the World Bank, the liberalization exercise contributes to a reduction in poverty incidence among farm households without exacerbating income inequality and thus generates gains to the poor (Ganesh, 2005). Durand-Morat and Wailes (2011) postulated that Malaysia has

[6] The World Trade Organization (WTO) is the only global international organization dealing with the rules of trade between nations, primarily the WTO agreements, negotiated and signed by the bulk of the world's trading nations and ratified in their parliaments. The goal is to help producers of goods and services, exporters, and importers conduct their business.

the potential to be a food secured nation resulting from rice trade liberalization through a significant decrease in consumer prices. Regional trade agreements are hypothesized to receive positive responses from participants. "Since the issuance of the ASEAN Integrated Food Security framework in 2008 and the further successful adoption of the ASEAN Trade in Goods and Agreement[7] (ATIGA) in 2009, rice deficit countries within the region would prefer to hang tenaciously on their long-held goal of rice self-sufficiency" (Alavi et al., 2012). The Trans-Pacific Partnership[8] (TPP) agreement also seeks to open trade initiatives among the members, particularly major rice exporters – Vietnam and Australia – thus contributing to food security (Malaysia International Trade Industry, 2015). Given that the self-sufficiency strategy in Malaysia's rice sector is misconstrued towards food security as well as rice farmers' and consumers' welfare, it is crucial to evaluate and analyze the national rice development policy comprehensively.

3. Purpose of Research

The general objective of this study is to examine deep-rooted national rice policy strategies in Malaysia. This encompasses the evaluation of a long-held self-sufficiency policy strategy to address food security and poverty concerns in light of the country's regional and bilateral trade participations. The specific objectives below will be achieved in comprehensive studies in Chapter II, III, and IV:

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[7] ASEAN Trade in Goods Agreement (ATIGA) aims to achieve free flow of goods in the region resulting to less trade barriers and deeper economic linkages among members, lower business costs, increased trade, and a larger market and economies of scale for businesses (ASEAN, 2017).

[8] The Trans-Pacific Partnership (TPP) agreement is a trade agreement between Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, Vietnam, and the United States (until January 23, 2017).

1) To measure the profitability, competitiveness, and the efficiency at production level of rice industry in Malaysia using a Policy Analysis Matrix (PAM) framework.
2) To estimate the impact of rice self-sufficiency and international trade policies in Malaysia at the national level using a partial, spatial equilibrium model.
3) To measure the impacts of international trade policy on rice production and consumption, poverty, and farmers' welfare at the household level on individual rice farmers in Malaysia using a Farm-Household model.

This research will address these overarching questions:

1) Should Malaysia maintain the current policy to pursue self-sufficiency in rice? (in both political and economic perspectives)
2) What are the consequences and welfare impacts of pursuing self-sufficiency in rice to farmers, consumers, and the government?
3) If Malaysia anticipates eliminating rice imports, how could the country achieve self-sufficiency in rice with respect to policy requirements?
4) What are the impacts of allowing free trade in rice on farmers, consumers, and the government?
5) How does the free trade policy affect individual rice farmers with respect to rice production and consumption, poverty, and welfare?

These policy evaluations and analysis would help to identify holistic impacts of the self-sufficiency and international trade policies on rice farmers, consumers, and the government at both the macro and micro levels.

4. Research Approach

This dissertation research evaluates rice policy interventionist strategies, and the impacts of self-sufficiency, international free trade, and food security at the national and farm-household levels to address the rice policy concerns in Malaysia. A comprehensive evaluation will be conducted covering the rice policy from the production level to the market, through conducting different research analyses and using different quantitative methods to measure the impact of rice policies holistically on farmers, consumers, and the government. This study begins with evaluating the competitiveness and efficiency in rice production policy using the Policy Analysis Matrix approach. The impact of self-sufficiency and international trade policies is presented in Chapter III using the RICEFLOW model to simulate alternative outcomes. Chapter IV analyzes the impact of international trade policy on rice farmers using the Farm-Household model. The results of the study will reveal the (in)efficiency of the food security policy.

4.1 Competitiveness and Efficiency in Rice Production

While limited studies attempt to measure competitiveness and efficiency of the rice industry in Malaysia, a few studies concluded that the industry has no clear comparative advantage. The evaluation at the production level visualizes the production performance given current technologies and policies. Using the Policy Analysis Matrix (PAM), originated by Monke and Pearson (1989), this study quantitatively measures the impact of the interventionist policies on profitability and the efficiency of resource used in the rice production system, and thus the competitiveness and the comparative advantage of the rice industry can be analyzed. PAM is a recognized approach and has been widely applied in the agricultural sector to implement an analytical process and to act as an empirical method for measuring the effects of policy on the rice sector. PAM provides a helpful framework to understand the effects of policy and serves as a useful tool to measure the magnitudes of policy transfers. Therefore, PAM can address and investigate crucial policy concerns, dealing with the competitiveness of production systems, which are associated with farm incomes, the efficient allocation of resources in agriculture and the comparative advantage, and the effects of policy and market failures with the allocation of investment to the agricultural sector (i.e. policy transfers).

4.2 Evaluations and Analysis of Self-sufficiency and International Trade

With the production status quo having been estimated in the PAM analysis, this study estimates deeper policy consequences of self-sufficiency and international trade policies on the rice sector at the macro level. The simulated estimations focus on the producer prices, consumer prices, domestic production, and rice imports under the self-sufficiency and free trade scenarios. From the self-sufficiency scenario, we then measure the subsidy, production factor, and technological efficiency requirements. From these measures, the government revenue or losses can also be identified and estimated. As the government recently decided to pursue self-sufficiency through removing bilateral rice trade, the impact of the self-sufficiency strategy has become extremely important to be determined which could provide a useful perspective for the government and policymakers in rice policy decisions. This study utilizes a partial, spatial equilibrium model, developed by Durand-Morat and Wailes (2010) that is based upon a spatial price equilibrium model specified by Takayama and Judge (1964). The model is identified as a spatial partial equilibrium of the global rice economy which simulates the behavior of the entire rice supply chain, from input markets to final consumption in multiple regions.

4.3 Evaluations and Analysis of International Trade on Farm-Household

The price estimations from the RICEFLOW simulation analysis are then applied at the micro level to measure the impact of rice policy to individual rice farmers at the household level, since farmers play an important role in achieving the rice policy goal. In addition, rice policy has aimed to improve livelihood and welfare, and to alleviate poverty among rice farmers for decades, thus determining the impact of rice policy at the farm household level is crucial. This study measures the impact of free trade policy on rice farmers. Although Malaysia actively participates in free trade agreements at both bilateral and regional levels, rice has been excluded from the agreements as it is identified and classified as a sensitive commodity. The government stance has been to favor rice farmers on an individual level without consideration being given how the policy affects the economy as a whole. On a purely theoretical level, free trade does hurt local rice farmers, yet, the magnitude of the impact requires a comprehensive study so that the effects can be quantitatively measured. This study develops a farm-household model for the individual rice farmers in Malaysia to measure the effects of the free trade on rice farmers with respect to poverty and welfare.

The three studies are organized to begin with: 1) the evaluation at the production level through evaluating the protectionist rice production policy in Chapter II, 2) the impact of self-sufficiency and international trade policies at the national level in Chapter III, and 3) the impact of international trade policies at the farm household level in Chapter IV. The policy implications from these comprehensive studies are discussed in Chapter V as the concluding remarks.

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Appendix Table 1.1: Current rice subsidy and policy programs in Malaysia.

Policy	Program	Description
Agricultural Input	Fertilizer subsidy of Federal Government Scheme	4 bags/ ha @ 20 kg/bag of Urea 12 bags/ha @ 20 kg/bag of Compound (NPK)
	Paddy production incentive of additional fertilizer	5 bags/ha @ 20 kg/bag of Organic, or 6 bottle/ha @ 1 liter/bottle of Foliar
	Rice production incentive for National Food Security Policy	Additional NPK: 6 bags/ha/season; 25 kg/bag Pesticides: RM200/ha/season Chemical: 3 Mt/ha (Once in 3 years)
	Paddy seed incentive	RM 1.03/kg (Paddy seed producers receive the value for supplying rice seeds)
Labor	Paddy production incentive (plowing)	RM 100/ha (Farmers receive the value for wages in plowing)
Production Output	Paddy price subsidy	RM 1,200/Mt (Farmers are paid at a producer price support)
	Paddy production subsidy	RM300/Mt (Farmers receives the value from output production)
	Yield increase incentive	RM 650/Mt (Farmers receive the value for yield increase)
Consumption	Rice subsidy	Rice voucher to low income group for ST15%
International Trade	ASEAN Trade in Goods Agreement (ATIGA)	20% *ad valorem* tariff of rice imports from most favored nations (MFN)
	Agreement on Agriculture[9] (AoA) of the World Trade Organization (WTO)	40% *ad valorem* tariff of rice import

Source: Ministry of Agriculture and Agro-based Industry, Malaysia; Ministry of International Trade and Industry (MITI).

[9] The Agreement on Agriculture (AoA) was negotiated during the Uruguay Round of the General Agreement on Tariffs and Trade, and entered into force with the establishment of the WTO on January 1, 1995.

Chapter II
Measuring the Competitiveness and Efficiency of Rice Sector in Malaysia Using Policy Analysis Matrix

Abstract

Despite having exerted distorting effects on not only rice markets, but also production input and factors markets, protectionist policies remain the most favored government's policy strategy in Malaysian rice industry. A wide range of policy programs have been mandated, which mainly embrace input and output subsidies, and producer support price in line with the self-sufficiency goal. Despite its small contribution to the national income, rice receives special attention and has been given a priority in series of the national development policies and resources due to a crucial and sensitive political issue to maintain rice farmers' livelihoods and welfare. Using the policy analysis matrix approach, this study measures the extent to which rice policies have distorted domestic markets and the impacts of the interventionist policies on rice production in Malaysia. The results reveal that without domestic supports, rice production is significantly unprofitable. Despite having been protected by the government, the rice production system is not competitive, and the protectionist strategy leads to policy distortions. Relative to rice imports, domestic rice has no comparative advantage since the imported rice indicates much lower at the comparable world price. Therefore, the government's interventionist policy instruments significantly have failed to drive competitiveness in the rice sector. In fact, policy distortions would induce unnecessary efficiency losses to realize the national self-sufficiency goal. Hence, the government policies should focus on the economic development at the macro level instead of stimulating policies to highly subsidize the rice economy. This study provides key measures of the effects of rice policies on the Malaysian rice production system that could be a guideline for policy decisions.

1. Introduction

While having no clear comparative advantage in rice production, Malaysia has continued supporting domestic rice primarily due to long-held policy objectives – to increase local farmers' livelihoods and to address food security concerns, which subsequently tend to realize the national self-sufficiency goal. A wide range of policy programs, especially at the level of production have been implemented to constantly support the rice industry, which mainly includes subsidy provisions of both inputs and outputs, farm infrastructures (including irrigation and water systems) and maintenance, and credit facilities using substantial public investment. As a result, rice has become a highly subsidized and protected food crop in Malaysia. In fact, rice is given a priority in the series of the national development policies and the government's funds for many years. However, the competitiveness of the rice industry and the efficiency of policy programs have been debated since the domestic production indicates a stagnant performance over many years, while use of subsidies has become the most favored policy strategy in national rice policy.

Currently, over half of the rice production cost is subsidized by the government which includes the majority of input costs for seeds, fertilizers, chemicals, and pesticides. For instance, fertilizer subsidies were 63.7% or RM 1.2 billion (US$ 300 million) from the total RM 1.9 billion (US$ 475 million) subsidy and incentive spending on rice farmers in 2016 (Mstar, 2016). Other subsidies include supports for production output and producer price. A projection showed that the elimination of producer price subsidies would negatively affect the local rice industry, on average decrease domestic production by 13%, decrease cultivated area by 13%, and reduce producer price by 20%, yet demonstrated no impacts on rice consumption because imports are allowed to fill the gap (Suleiman et al., 2014). The current producer price is highly protected and regulated above the world price to encourage rice farmers to boost their output as domestic rice sector has not been able to compete in an open market (Mohamed Arshad et al., 2007). The government also regards the subsidy programs as a crucial and sensitive political issue to maintain support of the rural sector since poverty is relatively high among rice farmers who mostly are Malays (Mohamad Arshad and Mohayidin, 1990).

In spite of government efforts to achieve a high degree of rice self-sufficiency, over the past several decades, rice production can only satisfy between 65% and 70% of domestic consumption each year. Several studies have found that the unfavorable outcomes stemmed from inefficient policy strategies due to the emphasis on self-sufficiency. Although studies also suggested significant positive effects of fertilizer subsidies on rice production, a substantial amount of subsidies would be reflected in costly use of tax payers' dollars and higher consumers' prices, yet since domestic production has been dormant for years, elimination of subsidies could potentially increase the economic net welfare and government revenues (Vengedasalam et al., 2011). Malaysia has practiced a price support policy in the rice sector since 1949, perhaps due to colonial roots, to purportedly guarantee the welfare of both rice farmers and consumers, claiming that this offers a fair price to both sides. The domestic producer price has recently increased to RM 1,200 (US$ 300) per metric ton paddy basis while the current world market rice price was US$ 280 per metric ton (United Nation, 2016). Despite having shown positive impacts to self-sufficiency, food security, and production sustainability, the producer price subsidy led to losses for the government (Mustapha, 1998). In addition, the Public Accounts Committee of Malaysia (PAC) reported significant difficulties administering the most recent subsidy, which were misappropriated during the reimbursement process to the appointed private vendors due to the management and supervisory deficiencies that resulted in a discrepancy in government accounts (*Berita Harian*, 2016).

Given those shortcomings, why does the government continue subsidizing rice farmers? Although the government is often motivated to provide production subsidies for farmers' livelihoods and welfare, it is possible that subsidies, which are supposed to be an economic effort, have been inappropriately abused and misused by interest groups and those seeking patronage, thus turning them into a political tool. It has been argued that, using taxpayers' dollars, the subsidies acted as an 'exchange' for political votes, hence rice in Malaysia becomes a political commodity. Often, monolithic political interests intrude on policy decisions, causing the government to constantly intervene in the rice domestic rice industry. This study evaluates and analyzes the impact of government protectionist policy on the rice sector and industry in Malaysia. The specific objectives are: 1) to measure the profitability of rice production at a private and social level of production costs; 2) to measure the competitiveness and efficiency that are reflected in policy transfer; and 3) to provide useful economic perspectives to the government and policymakers.

2. Theoretical Framework of Interventionist Policies

Government intervention, mainly subsidy and trade barriers have affected input and output prices that causes domestic prices to differ from international market prices. The interventionist policies drive a wedge between the world and the domestic price, restrict imports, and thus raise the domestic price above the world price. Either of those policies are intended to support producers, a subsidy and trade barrier transfer costs to consumers and the government resulting in welfare losses. The price changes would create policy distortions in some ways: 1) the quantities of the commodity that are produced, consumed, and traded (imported or exported),

2) the income transfers to/from producers, consumers, and the government budget, and 3) the efficiency losses in production and consumption.

The graphical description of input subsidy policy implication is shown in Figure 2.6[10]. This figure indicates that the market price for rice (P_1) shifts down from the equilibrium price (P_o), P_o to P_1, which implies consumers pay a lower price when production inputs are being subsidized, thus encouraging farmers to produce more outputs. Both farmers and consumers are better off from the input subsidy as both producer and consumer surpluses increase. Change in producer surplus is a gain of area a and b. Change in consumer surplus is a gain of c, d, and e. The total cost of subsidy is area a, b, c, d, e, and f, while f indicates the deadweight loss. The subsidy leads to a net economic loss to the country and an income transfer from taxpayers to consumers and producers. The government loses from the input subsidy policy, paying the input subsidy costs.

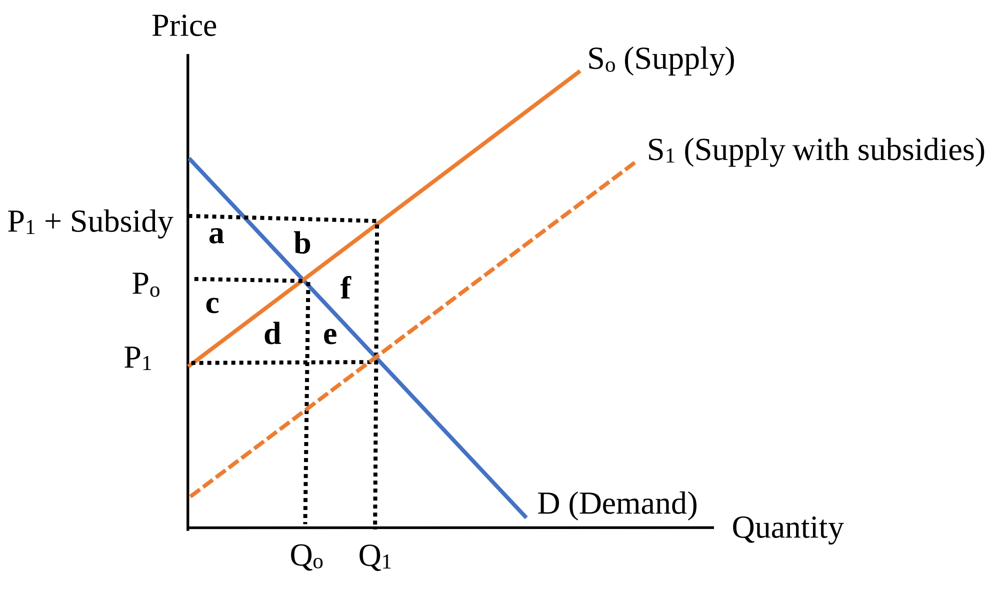

Figure 2.6: Welfare effects of domestic production subsidies.

[10] The graph does not follow the exact scale and coordinate, and therefore the affected areas do not represent the actual amount and quantity.

A producer price support policy raises the producer price (P_1) above the original market equilibrium price. This figure implies that consumers pay for the price support. The consumers surplus loss is the area below the demand curve and between P and P_1 (a + b). The producer surplus gain is the area above the supply curve between the P and P_1 (a, b and c). The surplus production $Q_2 – Q_1$ has a market value where Q_2 intersects the demand curve. However, if the government pays for the price support then the market price will fall where the Q intersects the demand curve benefitting consumers. The government loses from the guaranteed producer price policy (Figure 2.7).

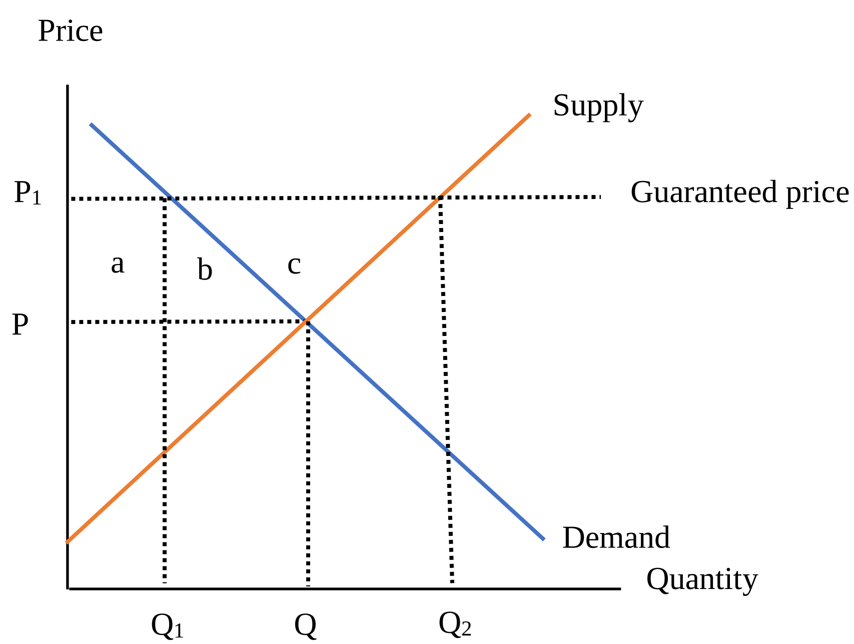

Figure 2.7: Welfare effects of producer price support policy.

3. Data and Method

3.1 Data Integration

This study utilizes secondary data from the government reports and databases from various institutions which include production budgets for rice and import prices. The production budgets were obtained from the annual reports by the Malaysian Department of Agriculture (DOA) and Farmers' Organization Authority (LPP) in production years 2014 and 2015. These production budgets were obtained for the major rice producing regions in Peninsular Malaysia, which are the largest rice subsidy recipients and are highly regulated by the government. Therefore, the costs and revenues data from these regions are considered the most accurate sources to be analyzed and thus represent the observed data for the effect of policy transfer analysis in the Malaysian rice production system. The CIF (cost, insurance, and freight) and the FOB (free on board) prices are obtained from the Malaysian Department of Statistics (DOSM) and the United Nation Comtrade database for 2014/15 marketing year. These prices are used to estimate the world comparable price at social level. The transportation, handling, and distribution costs of rice imports are obtained from BERNAS, the solely rice importer. With these data, both private and social valuations can be estimated.

3.2 Policy Analysis Matrix

To estimate private profits, social profits, and the effects of divergences, the principal analysis of this study employs the policy analysis matrix (PAM) approach which can also measure the competitiveness and the efficiency of rice production in Malaysia. PAM which was developed by Monke and Pearson (1989), is widely used and recognized as a useful method to analyze the impact of government policy on the profitability of agricultural systems and on the efficiency of resource use (see example: Yao, 1997; Ekasingh et al., 2000; Elbadawi et al, 2013;

Ude et al, 2013; Kanaka and Chinnadurai, 2013; Akramov and Malek, 2012; Basavaraj et al., 2013; Dibrova and Chan-khi, 2013; Mamza et al., 2014; Mantau et al., 2014; Pearson et al., 2003; Rae and Kasryno, 1993; Martinez et al., 2008; Olowa, 2014; Zheng et al., 2013; Khai and Yabe, 2013). PAM can also identify the effects of efficiency of interventionist policy which incurs any efficiency losses associated with a distorting policy. PAM is a quantitative economic analysis which utilizes a budget-based method, and thus allows one to evaluate and analyze development projects of public investments which stimulate the government policy programs in the agricultural sector (Monke and Pearson 1989; Gotsch et al., 2003). The production budgets are initially valued to further measure private and social profitability of a production system. Private budgets are based on current market prices paid and received by farmers, while social budgets are based on social prices that account for government policy programs that affect the market prices due to subsidies or taxes. "PAM approach to agricultural policy analysis can provide decision-makers and analysts with both a helpful conceptual construct for understanding the effects of policy and a useful technique for measuring the magnitudes of policy transfers" (Monke and Pearson, 1989).

PAM has two major parameter identities: 1) profitability and 2) divergence, which are measured across the matrix. Profits are defined as the difference between total (per unit) sales revenues and costs of production. They are measured at two different prices – private and social prices. The revenues represent the receipts that producers received from a production system, while production costs are the expenditure of the tradable intermediate inputs (i.e. fertilizer, pesticides, seed, transportation, etc.) and factors of production (i.e. labor and land). The divergence is estimated as the difference in revenues and costs between private and social prices, which then implies the effects of distorting policies and market failures. The analysis which utilizes an accounting matrix procedure also measures the extent of transfers that affected by the set of implemented policies and the inherent economic efficiency of a production system. Table 2.2 shows the structure of PAM and how parameters are measured.

Table 2.2: The structure of policy analysis matrix.

		Costs		
	Revenues	**Tradable Inputs**	**Domestic Factors**	**Profits**
Private profit	$\sum p^D_{n_t}\, q^D_{n_t}$	$\sum_i p^D_{i_t}\, q^D_i$	$\sum_j w^D_{jt}\, l^D_j$	**D=A-B-C**
	A	**B**	**C**	
Social profit	$\sum p^S_{n_t}\, q^S_{n_t}$	$\sum_i p^S_{i_t}\, q^S_i$	$\sum_j w^S_{jt}\, l^S_j$	**H=E-F-G**
	E	**F**	**G**	
Effects of Divergences	$\sum p^D_{n_t}\, q^D_{n_t}$ - $\sum p^S_{n_t}\, q^S_{n_t}$	$\sum_i p^D_{i_t}\, q^D_i$ - $\sum_i p^S_{i_t}\, q^S_i$	$\sum_j w^D_{jt}\, l^D_j$ - $\sum_j w^S_{jt}\, l^S_j$	**L=I-J-K**
	I	**J**	**K**	

Source: Monke and Pearson (1989).
where p_n and q_n denotes price and quantity of output for commodity n, p_i and q_i is price and quantity of tradable inputs per unit, w_j is price of domestic factor j, l_j is quantity of j per unit of output, a superscript D indicates the observed values under private prices, a superscript S indicates the observed values under social prices, and t is production year.

3.2.1 Private Profitability

The determination of private profit requires data of the actual or observed revenues and costs involved in a particular production system given current technologies and policies. The private, or actual market prices thus incorporate the underlying economic costs and valuations and the effects of all policies and market failures (Monke and Pearson, 1989). Private entries (the first row of the matrix) measures the competitiveness of the production system. The estimation of private profit (D) can be quantified as:

$$\pi^D = \left(p_{n_t}^D\, q_{n_t}^D\right) - \left[\sum_i p_{i_t}^D\, q_i^D - \sum_j w_{jt}^D\, l_j^D\right] \qquad [1]$$

A negative private profit implies producers receive a deficient rate of return and thus the production system is not competitive while a positive profit indicates reasonable returns and have a potential for business expansion.

3.2.2 Social Profitability

Social profits are measured from social prices which indicate the comparative advantage (efficiency) measures of the agricultural commodity system while the efficient outcomes are achieved when an economy's resources are used in activities that create the highest levels of output and income. The profits are also the measure of efficiency because both outputs and inputs are valued in prices that reflect scarcity values or social opportunity costs (Monke and Pearson, 1989). The social profits (H) is estimated as:

$$\pi^S = \left(p_{n_t}^S\, q_n^S\right) - \left[\sum_i p_{i_t}^S\, q_i^S - \sum_j w_{j_t}^S\, l_j^S\right] \qquad [2]$$

Social price is referred to as a border price of a tradable commodity. This indicates the price that exporters would deliver the commodity to a domestic market or the price that importers would pay to obtain a commodity to their markets. The comparable world price is the most accurate measure for the social opportunity cost of an imported commodity. For an importable good, the import price implies the opportunity cost of obtaining an additional unit to satisfy a country's domestic demand.

The choice of social prices has a significant impact on the estimation of the analysis that reflects social opportunity costs. Social prices are difficult to attain since the actual world prices may not reflect the impacts of the domestic country's market power. In the absence of actual imports or exports of the domestically produced commodity, world price equivalents must be estimated. To be correctly equivalent, the prices must consider the effects of international transport costs and the differences of quality in a commodity.

Comparative advantage that determines the ability of an agricultural system to compete without distorting government policies can be strengthened or eroded measures the shifts in a system's competitiveness that occur over time because of changes in economic parameters especially long-run world prices of tradable outputs and inputs, social opportunity costs of domestic factors of production (labor, capital, and land), and production technologies used in farming or marketing (Monke and Pearson, 1989). Subsequently, the measure of social prices has significant impacts on the analysis, and the valuation entails calculation of world price equivalents for the domestic product.

3.2.3 Effects of Divergence

Divergence is the second identity of analysis that represents the differences between private and social parameters (revenues, costs, and profits). It is vertically measured in the matrix and the values describe any divergences between the private price and the estimated social price must be explained by the effects of policy or by the existence of market failures. The effects of divergences of output, tradable inputs, domestic factors, and the net effect are specified as:

$$\alpha = \left(p_{n_t}^{D}\, q_n^{D}\right) - \left(p_{n_t}^{S}\, q_n^{S}\right) \qquad [4]$$

$$\beta = \sum_i p_{i_t}^{D}\, q_i^{D} - \sum_i p_{i_t}^{S}\, q_i^{S} \qquad [5]$$

$$\gamma = \sum_j w_{j_t}^{D}\, l_j^{D} - \sum_j w_{j_t}^{S}\, l_j^{S} \qquad [6]$$

$$\delta = \left[\left(p_{n_t}^{D}\, q_n^{D}\right) - \sum_i p_{i_t}^{D}\, q_i^{D} - \sum_j w_{j_t}^{D}\, l_j^{D}\right] - \left[\left(p_{n_t}^{S}\, q_n^{S}\right) - \sum_i p_{i_t}^{S}\, q_i^{S} - \sum_j w_{j_t}^{S}\, l_j^{S}\right] \qquad [7]$$

where α is the effects of divergence of output (output transfer), β is the effects of divergence of tradable inputs (tradable input transfer), γ is the effects of divergence of domestic factors (factor transfer), and δ is the total divergence effects (net transfers).

3.2.4 Analysis of Policy Transfers

From the results of both profit and divergence identities, the analysis can be extended which allows the estimation of policy transfer which can indicate whether a farming or production system satisfies agricultural policy parameters competitively and effectively. The estimations are the nominal protection coefficient output (NPCO), nominal protection coefficient of tradable input (NPCI), domestic resource cost (DRC), effective protection coefficient (EPC), subsidy ratio to producers (SRP), and profitability coefficient (PC).

Nominal Protection Coefficient Output (NPCO):

$$NPCO = \frac{Revenue\ in\ private\ prices}{Revenue\ in\ social\ price} = \frac{\sum p_{n_t}^{D}\, q_{n_t}^{D}}{\sum p_{n_t}^{S}\, q_{n_t}^{S}} \qquad [8]$$

The $NPCO$ is the ratio of the domestic market price of a product to its social price at a farm-gate. A value greater than one ($NPCO > 1$) indicates implicit a nominal protection or subsidy, and the value less than one ($NPCO < 1$) implicit nominal tax.

Nominal Protection Coefficient of Tradable Input (NPCI):

$$NPCI = \frac{Cost\ of\ Tradable\ Inputs\ in\ Private\ Prices}{Cost\ of\ Tradable\ inputs\ in\ Social\ Prices} = \frac{\sum_i p_{i_t}^{D}\, q_i^{D}}{\sum_i p_{i_t}^{S}\, q_i^{S}} \qquad [9]$$

The $NPCI$ is the ratio of the private to the social values of all the tradable inputs (seed, fertilizers, herbicides, pesticides). A $NPCI$ ratio greater than one ($NPCI > 1$) indicates that producers are taxed for the inputs and $NPCI$ less than 1 ($NPCO < 1$) indicates inputs are subsidized. Both $NPCO$ and $NPCI$ imply distortions of government policy in a production system.

Effective Protection Coefficient (EPC):

$$EPC = \frac{(Revenue - Cost\ of\ Tradable\ Inputs)\ in\ Private\ Prices}{(Revenue - Cost\ of\ Tradable\ Inputs)\ in\ Social\ Prices} = \frac{p_{n_t}^{D} - \sum_i p_{i_t}^{D}\, q_i^{D}}{p_{n_t}^{S} - \sum_i p_{i_t}^{S}\, q_i^{S}} \qquad [10]$$

The EPC measures the degree of policy transfer from product market-output and tradable-input policies. The coefficient represents the value added in private prices to value added in social prices, which indicates the combined divergences on outputs and tradable inputs. An EPC greater than 1 ($EPC > 1$) indicates positive protection of value added and the EPC less than 1 ($EPC < 1$) indicates the effective taxation of value added by producers. The EPC equal to one implies neither intervention nor impact of distortions in both the input and product markets, which results in a neutral effect on value-added.

Domestic Resource Cost (DRC):

$$DRC = \frac{(Labor\ Cost + Capital\ Cost + Land\ Cost)\ in\ Social\ Prices}{(Revenues - Cost\ of\ Tradable\ Inputs)\ in\ Social\ Prices}$$

$$= \frac{\sum_j w_{j_t}^S\, l_j^S}{\left(\left(\sum p_{n_t}^S\, q_{n_t}^S\right) - \sum_i p_{i_t}^S\, q_i^S\right)} \qquad [11]$$

The DRC ratio measures the social costs of a domestic resources relative to social profits. A ratio greater than one ($DRC > 1$) implies a production system is not competitive and not desirable relative to the social prices. The ratio smaller than one ($DRC < 1$) indicates the production system is socially desirable and competitive. The DRC is an important indicator to determine comparative advantage of a particular commodity. The lower value of DRC indicates a greater comparative advantage to other commodities in a market.

Subsidy Ratio to Producers (SRP):

$$SRP = \frac{\left[\sum p^{D}_{n_t} q^{D}_{n_t} - \sum_i p^{D}_{i_t} q^{D}_{i} - \sum_j w^{D}_{j_t} l^{D}_{j}\right] - \left[\sum p^{S}_{n_t} q^{S}_{n_t} - \sum_i p^{S}_{i_t} q^{S}_{i} - \sum_j w^{S}_{j_t} l^{S}_{j}\right]}{\sum p^{S}_{n_t} q^{S}_{n_t}} \qquad [12]$$

SRP measures the extent of subsidy in a production system. The ratio addresses the same measure as a proportion of the total social value of the system output as it measures the net transfer to the production system as a proportion of the total social income. A higher ratio of SRP indicates a subsidized and an uncompetitive system.

4. Empirical Results and Discussions

Prior to the analysis, the quantity of input and output, private prices, and social prices of rice production system (see Appendix Table 2.1, 2.2, and 2.3) are established to construct the private and social budgets. After estimating private and social budgets, we can measure the private and social profits as well as the effect of divergences for rice production in Malaysia.

4.1 Private Profits

Using private prices and the physical quantity of inputs and outputs, we can examine the production budget at private values (i.e. observed values) which presents revenue and expenditure for the rice production system. This private budget represents the revenue and production costs for rice per hectare using the direct-seeded approach of irrigated lowland rice farms in major producing areas in Malaysia[11]. At the private price, all domestic support policies are applied, and thus each subsidy and producer price support are explicitly presented. From the production budget, total subsidies account for 59.1% of the total rice production cost (per hectare), which implies that rice in Malaysia is heavily subsidized at farm level. These subsidies are applied to a range of subsidy policy programs, the majority of which include production inputs – seed, fertilizers, chemicals – while the rest are applied to wages and the output price incentives.

The current subsidies at farm level are provided in physical products, monetary form (direct payment), and farm infrastructure payments (water, drainage, and irrigation systems and maintenance). From the total rice production cost of RM 4,349.8 (per hectare), these subsidies are valued and account for RM 2,571.3 (per hectare) which encompass fertilizers (RM 1,772.0), pesticide (RM 200.0), labor (RM 100.0), other chemicals (RM 250). The revenue is estimated using the producer price at RM 1,200 (per metric ton) in paddy basis[12]. With the total production cost accounting for 86% of the total revenue, and at a 4.2 crop yield on average, indicates a profit of RM 703.36 (per hectare) at private price level (Table 2.3).

Table 2.3: The private budget of rice production (per hectare) in Malaysia.

Input-Output	Items	Costs (RM)	Total (RM)
Tradable Inputs	Subsidy: seed price RM 1.03/kg	154.50	
	Fertilizers:		1,772.00
	Subsidy: Urea	92.00	
	Subsidy: NPK	312.00	
	Subsidy: Organic or	120.60	
	Subsidy: Foliar	122.40	

[11] Relative to upland rice, irrigated or wetland rice farm is the largest planted area in Malaysia, and direct-seeded planting approach remains the most common practice and approach since the transplanting is a costlier method.
[12] Paddy basis is defined as dried and cleaned paddy and measured at the storage moisture content (MC) (IRRI).

Table 2.3 (Cont.)

Input-Output	Items	Costs (RM)	Total (RM)
Tradable Inputs	Subsidy: GML	720.00	
	Subsidy: Additional NPK	405.00	
	Chemicals:		709.80
	Herbicide	314.00	
	Insecticide	260.80	
	Fungicide	117.00	
	Pesticide	18.00	
	Subsidy pesticide (direct payment)	200.00	
	Subsidy: Water, irrigation, and drainage	249.30	
Domestic Factors	Labor:	1,928.00	1,928.00
	Subsidy: GML (Direct payment)	250.00	
	Subsidy: plowing (Direct payment)	100.00	
	Capital:		1,502.04
	Tractor services	300.00	
	Land rental	1,202.04	
Revenue	Total Revenue		5,053.20
	Total Cost		4,349.84
	Net Profit		703.36

Source: DOA; LPP.

4.2 Social Profits

Social price is more complex to estimate in constructing a policy analysis matrix because it must be estimated from other economic data and cannot be not directly observed as is the private price. According to Monke and Pearson, world prices are the most accurate indicators of social valuation for tradable commodities since the prices represent social opportunity costs for the domestically produced commodity (Monke and Pearson, 1989). In addition, the choice of the social price of rice depends on the assessments of grain classifications, rice grades, and the propensity that the commodity will continue to be traded. Therefore, a price adjustment using a world price equivalent that includes international transportation and handling costs is required. Since rice is a tradable output with the largest current rice imports by Malaysia is the Vietnamese long grain white rice (10% broken) relative to other exporting regions, grain classifications, and rice grades, this import price of rice is considered to be the best equivalent to the Malaysian long grain white rice (10% broken. Therefore, the import parity price for the Vietnamese white rice, which is equivalent to the farm gate price, is the most accurate for social valuation.

Using the CIF import price of Vietnamese long grain white rice in the marketing year 2013/14, which was recorded at US$ 464.84 per metric ton (Department of Statistics, Malaysia), the social valuation process also requires the transportation and handling costs (including price margins) from ports to milling plants, distribution centers, and farms, so that the equivalent farm gate price can be accurately estimated. The transportation and handling costs of long grain white rice (10% broken) from Malaysian ports to rice farms are estimated at RM 150 (per metric ton) (BERNAS). Using the average conversion factor for Malaysian rice at 65% (from paddy form to milled basis) (BERNAS) and the average currency exchange rate at RM 3.50 (US$ 1) in 2013/2014 (IMF), to be consistent with the price data timeline, the import parity value is estimated at RM 943 per metric ton or RM 0.943 per Kg (Table 2.4). This value is then applied as the producer price to estimate the social profits in the production budget of the social valuation.

Table 2.4: Import parity value of long grain white rice in Malaysia.

Adjustment of International Prices	Long Grain White
C.i.f. Malaysia (US$/Mt)	464.840
Exchange rate (MYR/USD)	3.500
C.i.f. Malaysia in domestic currency per Mt (RM/Mt)	1,626.940
Weight conversion factor (Kg/Mt)	1,000.000
C.i.f. Malaysia in domestic currency per Kg (RM/kg)	1.627

Table 2.4 (Cont.)

Adjustment of International Prices	Long Grain White
Transportation and handling costs to distribution centers (RM/Kg)	0.100
Value before processing (RM/Kg)	1.527
Processing conversion factor (%)	0.650
Import parity value (RM/Kg)	0.993
Distribution costs to farms (RM/Kg)	0.050
Import parity value at farm gate (RM/Kg)	0.943

Source: DOSM; BERNAS; UN Comtrade Database.

Using the equal physical input-output data (Appendix 2.1), and the estimated social prices of tradable inputs and domestic factors (Appendix 2.3), we can estimate the production budget of rice at social prices. The technology and resource supplies (including land rental and transportation services) are assumed to be constant, which implies equal crop yield in private production budgets. The social production budget for rice is presented in Table 2.5, which represents rice prices without any subsidy, accounting for the major differences between social and private prices. With the absence of subsidies for tradable inputs, domestic factors, and infrastructures, the price production cost at social prices is estimated at RM 6,953.2 (per hectare). The social revenue is measured at RM 3,968.91 (per hectare) using the import parity price at RM 943/Mt and the average crop yield at 4.2 Mt/ha. With the tremendously high total production cost at social prices over the total revenue, the social budget indicates a high loss at RM 2,984.3 (per hectare). As rice proves to be very costly to grow in Malaysia, removing subsidies at the production level would lead to significant losses for local rice farmers. This result also suggests that rice imports are much cheaper than the cost of producing rice domestically (per hectare basis).

Table 2.5: Social budget (in local currency RM) for rice production in Malaysia.

Input-Output	Item	Costs (RM)	Total (RM)
Tradable Input	Fertilizers:		1,649.60
	Urea	92.00	
	NPK	312.00	
	Organic or	120.60	
	Foliar	122.40	
	GML	720.00	
	Additional NPK	405.00	
	Chemicals:		909.80
	Herbicide	314.00	
	Insecticide	260.80	
	Fungicide	117.00	
	Pesticide	218.00	
	Irrigation and drainage	249.30	
Domestic Factor	Labor	2,278.00	2,278.00
	Capital:		1,502.04
	Tractor services	300	
	Land rental	1,202.04	
Revenue	Total Revenue		3,968.91
	Total Cost		6,953.24
	Net Loss		(2,984.33)

Source: Results are measured using import parity price.

4.3 Policy Analysis Matrix

The empirical analysis of the policy analysis matrix is the principal result in this study, which measures the effects of divergence between private and social valuations as presented in Table 2.6. Both private and social estimates from the production budgets are used to construct the matrix, allowing analysis of the competitiveness and efficiency of rice production in Malaysia and determination of the policy distortions or market failures that cause such divergences.

Table 2.6: Policy analysis matrix of rice production system in Malaysia.

	RM/hectare					
		Costs				
		Tradable Input	Domestic Factors			
	Revenues		Labor	Land	Capital	Profits
Private prices	5,053.2	919.8	1,928.0	1,202.0	300.0	703.4
Social prices	3,968.9	2,923.9	2,278.0	1,202.0	300.0	(2,735.0)
Effect of divergences	1,084.3	(2,004.1)	(350.0)	-	-	3,438.4

The divergences between private and social revenues indicate RM 1,084.3. This positive value implies that the producer price policy for domestic rice appears higher than the world price. In addition, this policy raises private prices which leads to a private revenue 21.5% greater than social revenue. The net transfer, the sum of all divergences that cause private profits to differ from social profits, is estimated at RM 3,438.4. With social profits having negative value, the policy transfers of the illustrated rice production system in Malaysia is the result of distorting policy. The positive profits, which indicate positive policy transfers imply that the government is providing support to the domestic rice production system. Because social losses that amount to RM -2,735.0 (per hectare), rice in Malaysia could not be profitably produced without any support to policy transfers. "The negative social profit indicates the country is wasting resources by allowing inefficient production, which occurs because of distorting policies" (Monke and Pearson, 1989). The net transfer of RM 3,438.4, raise the profits received by farmers and millers from RM -2,735.0 to RM 703.4. With these results, rice is not competitive to produce in Malaysia relative to rice imports. In addition, rice is highly challenging to produce without any domestic support from the government. This analysis is extended to measure the policy transfers in terms of the effects of the protective, competitive, and comparative advantage (efficiency) from the implemented rice policies in Malaysian rice production.

4.4 Protectionist Policy Measures

The previous analysis in PAM reveals that Malaysian rice production is highly protected, which leads to policy distortions. Table 2.7 presents the results of the policy analysis transfer from the protectionist rice policy in Malaysia using the nominal protection coefficient on output (NPCO), the nominal protection coefficient on input (NPCI), and the effective protection coefficient (EPC) measures. These results are measured from the equations [8], [9], and [10].

The NPCO allows a comparison between the production output of different prices at private and social levels. From the equation [8], the ratio of the private to social price of long grain white rice, the NPCO shows a value of 1.2732; the fact that this value is higher than one reveals that rice production output in Malaysia is highly protected. The current policies on the protective production output, which mainly refer to the imposition of import tariffs for rice trade coming from international markets, and the producer price support for local rice farmers to constantly maintain a value higher than the world rice prices by the government, allow outputs at private prices to be 27.3% higher than social prices (i.e. prices without the support policies).

Table 2.7: The policy transfer analysis of protectionist rice policies in Malaysia.

	Revenues	**Input Costs**	**NPCO**	**NPCI**	**EPC**
Private Prices	5,053.20	919.80	1.2732	0.3146	3.9554
Social Prices	3,968.91	2,923.90			
Effects of Divergences	1,084.29	(2,004.10)			

Source: Results are measured using PAM.

The NPCI measures the effects of distorting policies on tradable input costs in the rice production system. The coefficient indicates a positive transfer of 0.3146 with the input production costs are lowered by domestic subsidy support policies. This result implies that the domestic policies reduce the input costs by 68.5% from the social price, causing the input costs at private prices to be lower than social prices. Therefore, the input policies on domestic production for seed, fertilizer, and pesticide cause policy distortion in a production system. With the difference input costs of RM 2,004.1 (per hectare) which also refers to the current input subsidies, rice farmers have to pay RM 919.8 (per hectare) for the input costs, rather than RM 2,923.9 (per hectare) with the absence of domestic support policies.

The different effects of output and input protection policies can be simultaneously measured in the EPC coefficient. The EPC ratio of 3.95 represents the net impact of the input and output policies affecting the rice production system. This result implies that both output and input policies allow value added in private prices to be 295% higher than in social prices. The result of EPC reveals that the highly protected outputs and inputs lead to a distorted Malaysian rice production system.

The analysis of protection policy transfer for rice production policies in Malaysia reveals that rice sector at farm level is highly distorted. Policy distortions in output and input markets are complex to reconcile with the pursuit of economic competitive objectives, such as the self-sufficiency goal (Vousden, 1990). As the government's decision is to achieve rice self-sufficiency, both input and output policies are heterogeneously distorted. These distortions stimulate some unnecessary economic losses to achieve the goal of self-sufficiency. If the government removes trade barriers on rice imports allowing free trade, the producer price would decrease from the private to the social level. At this lower price, the country would increase rice imports, decrease domestic production, and thus increase rice consumption. While rice import prices are cheaper, the status quo forces consumers to pay a higher price for rice due to high subsidization of domestic production. Hence, the protectionist policies lead the country to give up potential gains from international trade.

4.5 Competitiveness and Efficiency Measures

With the PAM results, we can analyze the level of competitiveness and comparative advantage which refers to the efficiency of the implemented rice policies. These measures are analyzed using the domestic resource cost (DRC), the subsidy ratio to producer (SRP), and the profitability coefficient (PC). These results are measured from the equations [11], [12], and [13], shown in Table 2.8.

DRC is an important analysis which measures the efficiency of the entire a production system as it serves as a proxy measure for social profits. The DRC coefficient indicates a value greater than one ($DRC > 1$), 3.62, which demonstrates that Malaysia has no comparative advantage in domestic rice production. Lacking international competitiveness, which currently refers to the Vietnamese long grain white rice, the current protective rice policies are not efficient. With the government's policies continuing to emphasize domestic rice production to achieve the self-sufficiency goal, mainly through largely subsidizing inputs and outputs, these interventions would cause a significant inefficiency to the whole system of rice production. Hence, the policy programs reflect sizable policy distortions.

Table 2.8: Measures of comparative advantage and competitiveness rice in Malaysia.

	Revenues	Tradable Input Costs	Domestic Factors	Profits	DRC	SRP
Private Prices	5,053.20	919.80	3,430.04	703.36	3.6172	0.8663
Social Prices	3,968.91	2,923.90	3,780.04	(2,735.03)		
Effects of Divergences	1,084.29	(2,004.10)	(350.00)	3,438.39		

Source: Results are measured using PAM.

SRP measures net transfers across different systems of production as it allows for the comparisons between policies which subsidize production systems, and gauges the disaggregation into component transfers to show the distinct effects of policies on output, input, and domestic factors. SRP shows a significantly high ratio at 0.8663 (close to one), meaning that the divergences have highly distorted by the policies, which also means that gross revenues of the production system are increased by 86.6%. This ratio shows the net transfers from divergences largely result from social revenues. The ratio also implies that if policies on tradable inputs and domestic factors are eliminated, the rice production system's NPCO would have to be increased from 1.27 to 1.86 to maintain the same degree of private profit.

4.6 Sensitivity Analysis

The main purpose of sensitivity analysis is to examine the efficiency of policy transfers using the major analysis with changes in significant factors. Using the results of production inputs and crop yield effects from the international free trade policy at the farm-household level in Chapter IV, two scenarios are analyzed: 1) a decrease in production inputs by 16.2% and 2) a decrease in rice yield by 4.8%. The results of sensitivity analysis are presented in Table 2.9. In the first scenario, the DRC coefficient remains a value greater than one, 2.5061, which indicates that domestic rice production remains inefficient with reduction of production inputs. The EPC shows a lower 2.00 ratio than the baseline which demonstrates both output and input policies still allow value added in private prices to be 100% higher than in social prices, yet it is less protective than the baseline. The SRP shows a significantly lower ratio from the baseline at 0.4366, meaning that the divergences have still distorted by the policies, but in a lower degree, 43.6%, after the reduction of production inputs. In the second scenario, the DRC, EPC, and SRP measures indicate that rice production system in Malaysia remains protective and inefficient policy transfers when the crop yield reduces by 4.8%.

Table 2.9: Sensitivity analysis of policy analysis matrix.

Scenario	DRC	EPC	SRP
Baseline Scenario	3.6172	3.9554	1.2732
Decrease in production inputs by 16.2%	2.5061	2.0054	0.4366
Decrease in rice yield by 4.8%	4.4674	2.6362	0.4601

Source: Results are measured using PAM.

5. Conclusions

The lack of competitiveness and comparative advantage of domestic rice production in Malaysia has been shown since the rice sector has been highly intervened, protected, and supported by the government for decades. A wide range of policy programs have been realized, most of which include input and output subsidies and regulated producer price with the goal being to achieve total self-sufficiency in rice. Although it barely contributes to the national income, rice still receives special attention and has been given priority in a series of the national development policies in Malaysia. While subsidies have been the most favored policy strategy for many years and have involved substantial public investment, the domestic rice outcomes remain stagnant and only satisfy between 60-65% of the growing demand each year. In fact, the revised national rice policy provides additional input and output subsidies which burden government expenditure while the government seriously pursues self-sufficiency approach and aims to eliminate all rice imports in the near future. Therefore, it is crucial to evaluate and analyze the competitiveness and the efficiency of domestic rice production as well as the effects of policy transfer in the current Malaysian rice production system.

This study applies the policy analysis matrix (PAM) to measure the competitiveness and comparative advantage of the rice sector in Malaysia. The data on a production level which represents the costs of production and revenues in major producing areas is utilized. Prior to the analysis, production budgets at private price and social price levels are established. Then, the costs and revenues from the production budgets are applied to the PAM analysis to measure the profitability and divergence effects at both price levels. Further, the analysis is extended to measure the effects of the policy transfer. Despite having received substantial efforts and attention by the government, especially through realizing various domestic support programs, rice production in Malaysia suffers from comparative advantage relative to rice imports. The key results indicate that rice policy in Malaysia is highly distorted, as number of policy programs, that include subsidies, incentives, and price supports have raised private revenues and profits, and thus lead to socially unprofitable rice production. In addition, the protection measures also imply that the current policies are reducing the actual input costs while increasing the revenue through subsidizing inputs and imposing higher domestic prices than market prices. The effects of the divergences indicate that average rice farms generate a relatively low profit at private prices while producing losses at social prices when the opportunity costs of all the domestic factors involved in rice production are employed. The divergence is caused by government policies that distort the pattern of production, moving it away from the most efficient use of domestic resources and international trading opportunities. The competitiveness analysis proves that the government's decision in pursuing self-sufficiency through highly protecting the domestic rice industry lead to significant market failures since the international rice price (Vietnamese long grain white rice) is lower than local rice.

The government's interventionist policy instruments significantly failed to drive competitiveness in the Malaysian rice sector, hence leading to policy distortions. These distortions induce unnecessary efficiency losses to realize the national self-sufficiency goal. The government usually enacts distorting policies to favor particular interest groups, consciously trading off the consequent efficiency losses against their perception of such non-efficiency gains as changes in income distribution and improvement in the country's ability to feed its nation. With implementing protectionist policy, the government does not only distort the rice market, but also each agricultural input market which include seed, fertilizer, pesticide, and other chemicals. As rice in Malaysia is mostly operated by small farmers, it would be highly challenging to become a competitive industry and would require significant financial support by the government. This study provides key measures of the effects of rice policies on the production system that could be a guideline for future policy decisions.

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Appendix Table 2.1: Physical input and output of rice production system in Malaysia.

Input-Output	Items	Amount/Ha
Tradable Inputs	Seed (kg)	150.0
	Fertilizers:	
	Urea (kg)	80.0
	NPK (kg)	240.0
	Organic (kg) **or**	100.0
	Foliar (liter)	6.0
	Ground Magnesium Limestone (GML) (mt)	3.0
	Additional NPK (kg)	150.0
	Chemicals:	
	Herbicide	
	Basta (Liter)	4.0
	Clincher (mililiter)	500.0
	Sindex (gram)	1,000.0
	Insecticide	
	Evisect (kg)	1.0
	Confidor (mililiter)	500.0
	Actara (gram)	600.0
	Fungicide	
	Score 250L (mililiter)	250.0
	Fujicone (liter)	1.0
	Pesticide	
	Matikus (kg)	18.0
	Irrigation and drainage (M^3)	277.0
	Soil fertility - GML (RM/ha)	250.0
	Rice straw cleaning (RM/ha)	78.0
	Plowing (RM/ha)	220.0
	Irrigation and drainage (RM/ha)	150.0
	Rice-field mice control (RM/ha)	20.0
	Weed control (before planting) (RM/ha)	50.0
	Seed sowing (RM/ha)	50.0
	Weed control (after planting) (RM/ha)	150.0

Appendix Table 2.1 (Cont.)

Input-Output	Items	Amount/Ha
Domestic Factors	Replanting (RM/ha)	80.0
	Preparing working tracks (RM/ha)	80.0
	Pest and disease control (RM/ha)	150.0
	Fertilizing (RM/ha)	200.0
	Weedy rice control (RM/ha)	300.0
	Harvesting (RM/ha)	500.0
	Capital:	
	Tractor services (RM/ha)	300.0
	Land (ha)	1.0
Output	Yield (paddy basis, dried and cleaned) (Mt/ha)	4.21

Source: DOA; LPP.

Appendix Table 2.2: Private prices of rice production system in Malaysia.

Input-Output	Items	RM/Unit/Ha
Tradable Inputs	Certified seeds (kg)	1.40
	Fertilizer:	
	Urea (kg)	0.00
	NPK (kg)	0.00
	Organic (kg) **or**	0.00
	Foliar (liter)	0.00
	Ground Magnesium Limestone (GML) (mt)	0.00
	Additional NPK (kg)	0.00
	Chemicals:	
	Herbicide:	
	Basta (Liter)	32.50
	Clincher (mililiter)	0.21
	Sindex (gram)	0.08
	Insecticide:	
	Evisect (kg)	70.00
	Confidor (mililiter)	0.21
	Actara (gram)	0.14
	Fungicide:	
	Score 250L (mililiter)	68.00
	Fujicone (liter)	49.00
	Pesticide:	
	Matikus (kg)	18.00
	Irrigation (M^3)	0.00
Domestic Factors	**Labor:**	
	Soil fertility - GML (RM/ha)	0.00
	Rice straw cleaning (RM/ha)	78.00
	Plowing (RM/ha)	120.00
	Irrigation and drainage (RM/ha)	150.00
	Rice-field mice control (RM/ha)	20.00
	Weed control (before planting) (RM/ha)	50.00
	Seed sowing (RM/ha)	50.00
	Weed control (after planting) (RM/ha)	150.00
	Replanting (RM/ha)	80.00
	Preparing working track (RM/ha)	80.00
	Pest and disease control (RM/ha)	150.00

Appendix Table 2.2 (Cont.)

Input-Output	Items	RM/Unit/Ha
Domestic Factors	Fertilizing (RM/ha)	200.00
	Weedy rice control (RM/ha)	300.00
	Harvesting (RM/ha)	500.00
	Capital:	
	Tractor services (RM/ha)	300.00
	Land rental (RM/ha)	1,202.04
Output	Producer price support policy (paddy basis; dried and cleaned) (RM/Mt)	1,200.00

Source: DOA; LPP.

Appendix Table 2.3: Social prices of rice production system in Malaysia.

Input-Output	Items	RM/Unit/Ha
Tradable Inputs	Seed (RM/kg)	2.43
	Fertilizer:	
	Urea (kg)	1.15
	NPK (kg)	2.26
	Organic (kg) **or**	1.21
	Foliar (liter)	20.40
	Ground Magnesium Limestone (GML) (mt)	240.00
	Additional NPK (kg)	2.70
	Chemicals:	
	Herbicide:	
	Basta (Liter)	32.50
	Clincher (mililiter)	0.21
	Sindex (gram)	0.08
	Insecticide:	
	Evisect (kg)	70.00
	Confidor (mililiter)	0.21
	Actara (gram)	0.14
	Fungicide:	
	Score 250L (mililiter)	68.00
	Fujicone (liter)	49.00
	Pesticide:	
	Matikus (kg)	18.00
	Irrigation and drainage (M^3)	0.90
Domestic Factors	**Labor:**	
	Soil fertility - GML (RM/ha)	250.00
	Rice straw cleaning (RM/ha)	78.00
	Plowing (RM/ha)	220.00
	Irrigation and drainage (RM/ha)	150.00
	Rice-field mice control (RM/ha)	20.00
	Weed control (before planting) (RM/ha)	50.00
	Seed sowing (RM/ha)	50.00
	Weed control (after planting) (RM/ha)	150.00
	Replanting (RM/ha)	80.00
	Preparing working track (RM/ha)	80.00
	Pest and disease control (RM/ha)	150.00
	Fertilizing (RM/ha)	200.00

Appendix Table 2.3 (Cont.)

Input-Output	Items	RM/Unit/Ha
Domestic Factors	Weedy rice control (RM/ha)	300.00
	Harvesting (RM/ha)	500.00
	Capital:	
	Tractor services (RM/ha)	300.00
	Land rental (RM/ha)	1,202.04
Output	Import parity value at farm gate (RM/Mt)	942.51

Source: DOA; LPP.

Chapter III
Self-sufficiency and International Trade Policies on Rice Sector in Malaysia: Approaches to Food Security using Partial Equilibrium Analysis

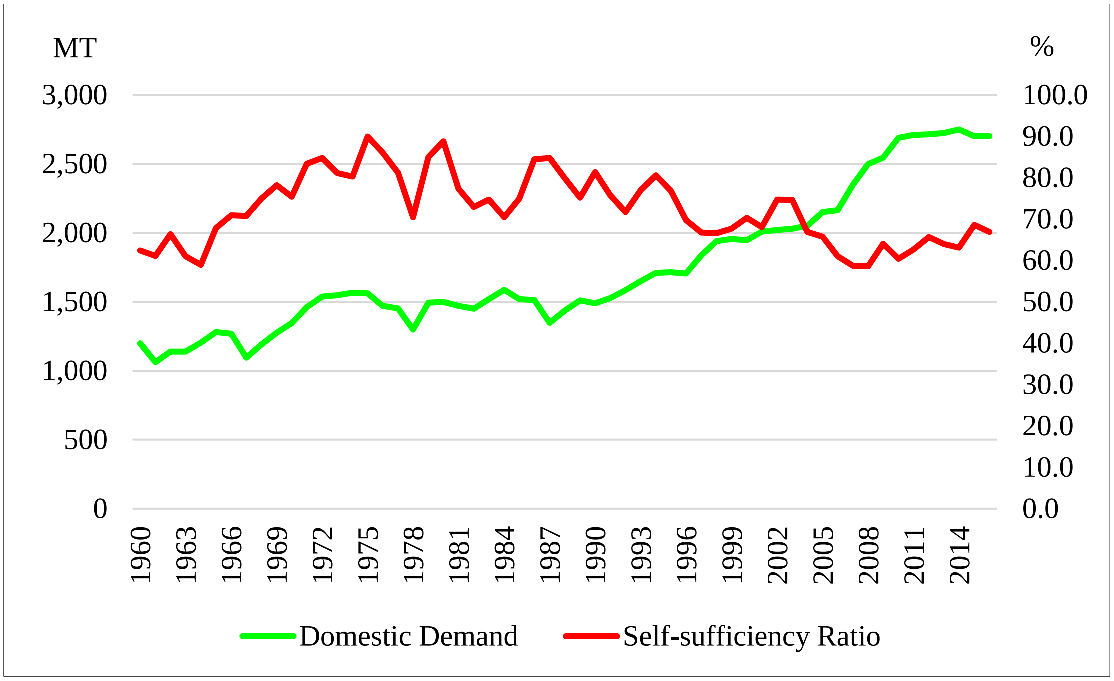
Abstract

While much evidence shows self-sufficiency is not an efficient policy strategy to address food security concerns as well as poverty alleviation, Malaysia is following a self-sufficiency strategy in its primary staple, rice. This study evaluates and analyzes the impact of two alternative approaches to achieve food security, namely, pursuing rice self-sufficiency, and allowing free trade in rice. The results indicate that even though Malaysia could achieve self-sufficiency in rice, consumers are worse off, since consumer rice prices increase sharply. On the other hand, rice producers are better off due to higher producer prices and domestic production. The government welfare worsens from the self-sufficiency policy due to massive requirements on additional subsidies and the loss of import tariff revenues. Free trade results in lower consumer prices and greater rice consumption, thus favoring consumer welfare. Producer welfare worsens due to higher import competition and lower producer prices. With a long-held food security rationale, rice self-sufficiency neither guarantees nor promises food security in Malaysia. Pursuing self-sufficiency would effectively punish consumers, and even the government loses from the policy. Otherwise, self-sufficiency could also be a political strategy in political economic environment to become an independent region without relying on external food sources. This study provides useful economic insights to the government and policymakers on self-sufficiency and free trade assessments for policy direction of rice sector in Malaysia.

1. Introduction

Self-sufficiency has been brought to the world's attention and has moved to the higher policy agenda particularly to address food security concerns in most rice-staple and rice-deficit regions among developing countries. Despite the criticism for not being an efficient approach, self-sufficiency has been promoted and adopted as the pertinent solution to achieve food security objectives, especially in the aftermath of the recent global food crisis (FAO, 2016). Malaysia announced its intention to pursue self-sufficiency by the year 2020 and has recently been extended to the year 2050 (National Transformation 2020-2050). The pursue of self-sufficiency is not only for food security reasons, but also the result of a political economy that prioritizes farmers' interests and strives to guarantee the welfare of rice farmers. Since the majority of rice farmers are poor smallholders, self-sufficiency may help ameliorate poverty among farmers.

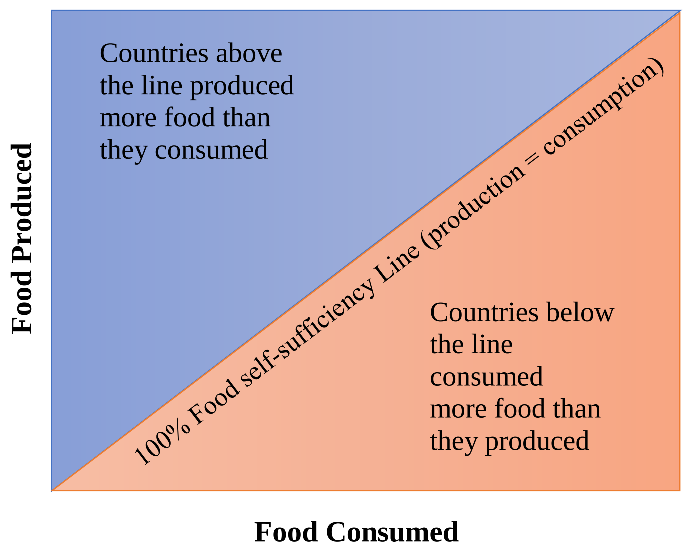
Food self-sufficiency is not a new policy strategy in Malaysia as the country has historically focused on supported domestic rice production to obtain a high degree self-sufficiency. As domestic demand for rice is growing, self-sufficiency goals become more challenging (Figure 3.8). Intensification of rice production has been one way to improve land productivity and output. Currently the crop intensity of rice is considerably high, ranging between 170% and 180%, yet domestic production remains constrained by its marginal productivity (Mailena et al., 2014). The expansion of rice acreage is highly constrained in Malaysia. Most arable land in Malaysia is under permanent palm oil and rubber crops. Pursuing self-sufficiency with a constrained supply of land requires significant gains in productivity or otherwise will lead to higher market prices, and consequently reduced consumer welfare.



Source: Production, Supply and Distribution (PS&D), USDA.

Figure 3.8: Trends of domestic demand and self-sufficiency ratio for rice in Malaysia, 1960 – 2016.

Even if food self-sufficiency and food security are interconnected, the government's stance on self-sufficiency is misconstrued while often interpreting to food security. According to the Food and Agricultural Organization (FAO), food self-sufficiency is referred to "The extent to which a country can satisfy its food needs from its own domestic production", "Closing borders adopting complete autarky for food sector, and "A country producing sufficient food to cover its own needs" (Clapp, 2017; FAO, 2016; FAO, 1999) (Figure 3.9). Food security, on the other hand, pertains to food availability, accessibility, nutrition, and stability across the three dimensions (FAO, 2008). As such, food security makes no reference to the source of food (Clapp, 2014), and therefore food security and self-sufficiency are divergent and express different concepts. The World Bank stressed that ''Food self-sufficiency should be weighed against the benefits of cheaper imports" (World Bank, 2012). In fact, self-sufficiency has also been claimed as outcomes when a country prioritizes political decisions over economic rationale in food policy choices which characterize by conflict between interests that support local production and those that believe self-sufficiency is a costlier path and thus worsens public investments (Clapp, 2017).



Source: Clapp (2017)

Figure 3.9: The concept of food self-sufficiency.

Self-sufficiency has been criticized because it embraces policies which are being inefficient and distort the market resulting in weakened incentives for food production, thus leading to higher food prices in the long run (Naylor and Falcon, 2010). Strongly emphasizing to the self-sufficiency goal diverts government's attention from pressing food security concerns at the household level (Von Braun and Paulino, 1990). Other countries are also discovering that self-sufficiency is more likely to cause negative consequences (Mosavi and Esmaeili, 2012).

Instead, liberalizing food trade shows many advantages to improve food security as well as economic growth, especially for developing economic regions. Many developing countries realized that the free trade was an effective approach for sustained development. For instance, Latin America and East Asia indicated significant economic development growth in 1985 to 2005 when practicing the free trade (OECD, 2008), and thus there were positive relationships between free trade and economic growth (Von Braun and Diaz-Bonilla, 2008). The World Bank reviewed many studies regarding globalizing trade to poverty reduction and concluded that the degree of trade openness played a significant role and benefited certain countries to better integrate into the world economy (World Bank, 2002). In fact, a rice import tariff will not help local producers, and even punish local consumers (Jolly et al., 2009).

Malaysia has been active participating free trade agreements (FTAs) in both bilateral and regional levels and is currently involved in 13 FTAs as well as a member of the World Trade Organization (WTO) (Table 3.10). Nevertheless, Malaysia has excluded rice in the FTAs and declared as a sensitive product, which allows it to extend protection to local rice industry. Under ASEAN[13]-Australia-New Zealand Regional Free Trade Agreement, rice remains excluded from Malaysia's tariff commitments until 2023, when its tariff will be bound at 30% and then reduced annually until it is eliminated in 2026 (Malaysian Ministry of International Trade and Industry, 2006).

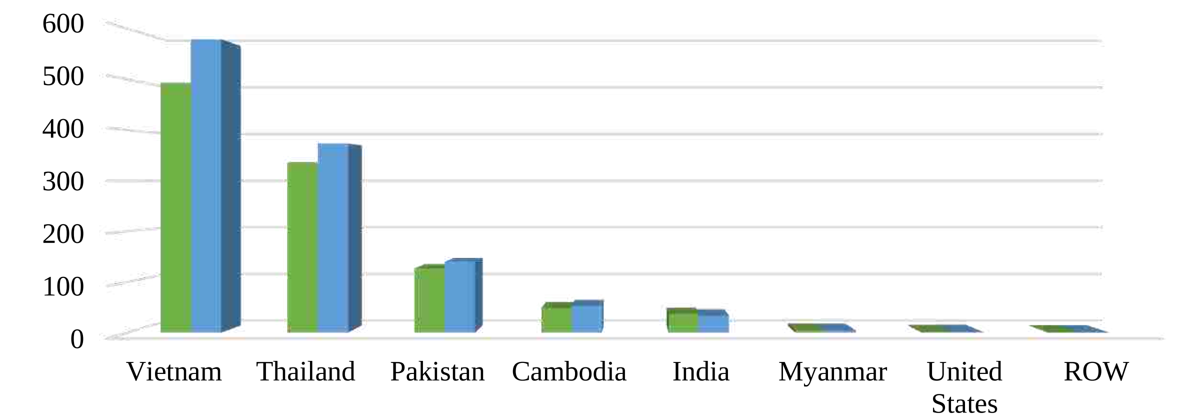
[13] The Association of Southeast Asian Nations (ASEAN) was formed to promote political and economic cooperation and regional stability which is currently participated by 10-member countries – Malaysia, Indonesia, Singapore, Brunei, Vietnam, Thailand, Philippines, Cambodia, Myanmar, and Laos.

Table 3.10: Malaysia: Current bilateral and regional free trade agreements (FTAs).

	Free Trade Agreements	Participating Date
Bilateral	Malaysia-Japan Economic Partnership Agreement (MJEPA)	13 July 2006
	Malaysia-Pakistan Closer Economic Partnership Agreement (MPCEPA)	1 Jan. 2008
	Malaysia-New Zealand Free Trade Agreement (MNZFTA)	1 Aug. 2010
	Malaysia-India Comprehensive Economic Cooperation Agreement (MICECA)	1 July 2011
	Malaysia-Chile free Trade Agreement (MCFTA)	25 Feb. 2012
	Malaysia-Australia free Trade Agreement (MAFTA)	1 Jan. 2013
	Malaysia-Turkey Free Trade Agreement (MTFTA)	1 Aug. 2015
Regional	ASEAN-China Free Trade Agreement (ACFTA)	1 July 2003
	ASEAN-Korea Free Trade Agreement (AKFTA)	1 July 2006
	ASEAN-Japan Comprehensive Economic Partnership (AJCEP)	1 Feb. 2009
	ASEAN-Australia-New Zealand Free Trade Agreement (AANZFTA)	1 Jan. 2010
	ASEAN-India Free Trade Agreement (AIFTA)	1 Jan. 2010
	ASEAN Trade in Goods Agreement (ATIGA)	17 May 2010

Source: Ministry of International Trade and Industry, Malaysia.

Despite the substantial government’s efforts to expand the areas in which rice is grown, upgrading technologies and research and development, developing and maintaining infrastructures, and investing in subsidy and incentive programs, the domestic production is still insufficient, covering between 60 – 65% of the total domestic demand. Malaysia has been a net rice importer for many years, depending on rice imports to satisfy the required domestic demand. Our projections to 2020 still suggest a significant reliance on imports (Figure 3.10). Therefore, the government’s decision to eliminate rice trades is pondered as an extreme policy strategy as Malaysia is not competitive in rice production (see Chapter II). Using a massive public investment and implicitly taxpayers’ dollars to support a highly subsidized crop in order to achieve self-sufficiency goal, it is crucial to evaluate the policies and analyze the impact of a long-held policy strategy at the macro level.



	Vietnam	Thailand	Pakistan	Cambodia	India	Myanmar	United States	ROW
2013-15	493.15	336.38	126.81	48.48	36.67	3.9	1.22	0.46
2020	579.00	373.20	139.78	52.89	33.20	3.73	1.38	0.53

Source: RICEFLOW Database.

Figure 3.10: Bilateral rice trades (in Thousand Mt) from Malaysian trading partners.

From the discussion above, some of the overarching questions this study attempts to answer includes: 1) What are the consequences of enforcing a total rice self-sufficiency? 2) What are the main limitations to achieve the self-sufficiency?, and 3) Is rice self-sufficiency an efficient approach to pursue? Subsequently, the main objective of this study is to evaluate and analyze the impacts of rice self-sufficiency, as an alternative, international free trade in Malaysia.

The specific objectives are:

1) To simulate the impacts of self-sufficiency policy on total rice output and consumption.
2) To estimate the subsidy and production input requirements to achieve rice self-sufficiency.
3) To measure the government’s potential gains or losses from rice self-sufficiency.
4) To assess the effects of removing rice trade restrictions on rice production and consumption.

This study utilizes a spatial partial equilibrium model of the global rice economy to simulate two main policy scenarios; 1) rice self-sufficiency in Malaysia, and 2) the complete removal of import tariffs on rice in Malaysia. The self-sufficiency policy scenario is simulated by eliminating Malaysia's bilateral import volume, while the free trade is simulated by removing existing import tariffs affecting rice imports in Malaysia. Prior to the simulation analysis, a baseline for the year 2020 is established to be consistent with the policy goal timelines, and therefore the results would be more realistic and representative. From self-sufficiency scenarios, we further estimate the policy requirements on subsidy, production input, technology efficiency, and the government potential revenues and losses.

2. Materials and Methods

2.1 Modeling Framework

This study applies a spatial partial equilibrium model of the global rice economy (Durand-Morat and Wailes, 2010). The model simulates the behavior of the entire rice supply chain, from input markets all the way up to the aggregate final demand, in multiple countries/regions (set R) around the world. Production of endogenous rice commodities (set CE[14]) is specified as a weak-separable, constant return to scale production function.

$$Y_{c,r} = H_{c,r}\{G_{c,r}(FAC_{c,r}), INT_{c,r}\}\ \forall c \in CE, r \in R \qquad [1]$$

[14] $CE = \{LGP, LGB, LGW, MGP, MGB, MGW, FRP, FRB, FRW\}$, where LG, MG, and FR stand for long grain, medium/short grain, and fragrant rice, and P, B, W stand for paddy/rough, brown/whole, and white/milled rice.

Where Y represents output, H and G are technology functional forms, FAC[15] is the set of factors of production, and INT[16] is the set of intermediate inputs.

Defining G in [1] as a constant elasticity of substitution (CES) function, the derived demand for factor of production, QFC, is:

$$QFC_{f,c,r} * AFC_{f,c,r} = QVA_{c,r} * SVA_{f,c,r} * \left[\frac{PFC_{f,c,r}}{PVA_{c,r} * AFC_{f,c,r}}\right]^{-\sigma VA_{c,r}} \quad \forall f \in FAC, c \in CE, r \in R \quad [2]$$

$$PVA_{c,r} = \left[\sum_{f} SVA_{f,c,r} * \left(\frac{PFC_{f,c,r}}{AFC_{f,c,r}}\right)^{1-\sigma VA_{c,r}}\right]^{\frac{1}{1-\sigma VA_{c,r}}} \quad \forall c \in CE, r \in R \quad [3]$$

Where AFC, PFC, and SVA are a factor-, sector-, and region-specific augmenting technical change variable, factor price variable, and cost share in value added, respectively, and QVA and PVA are a sector- and region-specific derived demand and price for the value-added composite, respectively. Finally, σVA is the sector- and region-specific elasticity of substitution in value-added.

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15 $FAC = \{L, T, K\}$, where L is land, T labor, and K capital.

16 $INT = \{seeds, herbcides, pesticides, water, energy, LGP, LGB, MGP, MGB, FRP, FRB\}$

Defining H in [1] as a constant elasticity of substitution (CES) function, the derived demands for intermediate inputs QIC, and for the composite value added $QVA_{c,r}$, are:

$$QIC_{i,c,r} * AIC_{i,c,r} = \frac{Y_{c,r}}{AY_{c,r}} * SITC_{i,c,r} * \left[\frac{PIC_{i,c,r}}{PY_{c,r}} * AIC_{f,c,r} * AY_{c,r}\right]^{-\sigma Y_{c,r}}, \ \forall i \in INT, c \in CE, r \in R \quad [4]$$

$$QVA_{c,r} * AVA_{c,r} = \frac{Y_{c,r}}{AY_{c,r}} * SVATC_{c,r} * \left[\frac{PVA_{c,r}}{PY_{c,r}} * AVA_{c,r} * AY_{c,r}\right]^{-\sigma Y_{c,r}}, \ \forall c \in CE, r \in R \quad [5]$$

Where AIC, PIC, and $SITC$ are input-, sector-, and region-specific input augmenting technical change variable, input price variable, and input cost share in total cost, respectively.

Furthermore, AVA, AY, and PY, and $SVATC$ are sector- and region-specific value-added augmenting technical change variable, output augmenting technical change variable, output price variable, and value-added cost share in total cost, respectively. Finally, σY is the sector- and region-specific elasticity of substitution in final output.

The model assumes zero profits[17] in production (Equation [6]) and equilibrium in output markets (Equation [7i] for paddy rice commodities[18], and [7ii] for other rice commodities).

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[17] Zero profit conditions are used to guarantee that no extra profits exist in any production activity; by forcing equality between costs and revenues, these conditions ensure that factors receive their normal rates of return.

[18] Set $CP = \{LGP, MGP, FRP\}. CP \in CE$.

$$PY_{c,r} = \frac{\left[SVATC_{c,r} * \left(\frac{PVA_{c,r}}{AVA_{c,r}}\right)^{1-\sigma Y_{c,r}} + \sum_i SITC_{i,c,r} * \left(\frac{PIC_{i,c,r}}{AIC_{i,c,r}}\right)^{1-\sigma Y_{c,r}}\right]^{\frac{1}{1-\sigma Y_{c,r}}}}{AY_{c,r}},$$

$$\forall c \in CE, r \in R \qquad [6]$$

$$Y_{c,r} = QD_{c,r} + \sum_s QBX_{c,r,s} + QK_{c,r}, \qquad \forall c \in CP, r \in R \qquad [7i]$$

$$Y_{c,r} = QD_{c,r} + \sum_s QBX_{c,r,s}, \qquad \forall c \in CCP, r \in R \qquad [7ii]$$

Where QD represent the volume of output c sold in the domestic market, QK is the change in stocks[19] of good c, and QBX is the volume of bilateral exports of c from region r to region s.

Import demand follows the Armington approach (Armington, 1969), by which imports by source and domestic production are treated as heterogeneous products. Agents first decide on the sourcing of imports (Equation 8) based on the relative level of prices from each source (Equation [9]).

$$QBX_{c,s,r} = QM_{c,r} * SMS_{c,s,r} * \left[\frac{PMMS_{c,s,r}}{PMM_{c,r}}\right]^{-\sigma M_{c,r}}, \ \forall c \in CE, r \in R, s \in R \qquad [8]$$

[19] Only stocks of paddy rice are allowed. Thus $QK_{c,r}$ is defined over the commodity subset CP.

$$PMM_{c,r} = \left[\sum_{s} SMS_{c,s,r} * PMMS_{c,s,r}{}^{1-\sigma M_{c,r}}\right]^{\frac{1}{1-\sigma M_{c,r}}}, \qquad \forall c \in CE, r \in R \qquad [9]$$

Where $PMMS$ is the market price of import good c into region r from source s, PMM is the composite market price of import good c in r, QM is the demand for the composite import good c in r, and SMS is the value-share of good c's imports into r by source s. $\sigma M_{c,r}$ is the elasticity of substitution of imported good c in r by source.

After sourcing imports, then agents decide on the optimal mix of imported and domestic products (Equation [10] and [11]) based on their relative price levels (Equation [12]).

$$QM_{c,r} = QQ_{c,r} * SMQ_{c,r} * \left[PMM_{c,r}/PQ_{c,r}\right]^{-\sigma Q_{c,r}}, \ \forall c \in CE, r \in R \qquad [10]$$

$$QD_{c,r} = QQ_{c,r} * SDQ_{c,r} * \left[PY_{c,r}/PQ_{c,r}\right]^{-\sigma Q_{c,r}}, \ \forall c \in CE, r \in R \qquad [11]$$

$$PQ_{c,r} = \left[SMQ_{c,r} * PMM_{c,r}{}^{1-\sigma Q_{c,r}} + SDQ_{c,r} * PY_{c,r}{}^{1-\sigma Q_{c,r}}\right]^{\frac{1}{1-\sigma Q_{c,r}}}, \ \forall c \in CE, r \in R \qquad [12]$$

Where PQ is the market price of composite good c in region r, QQ is the output of composite good c in r, and SMQ and SDQ are the value-shares of the import composite and domestic good c in r. $\sigma Q_{c,r}$ is the elasticity of substitution between domestic and imported good c in r.

Final demand for milled rice $c \in CFC$[20] in region r, is the product of population and per-capita demand $D_{c,r}$, which is specified as a double log function of income and prices (Equation [13]). Z_r represents income by region, φ_r is the income demand elasticity, and $\omega_{c,g,r}$ is the matrix of own and cross-price demand elasticities.

$$\log D_{c,r} = \varphi_r * \log Z_r + \sum_{g \in FC} \omega_{c,g,r} * \log PQ_{g,r} \ , \ \forall c \in CFC, r \in R \qquad [13]$$

The supply of exogenous intermediate inputs (seeds, fertilizers, pesticides, energy, and water), capital, and labor are specified as perfectly elastic, thus their prices (PFC) are treated as constant, exogenous variables. Land is considered the only factor with limited supply. Hence, sectoral output Y is constrained only by the supply of land $L_{c,r}$ used in the production of paddy rice, which is represented by a double log function of land rental rates $PL_{c,r}$.

$$\log L_{c,r} = \theta_{c,r} \log PL_{c,r} \ , \ \forall c \in CP, r \in R \qquad [15]$$

The land own-price supply elasticity $\theta_{c,r}$ are calibrated following Keller (1976) to reflect rice supply elasticities found in the literature.

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[20] Set $CFC = \{LGW, MGW, FRW\}. CFC \in CE.$

2.2 Database

The database disaggregates rice into nine commodities across 76 regions in the world covering over 90 percent of global production, consumption, and trade. The nine commodities result from the combination of three rice types (long grain, medium/short grain, and fragrant rice) and three milling degrees (paddy, brown, and white rice). The database represents global rice market situation in 2013 – 2015. Data on rice production and stock changes come primarily from the USDA's Production, Supply, and Demand database (PSD) and FAOSTAT. Rice production by type comes from many different sources, including national statistics offices, USDA's Global Agricultural Information Network (GAIN) reports, and industry publications such as Creed Rice Market Report and The Rice Trader. Data on producer and consumer prices come from many of the sources cited above as well as FAO's Global Information and Early Warning System (GIEWS). Rice trade data comes primarily from UN's COMTRADE database. Information on rice trade by type comes from many sources, including Thailand's Ministry of Commerce, India's Ministry of Commerce and Industry, Pakistan Bureau of Statistics, and USDA's Global Agricultural Trade System. Information on trade policies is compiled from many sources, including the World Trade Organization (WTO), the Association of Southeast Asian Nations (ASEAN), the Organization of American States's Foreign Trade Information System, and other national reporting agencies. The elasticities of rice supply and demand come primarily from the Food and Agricultural Policy Research Institute (FAPRI). The Armington elasticities are taken from the Global Trade Analysis Project (GTAP).

3. Rice Policy Scenarios

This section describes the procedure to estimate the relevant scenarios specified in this study which comprise of the baseline analysis for the year 2020, self-sufficiency scenario, and international free trade scenario.

3.1 Baseline Analysis for the Year 2020

The baseline for the year 2020 is constructed by shocking the 2013-15 database with projected population growth and gross domestic product (GDP) growth developed by Global Insights (see Appendix Table 3.1 and 3.2). According to Food and Agriculture Organization (FAO), overall demand for food was affected by population growth, while economic development and rising incomes tend to shift diets toward more expensive and resource-intensive food products to produce (FAO, 2010). The projections by the International Food Policy and Research Institute (IFPRI, 2014) suggest that slower population growth could significantly lower malnutrition along with increased agricultural productivity, economic growth and investment in health and education. Because population trends will continue to affect the demand for food in future, it is important that demographic projections be incorporated into plans to improve agricultural production and achieve greater food security (Rosegrant et al., 2001). Furthermore, the FAO suggests that high malnutrition can lead to loss in gross domestic product (GDP) of as much as 4% to 5% (IFPRI, 2014). Therefore, the population and GDP growth are the key pillars to determine economic development for a region.

3.2 Self-sufficiency Scenario

Self-sufficiency scenario is defined to simulate the elimination of Malaysian bilateral trade of long grain rice by the year 2020. The closure of the model is altered so as to exogenize the variable representing bilateral import volumes (*qyb*) (originally endogenous) and endogenizing the variable representing the power of bilateral import policies (*tys*). This change in the closure allows us to find the power of import tariffs needed to bring import volumes to a target level. In this study, the target was to reduce the volume of long grain rice imports by 95%. Imports of medium grain and fragrant rice are not restricted since, first, they represent a marginal part of the total domestic rice market, and second, they are consumed primarily by high income households and therefore contribute little to improving food security in Malaysia.

3.3 Free Trade Scenario

Free trade scenario in this study is defined as the removal of import tariffs on rice in Malaysia. Malaysia applies different levels of import tariffs across trade partners (see Appendix Table 3.3). We incorporate free trade in the model by shocking the power of the bilateral import tariffs (*tys*) to zero (see Appendix Table 3.4).

4. Empirical Results and Discussions

The following section presents and discusses the main results from each of the relevant scenarios defined above. In the baseline analysis for the year 2020, the changes in the variables represent their evolution relative to their state in the period 2013-15. The self-sufficiency and free trade scenarios used the 2020 baseline results as starting points. Thus, the changes in the variables resulting from these two scenarios represent the state of these variables relative to their state in 2020 without the shocks implied by the self-sufficiency and free trade scenarios.

4.1 Baseline Analysis for the Year 2020

The results of the 2020 baseline reveal that self-sufficiency in 2020 will be at 66.7%, slightly higher than the current average of 65%. In other words, given the projected market conditions and levels of intervention by the Malaysian government, Malaysia is set to continue depending strongly on the international rice market to service a growing rice demand.

The domestic production of long grain paddy (LGP) marginally grows at 6.8% as well as increase in milling industry by 6.6%. The producer prices (i.e. cost of production) are estimated to increase by 17.8% and 17.2% for long grain paddy and long grain white, respectively. With increases in producer prices, consumer prices increase by 17.6% for long grain rice. The aggregate demand for each type of rice is expected to grow, primarily due to the growing population. Imports of all rice types increase (Table 3.11 and Figure 3.11). Vietnam and Thailand remain the main rice suppliers to the Malaysian market (see Appendix Table 3.1).

Table 3.11: Results of the baseline analysis for the year 2020.

Parameters	Baseline 2013-15	Baseline 2020	
		(%)	Level
Producer price (RM/Mt)			
Long grain paddy	1,733.4	17.8	2,041.4
Long grain brown	1,745.0	17.6	2,052.4
Long grain white	1,791.3	17.2	2,099.0
Consumer price (RM/Mt)			
Long grain white	2,908.6	17.6	3,421.4
Medium grain white	4,873.8	10.8	5,399.0
Fragrant white	6,193.2	31.2	8,128.0
Domestic production (thousand Mt milled basis)			
Long grain paddy	1,764.6	6.8	1,885.0
Long grain brown	1,837.0	6.6	1,958.0
Long grain white	1,837.7	6.6	1,958.0
Imports (thousand Mt milled basis)			
Long grain white	941.3	3.3	975.4
Medium grain white	1.4	11.9	1.5
Fragrant white	103.6	10.5	114.5

Table 3.11 (Cont.)

Parameters	Baseline 2013-15	Baseline 2020	
		%	Level
Demand (thousand Mt milled basis)			
Long grain white	2,779.0	5.5	2,932.0
Medium grain white	1.4	11.6	1.5
Fragrant white	103.7	10.7	114.8
Self-sufficiency level in long grain (%)	66.1	66.7	

These results suggest that Malaysia's goal of achieving rice self-sufficiency by 2020 are unrealistic at the projected market and government intervention conditions.

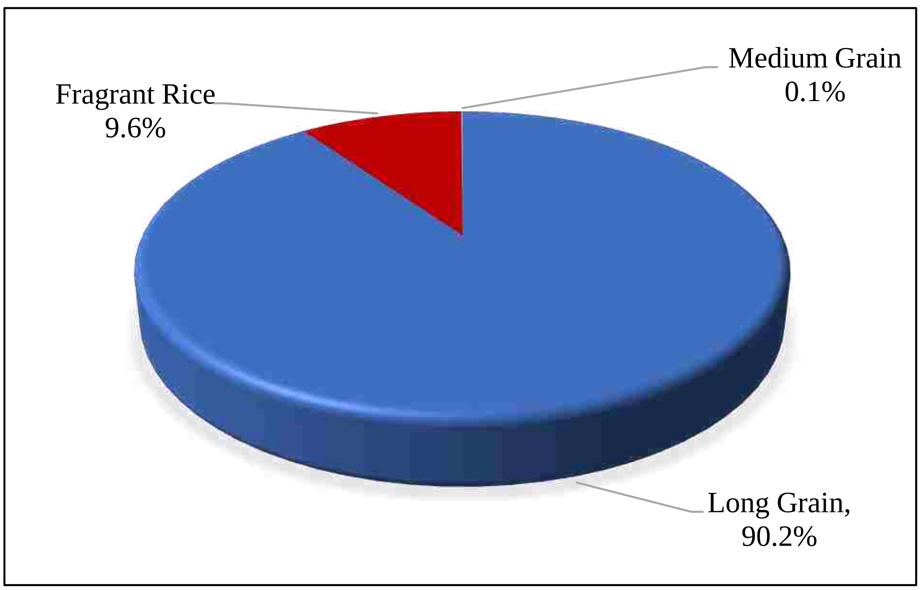


Figure 3.11: Projections on Malaysia's rice imports by 2020.

4.2 Self-sufficiency Scenario

The results of the self-sufficiency scenario for rice commodities in Malaysia are presented in Table 3.12. Recall that this scenario entails reducing imports of long grain rice by 95%. The massive decrease in rice imports stimulate the domestic production to increase by

53.3%, which is only possible with a 170.3% increase in producer price. By the underlying a zero-profit condition[21], this increase also implies the increase in cost of production that is mostly derived from a constraint in land factor. The higher production cost of paddy rice and consequential increase in the market price of paddy rice transfers to higher consumer prices. As a result, the demand for long grain rice declines by 23.9%.

Rice producers gain as a result of the self-sufficiency policy due to increases in producer surplus. However, rice consumers are worse off since the market prices are much higher (i.e. decrease in consumer surplus), hence rice self-sufficiency entails significant welfare shifts from consumers to producers. These results suggest that self-sufficiency will likely adversely affect food security objectives since the policy increases prices and limits consumption.

Table 3.12: Results of the self-sufficiency scenario.

Parameters	Baseline 2013-15	Baseline 2020		Self-sufficiency	
		(%)	Level	(%)	Level
Producer price (RM/Mt)					
Long grain paddy	1,733.4	17.8	2,041.4	170.3	5,516.9
Long grain brown	1,745.0	17.6	2,052.4	168.9	5,519.3
Long grain white	1,791.3	17.2	2,099.0	165.3	5,567.6
Consumer price (RM/Mt)					
Long grain white	2,908.6	17.6	3,421.4	165.3	9,075.3
Medium grain white	4,873.8	10.8	5,399.0	0.0	5,399.0
Fragrant white	6,193.2	31.2	8,128.0	0.2	8,146.7
Domestic production (thousand Mt)					
Long grain paddy	1,764.6	6.8	1,885.0	53.3	2,890.5
Long grain brown	1,837.0	6.6	1,958.0	51.4	2,965.0
Long grain white	1,837.7	6.6	1,958.0	51.2	2,959.9
Imports (thousand Mt milled basis)					
Long grain white	9,41.3	3.3	975.4	-95.0	48.8
Medium grain white	1.4	11.9	1.5	7.1	1.6
Fragrant white	103.6	10.5	114.5	7.1	122.6

[21] By virtue of the zero-profit condition, the product price by activity equals the unitary cost of production (Durand-Morat and Wailes, 2010).

Table 3.12 (Cont.)

Parameters	Baseline 2013-15	Baseline 2020		Self-sufficiency	
		(%)	Level	(%)	Level
Demand (thousand Mt milled basis)					
Long grain white	2,779.0	5.5	2,932.0	-23.9	2,231.8
Medium grain white	1.4	11.6	1.5	7.1	1.6
Fragrant white	103.7	10.7	114.8	7.1	122.9
Welfare change					
Producer surplus (US$ bill.)					2.8
Consumer surplus (US$ bill.)					-3.5
Self-sufficiency in long grain (%)	66.1		66.7		97.8

The government loses US$ 121.5 million in import tariff revenues as a result of self-sufficiency in long grain rice, which is the difference between market price and cost, insurance, and freight (CIF) price of bilateral import, value US$ 652.9 million and US$ 531.4 million, respectively. Despite feasibly achieving rice self-sufficiency by the year 2020, the government would suffer from a rice import tariff revenue loss.

Malaysia is an important player in the international rice market, and therefore the achievement of rice self-sufficiency is expected to have sizable spillover effects into other regions. Vietnam, the main supplier of rice into Malaysia, is expected to lose the most as its export volume drops by 3.05%, followed by India, Myanmar, Pakistan, and the United States (Table 3.13). The results above show that rice self-sufficiency will generate significant welfare redistributions from consumers and the government to rice producers in Malaysia, and will have significant spillover effects onto the rice global market. The options available to counter the significant price spike expected under rice self-sufficiency are limited, and their assessments suggest that harmonizing the goals of self-sufficiency and food security through stable rice prices will be extremely challenging.

Table 3.13: Global impacts of self-sufficiency policy in Malaysia.

Exporting Regions	% Change of Export Volume
Vietnam	-3.05
Thailand	-0.14
Pakistan	-1.54
Myanmar	-1.63
India	-1.70
United States	-1.53
ROW (Rest of the World)	-1.83

4.3 Output Subsidy Requirements

An option to offset the rice price increase resulting from rice self-sufficiency could be to expand producer subsidies. The subsidy expansion would bring the consumer price down at the pre-self-sufficiency level, so the price becomes lower. The required subsidy and the cost of the subsidy program can be estimated using the producer prices and domestic production in the self-sufficiency scenario. The total subsidy (in local currency per metric ton) is estimated at RM 3,475.5/Mt (US$ 810/Mt). The total cost of subsidy program is estimated at RM 10.04 billion (US$ 2.34 billion). With the current total subsidy program is RM 1.8 billion (DOA, 2010), the government needs a substantial additional expenditure to realize self-sufficiency in rice while maintaining prices at the baseline level (Table 3.14).

Table 3.14: Required subsidy and total subsidy program for self-sufficiency.

Parameter	Producer Prices (RM/Mt)		RM/ Mt
	Baseline 2020	Self-sufficiency	
Required subsidy	2,041.4	5,516.9	3,475.5
	Total subsidy (RM/Mt)	**Domestic production (thousand Mt in paddy basis)**	**RM (Billion)**
Required total subsidy	3,475.5	2,890.5	10.04

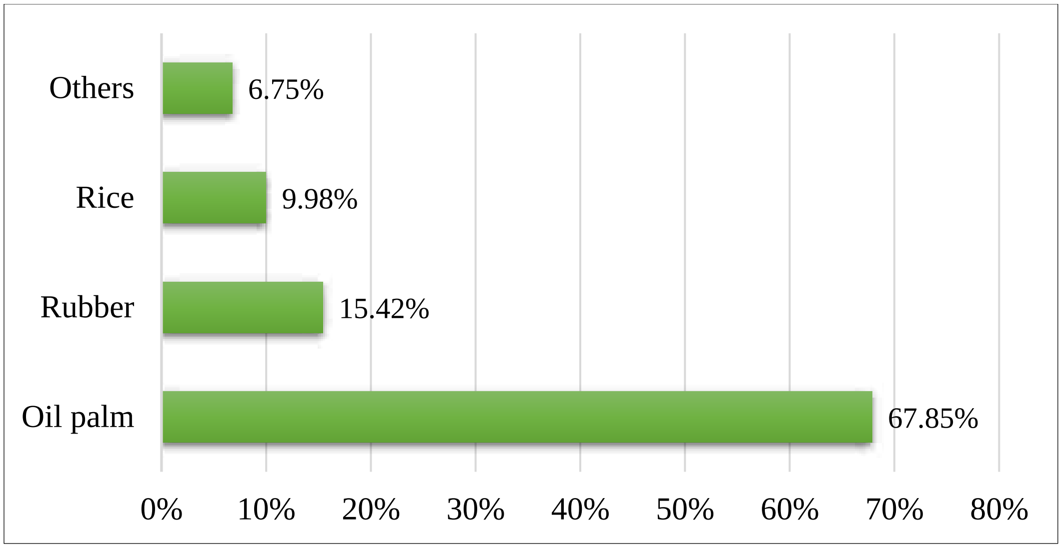
4.4 The Requirements of Production Input.

The primary rice production technology is specified as Leontief production function (no substitution between production inputs). Additionally, all factors of production are assumed to be perfectly elastically supplied except for land. This specification of production and input markets means that the changes in the rice market will be primarily dictated by the specification of land markets. In the self-sufficiency scenario, the growth of domestic production (53.3%) translates into a 53.3% increase in land demand. Given the inelastic supply of land assumed in this study, such an expansion in land demand results in very large increases in land rental rates (Table 3.15). The increase in required land in the self-sufficiency scenario would also lead to an incredibly higher cost of production, subsequently would transfer to much higher consumer prices.

Table 3.15: The required land input of production.

Parameters	Baseline 2020	Self-sufficiency
Rice acreage at baseline (‘000 Ha)	690.0	736.9
Growth in required land input (%)	6.8	53.3
Required land acreage (‘000 Ha)	736.9	1,129.8
Domestic rice production (‘000 Mt, paddy basis)	1,885	2,890.5

The majority of agricultural land in Malaysia is used to produce palm oil and rubber, which the most important agricultural commodities for the national income, thus rice farmland is limited to less than 10% of the total agricultural land (Figure 3.12). The land substitution possibilities between an annual crop such as rice and permanent crops such as rubber and palm oil are limited by the high investment required in the later.



Source: FAOSTAT (2014)

Figure 3.12: Malaysia: Agricultural land use (area harvested) by commodity.

Possible solutions to overcome the land constraint include the utilization of technology and research and development such as the development of non-irrigated farmland, but it is still challenging for Malaysia regarding land availability. To expand rice acreage, another way is through increasing rice-land-use intensity (number of rice crops produced per year on the same field). However, the existing crop intensity in Malaysia is relatively high, ranging from 170% to 180%. Forcing the crop intensity to be much higher would be extremely challenging, especially with respect to the agronomy dimensions and crucial water resource adequacy (FAO, 2005).

4.5 The Requirement for Technological Efficiency.

Technological efficiency is based on the intensification of productivity, primarily land productivity. Higher yields per hectare can enable Malaysia to achieve higher output without increasing acreage. Therefore, the required crop yield to achieve self-sufficiency, which represents the needed productivity improvement, is measured. At the baseline 2020, with the land acreage of 690 (thousand ha) to produce 1,958 (thousand Mt, milled basis), the required crop yield is 2.83 Mt/ha[22] (milled basis) or 4.73 Mt/ha (paddy basis). In self-sufficiency scenario, with the required land acreage is 736.9 (thousand ha) to produce 2,959.9 (thousand Mt, milled basis) rice, the required crop yield is 4.02 Mt/ha (milled basis) or 6.18 Mt/ha (paddy basis). At this productivity gain, domestic rice production can be achieved at the self-sufficiency level and consumer prices remain at the pre-self-sufficiency level, thus preventing prices from surging up (Table 3.16). However, these findings suggest that the challenge for Malaysia to achieve self-sufficiency while keeping rice price stability is significant and would require yield gains of 30% in relatively few years. To put this in perspective, it took Malaysia around 15 years (since 1998-2000) to increase average rice yields by 30 percent to reach the 2014-16 average yield of 4.02 Mt/ha (paddy basis).

Table 3.16: The required technological efficiency on productivity.

Parameters	Baseline 2020	Self-sufficiency
Land acreage (in thousand ha)	690.0	736.9
Domestic production (in thousands, milled basis)	1,958.0	2,959.9
Required crop yield Mt/ha (in milled basis)	2.83	4.02
Required crop yield Mt/ha (in paddy basis)	4.73	6.18

Since most of the tropical rice-growing countries in Asia have a high population growth rate and limited land for rice cultivation, in order to be a food-secured nation, the productivity gain is crucial. Hybrid rice adoption can be a way to meet this objective (FAO, 2004). The hybrid rice technology aims to increase the yield potential of rice beyond the level of inbred high-yielding varieties (HYVs) by exploiting the phenomenon of hybrid vigor or heterosis.

[22] The crop yield is estimated as the division of domestic production (1,885 in thousand Mt, paddy basis) to the land acreage (736.9 in thousand ha).

However, a number of challenges have been identified which affect the large-scale adoption of hybrid rice, including inferior grain quality, and the high cost of seed (FAO, 2004). Another potential technology for limited irrigated land is the upland rice, which are grown in well-drained, non-puddled, and non-saturated soils. With good management practices, upland rice (aerobic rice) tends to produce at least 4-6 Mt/ha, however more species of weeds tend to experience in rice field that are not permanently flooded than in flooded rice, especially in the tropic environments. Also, soil-borne pests and diseases such as nematodes, root aphids, and fungi have been found to possibly occur more in upland rice (Maclean et al., 2013). Malaysia has ventured in both hybrid and upland rice varieties through the Malaysian Agricultural Research and Development Institute (MARDI) since 2005. Since the hybrid rice does not perform well with a direct-seeding approach, which the most applied planting approach in Malaysia, farmers need to apply a high-technology machinery for planting process, which is not available to most small rice farmers. As a result, "Earlier works on hybrid rice in Malaysia had never delivered a success" (GRAIN, 2008). Aerobic rice, a combination of upland and high-yield lowland rice varieties (Tuong and Bouman, 2003) is another effort to achieve self-sufficiency in rice. Despite having been stable productivity, the aerobic rice resulted in lower crop yields than irrigated lowland rice, ranged 2.2 to 3.6 Mt/ha. In fact, the aerobic rice tends to expose higher weed infestation with a poor soil structure in adverse non-irrigated environment, which was consistently required higher inputs. With most rice farmers in Malaysia are among the poor, this condition would be the most challenging to maintain the production performance (Chan et al., 2012).

4.6 Free Trade Scenario

As described above, the free-trade scenario implies removing all existing long grain rice import tariffs in Malaysia (see Appendix Table 3.3 for information on the actual levels of import protection administered by Malaysia). With free trade, the producer price for long grain rice in Malaysia decreases by 11.9%, and domestic production by 5.3%, yielding a self-sufficiency level of 61.8%. The increased competition in the Malaysian rice market leads to a reduction in consumer prices of 14.74% and a consequent increase in domestic consumption of long grain rice of 4.44%. The higher domestic demand further expands rice imports by 19.85% (Table 3.17).

The results are consistent with the trade theory that reveals rice producers lose, yet consumers gain and better off from the international free trade policy. From the consumers' perspectives, a free trade scenario appears to allow for a more food secured economy relative to a self-sufficiency scenario, since the free trade is not punishing consumers at the price level and thus, consumers gain from the free trade. However, producers would be worse off (i.e. decrease producer surplus), and the government will lose tariff revenues from the free trade.

Table 3.17: Results of free trade scenario.

Parameters	Baseline 2013-15	Baseline 2020		Free Trade Policy	
		(%)	Level	(%)	Level
Producer price (RM/Mt)					
Long grain paddy	1,733.40	17.80	2,041.40	-11.90	1,798.47
Long grain brown	1,744.90	17.60	2,052.40	-11.81	1,810.01
Long grain white	1,791.30	17.20	2,099.00	-11.55	1,856.57
Consumer price (RM/Mt)					
Long grain white	2,908.60	17.60	3,421.40	-14.74	2,917.09
Medium grain white	4,874.00	10.80	5,399.00	0.01	5,399.54
Fragrant white	6,193.00	31.20	8,128.00	-0.04	8,124.75

Table 3.17 (Cont.)

Parameters	Baseline 2013-15	Baseline 2020		Free Trade	
		(%)	Level	(%)	Level
Domestic production (thousand Mt)					
Long grain paddy	1,764.60	6.80	1,885	-5.30	1,785.10
Long grain brown	1,837.00	6.60	1,958	-5.11	1,857.95
Long grain white	1,837.70	6.60	1,958	-5.08	1,858.53
Imports (thousand Mt milled basis)					
Long grain white	941.3	3.30	975.4	19.85	1,169.02
Medium grain white	1.4	11.90	1.5	-1.08	1.48
Fragrant white	103.6	10.50	114.5	-1.08	113.26
Demand (thousand Mt milled basis)					
Long grain white	2,779.00	5.50	2,932.00	4.44	3,062.18
Medium grain white	1.4	11.60	1.5	-1.08	1.48
Fragrant white	103.7	10.70	114.8	-1.08	113.56
Welfare change					
Producer surplus (US$ mill.)					-125.8
Consumer surplus (US$ mill.)					328.0
Self-sufficiency level (%)	66.13		66.73		61.82

While self-sufficiency policy would improve welfare to rice producers, albeit a minor segment of total population, the policy will not only lead to a substantial increase in consumer prices, but also gargantuan government costs. Instead, free trade could be welfare improving to most of the population of the country as rice remains a primary food staple. From a policy perspective, the government and policymakers should gauge the implications of the policies on economy as a whole. The government’s stance on self-sufficiency needs to be reconsidered as this policy strategy is economically misguided. The significant differences in welfare allocation between the two scenarios described above imply that the political economy becomes even more crucial in deciding the policy output. Since Malaysia is pursuing self-sufficiency, the forces supporting a small group of the population are winning the battle to the expense of the larger consumer group.

5. Conclusions

Rice self-sufficiency has become a policy cornerstone in Malaysia, and it is a maintained strategy to be the best way to address food security concerns. Various strategies can be utilized to achieve a desired level of self-sufficiency which lead to substantial public investment to support domestic rice production. As a result, rice has become a highly subsidized and protected food crop. The government's mandate is to seriously pursue self-sufficiency in rice and achieve the policy goal by the years 2020.Most recently this goal has been extended to 2050. With this mandate, the government aims to close all trading borders and eliminate rice imports coming from international markets and suppliers. As Malaysia is not a competitive rice producer, this extreme policy decision will require a massive additional expenditure at the production level. Instead, liberalizing rice trade offers positive effects on food security and implicitly economic growth as Malaysia has actively participated in both bilateral and regional free trade agreements.

This study evaluates and analyzes the impact of self-sufficiency and free trade policies on rice sector in Malaysia at the national level using a spatial partial equilibrium model. As expected, the results correspond to economic theory with self-sufficiency greatly benefitting rice farmers at the expense of consumers. On the other hand, the free trade showed opposite policy impact since farmers' welfare will be worsen while increasing consumers' welfare. From this study, these two policy scenarios clearly represent the opposite direction in terms of welfare distribution, and the estimations of producer and consumer surplus corroborate the findings. Self-sufficiency will create massive welfare shifts from consumers and the government to rice producers. Despite improving welfare to rice producers, albeit a small group, self-sufficiency punish consumers, which also include rice producers, due to highly increased consumer price. As affordable food price is a key concepts of food security, self-sufficiency does not guarantee food security at the national level. The government loses from self-sufficiency, thus pursuing self-sufficiency is highly challenging for Malaysia. As part of the ASEAN, Malaysia could participate in a regional approach for strengthening food security to address its rice-deficit issue. Instead, free trade offers a more food secured economy. With free trade, although rice producers are worse off, albeit a marginal degree, and the government loses from import tariff revenues, the consumers would be better off due to decreasing prices with a more competitive market environment from external rice suppliers.

Since this study focuses on rice in terms of final consumption, the model is not allowed for substitution to other sources of calories which means consumers continue to consume rice with no substitutions. As dictated by elasticities, consumers are not allowed to switch to wheat, corn, and etc. Further analysis should focus on substitution of other food sources in the final consumption. Also, the estimations for each parameter are based on the fact that Malaysia pursues total self-sufficiency goal by the year 2020, as mandated by the government in the national agricultural policy for 2010-2020. However, the government has recently extended the self-sufficiency goal to the year 2050 under the national masterplan for 2020 - 2050, and thus the country has another 30 years to improve its rice sector to achieve self-sufficiency in the future.

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Appendix Table 3.1: The projections of population growth by regions.

Regions	In Million								%	%
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Baseline (2013-2015)**	**Change (2020)**
Argentina	42.5	43.0	43.4	43.8	44.3	44.7	45.1	45.5	43.0	5.9
Australia	23.3	23.6	24.0	24.3	24.6	25.0	25.3	25.6	23.6	8.4
Bangladesh	157.2	159.1	161.0	162.9	164.8	166.7	168.6	170.5	159.1	7.2
Benin	10.3	10.6	10.9	11.2	11.5	11.8	12.1	12.4	10.6	16.6
Bolivia	10.4	10.6	10.7	10.9	11.1	11.2	11.4	11.5	10.6	9.3
Brazil	204.3	206.1	207.8	209.6	211.2	212.9	214.5	216.0	206.1	4.8
Burkina Faso	17.1	17.6	18.1	18.6	19.2	19.7	20.3	20.9	17.6	18.6
Canada	35.1	35.5	35.8	36.2	36.6	37.0	37.4	37.8	35.5	6.5
Cambodia	15.1	15.3	15.6	15.8	16.1	16.3	16.6	16.8	15.3	9.7
Cameroon	22.2	22.8	23.3	23.9	24.5	25.1	25.7	26.3	22.8	15.6
Chile	17.6	17.8	17.9	18.1	18.3	18.5	18.7	18.8	17.8	6.1
China	1,362.5	1,369.4	1,376.0	1,382.3	1,388.2	1,393.7	1,398.6	1,402.8	1369.3	2.4
Colombia	47.3	47.8	48.2	48.7	49.1	49.5	49.9	50.2	47.8	5.1
Costa Rica	4.7	4.8	4.8	4.9	4.9	5.0	5.0	5.0	4.8	6.0
Cote D'Ivoire	21.6	22.2	22.7	23.3	23.8	24.4	25.0	25.6	22.2	15.4
Cuba	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	-0.1
Ecuador	15.7	15.9	16.1	16.4	16.6	16.9	17.1	17.3	15.9	9.0
Egypt	87.6	89.6	91.5	93.4	95.2	97.0	98.8	100.5	89.6	12.2
El Salvador	6.1	6.1	6.1	6.1	6.2	6.2	6.2	6.2	6.1	2.0
European Union	504.3	504.8	505.3	505.9	506.5	507.1	507.7	508.2	504.8	0.7
Gambia	1.9	1.9	2.0	2.1	2.1	2.2	2.3	2.3	1.9	20.5
Ghana	26.2	26.8	27.4	28.0	28.6	29.2	29.7	30.3	26.8	13.3
Guatemala	15.7	16.0	16.3	16.7	17.0	17.3	17.7	18.0	16.0	12.5
Guinea	11.9	12.3	12.6	12.9	13.2	13.5	13.8	14.1	12.3	15.1
Guinea Bissau	1.8	1.8	1.8	1.9	1.9	2.0	2.0	2.1	1.8	14.9
Guyana	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	3.0
Haiti	10.4	10.6	10.7	10.8	11.0	11.1	11.2	11.4	10.6	7.6
Honduras	7.8	8.0	8.1	8.2	8.3	8.4	8.5	8.7	8.0	8.6
Hongkong	7.2	7.2	7.3	7.3	7.4	7.5	7.5	7.6	7.2	4.6
India	1,279.5	1,295.3	1,311.1	1,326.8	1,342.5	1,358.1	1,373.6	1,388.9	1295.3	7.2
Indonesia	251.3	254.5	257.6	260.6	263.5	266.4	269.1	271.9	254.4	6.9
Iran	77.2	78.1	79.1	80.0	80.9	81.8	82.6	83.4	78.1	6.7
Iraq	34.1	35.3	36.4	37.5	38.7	39.8	40.9	42.0	35.3	19.0
Japan	127.0	126.8	126.6	126.3	126.0	125.7	125.4	125.0	126.8	-1.4
Kenya	43.7	44.9	46.1	47.3	48.5	49.7	50.9	52.2	44.9	16.3
Laos	6.6	6.7	6.8	6.9	7.0	7.2	7.3	7.4	6.7	10.6
Liberia	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	4.4	14.5
Malaysia	29.5	29.9	30.3	30.8	31.2	31.6	32.0	32.4	29.9	8.3
Mali	16.6	17.1	17.6	18.1	18.7	19.3	19.9	20.5	17.1	19.7
Mexico	123.7	125.4	127.0	128.6	130.2	131.8	133.4	134.9	125.4	7.6
Myanmar	53.0	53.4	53.9	54.4	54.8	55.3	55.8	56.2	53.4	5.2

Appendix Table 3.1 (Cont.)

Regions	**In Million**								%	%
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Baseline (2013-2015)**	**Change (2020)**
Nicaragua	**5.9**	**6.0**	**6.1**	**6.2**	**6.2**	**6.3**	**6.4**	**6.4**	**6.0**	**6.7**
Niger	18.4	19.1	19.9	20.7	21.6	22.4	23.4	24.3	19.1	27.1
Nigeria	172.8	177.5	182.2	187.0	191.8	196.8	201.7	206.8	177.5	16.5
Pakistan	181.2	185.0	188.9	192.8	196.7	200.7	204.6	208.4	185.1	12.6
Panama	3.8	3.9	3.9	4.0	4.1	4.1	4.2	4.2	3.9	9.4
Paraguay	6.5	6.6	6.6	6.7	6.8	6.9	7.0	7.1	6.6	7.9
Peru	30.6	31.0	31.4	31.8	32.2	32.6	32.9	33.3	31.0	7.6
Philippines	97.6	99.1	100.7	102.3	103.8	105.3	106.9	108.4	99.1	9.4
Rwanda	11.1	11.3	11.6	11.9	12.2	12.4	12.7	13.0	11.3	14.6
Russia	143.4	143.4	143.5	143.4	143.4	143.3	143.1	142.9	143.4	-0.4
Saudi Arabia	30.2	30.9	31.5	32.2	32.7	33.3	33.8	34.4	30.9	11.3
Senegal	14.2	14.7	15.1	15.6	16.1	16.5	17.0	17.5	14.7	19.2
Singapore	5.4	5.5	5.6	5.7	5.8	5.9	5.9	6.0	5.5	9.1
Sierra Leone	6.2	6.3	6.5	6.6	6.7	6.9	7.0	7.2	6.3	13.6
South Korea	49.8	50.1	50.3	50.5	50.7	50.9	51.1	51.3	50.1	2.4
South Africa	53.4	54.0	54.5	55.0	55.4	55.9	56.3	56.7	54.0	5.0
Sri Lanka	20.5	20.6	20.7	20.8	20.9	21.0	21.1	21.2	20.6	2.6
Suriname	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.5	5.0
Taiwan	23.3	23.4	23.5	23.5	23.6	23.6	23.7	23.7	23.4	1.4
Tanzania	50.2	51.8	53.5	55.2	56.9	58.6	60.4	62.3	51.8	20.1
Thailand	67.5	67.7	68.0	68.1	68.3	68.4	68.5	68.6	67.7	1.3
Togo	6.9	7.1	7.3	7.5	7.7	7.9	8.1	8.3	7.1	16.5
Turkey	76.2	77.5	78.7	79.6	80.4	81.1	81.7	82.3	77.5	6.2
UAE	9.0	9.1	9.2	9.3	9.4	9.5	9.7	9.8	9.1	8.0
Uganda	36.6	37.8	39.0	40.3	41.7	43.0	44.4	45.9	37.8	21.3
Uruguay	3.4	3.4	3.4	3.4	3.5	3.5	3.5	3.5	3.4	2.2
USA	317.1	319.5	322.0	324.5	327.1	329.8	332.4	335.0	319.5	4.8
Venezuela	30.3	30.7	31.1	31.5	31.9	32.3	32.7	33.1	30.7	7.9
Vietnam	91.4	92.4	93.4	94.4	95.4	96.4	97.3	98.2	92.4	6.2

Source: Arkansas Global Rice Model (AGRM).

Appendix Table 3.2: The projections of gross domestic product by regions.

Regions	Billion US$								%	%
	2013	2014	2015	2016	2017	2018	2019	2020	Baseline (2013-2015)	Change 2020
Argentina	458.1	446.7	457.5	450.0	476.3	476.3	489.9	502.0	454.1	10.6
Australia	1357.4	1395.3	1428.9	1463.4	1537.7	1537.7	1583.1	1627.3	1393.8	16.7
Bangladesh	137.7	146.0	155.6	166.5	188.6	188.6	200.9	213.7	146.4	45.9
Benin	7.5	8.0	8.3	8.7	9.4	9.4	9.8	10.2	7.9	28.6
Bolivia	23.2	24.5	25.7	26.6	28.6	28.6	29.8	31.1	24.4	27.2
Brazil	2412.8	2424.9	2333.4	2250.5	2307.1	2307.1	2385.4	2475.5	2390.3	3.6
Burkina Faso	10.8	11.4	11.9	12.4	13.8	13.8	14.5	15.3	11.4	34.6
Canada	1735.2	1779.7	1796.5	1820.2	1901.6	1901.6	1945.0	1984.2	1770.4	12.1
Cambodia	13.9	14.8	15.9	17.0	19.4	19.4	20.7	22.0	14.9	48.3
Cameroon	27.2	28.8	30.1	31.6	34.9	34.9	36.6	38.3	28.7	33.4
Chile	253.1	257.7	263.6	267.6	279.6	279.6	288.7	300.2	258.1	16.3
China	7748.4	8314.0	8889.9	9485.2	10717.2	10717.2	11370.2	12062.3	8317.4	45.0
Colombia	334.2	348.9	359.6	366.8	383.8	383.8	394.7	407.6	347.6	17.3
Costa Rica	41.6	42.8	44.4	46.1	49.6	49.6	51.6	53.7	42.9	25.1
Cote D'Ivoire	28.8	31.2	33.7	36.3	41.5	41.5	43.5	45.3	31.2	45.0
Cuba	70.0	70.7	73.8	74.3	78.9	78.9	82.3	86.2	71.5	20.6
Ecuador	83.2	86.5	86.6	84.5	87.0	87.0	89.4	91.9	85.4	7.5
Egypt	228.0	233.1	242.9	253.6	277.3	277.3	290.9	305.3	234.7	30.1
El Salvador	22.7	23.0	23.6	24.1	25.1	25.1	25.6	26.2	23.1	13.1
European Union	17240.3	17521.1	17895.8	18226.8	18506.3	18812.2	19110.3	19406.4	17552.4	10.6
Gambia	1.0	1.0	1.1	1.1	1.2	1.2	1.2	1.3	1.0	25.8
Ghana	43.0	44.8	46.5	48.1	54.4	54.4	57.7	60.5	44.8	35.1
Guatemala	46.0	47.9	49.9	51.6	55.1	55.1	57.1	59.2	47.9	23.6
Guinea	5.2	5.3	5.3	5.5	6.0	6.0	6.4	6.8	5.3	29.1
Guinea Bissau	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	0.9	28.6
Guyana	2.3	2.4	2.4	2.5	2.7	2.7	2.8	2.9	2.4	23.9
Haiti	7.6	7.8	7.9	8.0	8.3	8.3	8.5	8.7	7.8	12.5
Honduras	17.6	18.1	18.8	19.5	20.8	20.8	21.6	22.4	18.2	23.2
Hong Kong	252.0	258.3	264.7	268.8	278.7	278.7	284.7	291.4	258.3	12.8
India	1895.6	2032.1	2185.5	2336.9	2702.8	2702.8	2913.5	3137.6	2037.7	54.0
Indonesia	897.3	942.3	987.5	1037.3	1147.3	1147.3	1208.3	1274.6	942.4	35.3
Iran	444.5	463.8	470.5	491.4	538.0	538.0	564.2	590.6	459.6	28.5
Iraq	162.0	155.7	152.7	158.0	169.2	169.2	177.1	186.2	156.8	18.7

Appendix Table 3.2 (Cont.)

Regions	Billion US$								%	%
	2013	2014	2015	2016	2017	2018	2019	2020	Baseline 2013-15	Change 2020
Japan	5910.5	5924.9	5998.7	6057.6	6176.2	6176.2	6218.9	6229.6	5944.7	4.8
Kenya	46.9	49.4	52.2	55.2	61.9	61.9	65.2	68.2	49.5	37.8
Laos	8.5	9.1	9.7	10.4	11.9	11.9	12.7	13.5	9.1	48.6
Liberia	1.3	1.4	1.4	1.5	1.6	1.6	1.7	1.8	1.4	31.7
Malaysia	296.5	314.3	330.0	343.6	372.9	372.9	391.1	411.2	313.6	31.1
Mali	9.8	10.5	11.1	11.7	12.8	12.8	13.4	14.0	10.5	33.8
Mexico	1153.5	1179.6	1210.7	1238.1	1290.9	1290.9	1327.0	1367.2	1181.3	15.7
Myanmar	51.1	55.0	59.1	63.2	72.6	72.6	77.7	83.0	55.1	50.7
Nicaragua	10.2	10.7	11.2	11.7	12.7	12.7	13.2	13.8	10.7	28.3
Niger	6.8	7.3	7.7	8.1	9.1	9.1	9.6	10.1	7.3	39.0
Nigeria	425.4	452.3	464.9	455.6	465.2	465.2	479.9	499.0	447.5	11.5
Pakistan	193.7	202.9	214.1	226.4	250.3	250.3	263.8	277.4	203.6	36.3
Panama	37.7	39.9	42.2	44.2	47.6	47.6	49.4	51.3	39.9	28.3
Paraguay	23.6	24.7	25.4	26.3	27.9	27.9	28.8	29.6	24.6	20.7
Peru	176.3	180.7	186.7	194.0	207.7	207.7	216.2	225.9	181.2	24.6
Philippines	236.3	251.0	265.8	283.9	320.9	320.9	340.9	361.3	251.1	43.9
Rwanda	7.0	7.5	7.9	8.4	9.4	9.4	10.0	10.5	7.5	40.6
Russia	1783.1	1796.2	1730.0	1719.5	1759.9	1759.9	1798.7	1849.9	1769.7	4.5
Saudi Arabia	626.8	649.6	672.2	680.6	711.3	711.3	730.8	755.2	649.5	16.3
Senegal	14.2	14.8	15.7	16.7	18.7	18.7	19.7	20.8	14.9	39.6
Singapore	272.5	281.4	287.0	291.2	301.0	301.0	308.3	316.7	280.3	13.0
Sierra Leone	3.8	4.0	3.2	3.4	3.6	3.6	3.8	4.0	3.7	9.1
South Korea	1194.8	1234.7	1266.9	1302.0	1375.5	1375.5	1413.4	1450.6	1232.1	17.7
South Africa	406.3	412.9	418.1	419.1	432.3	432.3	443.6	456.0	412.4	10.6
Sri Lanka	70.0	75.2	79.8	84.3	93.8	93.8	99.2	104.8	75.0	39.7
Suriname	4.9	5.0	4.9	4.5	4.7	4.7	4.8	4.9	4.9	-0.3
Taiwan	483.5	502.9	506.6	512.5	531.8	531.8	544.3	558.8	497.7	12.3
Tanzania	37.8	40.5	43.3	46.2	52.3	52.3	55.4	58.6	40.5	44.6
Thailand	378.6	381.7	392.5	404.8	429.9	429.9	443.4	458.0	384.2	19.2
Togo	3.7	3.9	4.1	4.4	4.8	4.8	5.1	5.4	3.9	38.5
Turkey	847.2	872.9	907.2	920.2	965.9	965.9	994.1	1024.3	875.8	17.0
UAE	336.7	347.1	360.2	365.6	387.4	387.4	404.4	422.7	348.0	21.5
Uganda	22.5	23.6	24.8	26.2	29.3	29.3	31.1	33.2	23.6	40.5
Uruguay	45.9	47.4	47.8	48.1	50.3	50.3	51.7	53.3	47.0	13.3
USA	15802.9	16177.5	16597.5	16855.7	17696.4	17696.4	18102.8	18478.7	16192.6	14.1
Venezuela	266.9	256.5	241.7	213.5	195.2	195.2	196.9	198.7	255.0	-22.1
Vietnam	136.0	144.1	153.7	163.0	184.3	184.3	196.1	208.7	144.6	44.3

Source: Arkansas Global Rice Model (AGRM)

Appendix Table 3.3: Bilateral trades import volume and import tariffs.

Exporting Regions	Commodities	Trade Volume (Thousand Mt)	*Ad valorem* Tariff
Vietnam	Long grain white	548.4	20%
	Fragrant white	30.6	
Thailand	Long grain brown	0.7	20%
	Fragrant brown	0.0	
	Long grain white	346.6	
	Fragrant white	25.9	
Pakistan	Long grain white	125.9	40%
	Fragrant white	13.9	
Cambodia	Long grain white	20.2	20%
	Fragrant white	32.7	
India	Long grain brown	0.1	40%
	Long grain white	22.1	
	Fragrant White	11.0	
Myanmar	Long grain white	3.7	20%
United States	Long grain brown	0.1	40%
	Long grain white	0.3	
	Medium grain white	1.0	
Rest of the World (ROW)	Long grain white	0.0	40%
	Medium grain white	0.5	

Source: RICEFLOW Database.

Appendix Table 3.4: The exogenous variables for free trade scenario.

Regions	Rice commodities	Import Tariffs (%)	
		Ad valorem	Free trade
India	Long grain paddy Long grain brown Long grain white	40	1-1.40/1.40 = -28.57
Thailand	Long grain brown Long grain white	20	1-1.20/1.20 = -16.67
USA	Long grain brown Long grain white	40	1-1.40/1.40 = -28.57
Vietnam	Long grain white	20	1-1.20/1.20 = -16.67
Cambodia	Long grain white	20	1-1.20/1.20 = -16.67
Myanmar	Long grain white	40	1-1.40/1.40 = -28.57
Pakistan	Long grain white	40	1-1.40/1.40 = -28.57
ROW	Long grain white	40	1-1.40/1.40 = -28.57

Source: RICEFLOW Database.

Chapter IV
The Impact of International Trade Policies on Heterogeneous Rice Farmers in Malaysia Using Farm-Household Model

Abstract

Despite having negotiated both bilateral and regional free trade agreements (FTAs), Malaysia has excluded rice from the FTAs including the ATIGA (ASEAN Trade in Good Agreement) and TPP (Trans-Pacific Partnership) agreements because rice is regarded as a sensitive commodity. The government is pursuing an autarky approach as part of its national rice policy objectives. Although poverty mitigation has been a long-standing goal in Malaysian rice policy, most farmers remain living in poverty. This poverty reduction goal is why the government retains prohibitive barriers in rice trade as a protective measure to domestic rice farmers. Instead of liberalizing trade, Malaysia has decided to achieve rice self-sufficiency by 2020 and recently extended the policy goal to eliminate bilateral rice trades by 2050. While rice farmers are highly protected in Malaysia, the impacts of free trade are often misconstrued to focus only on the negative effects on the domestic production side and rice farmers' incomes and welfare. This study develops a farm household model of heterogeneous rice farmers in Malaysia to analyze the impact of free trade policy on rice farmers using both income and rice consumption poverty measures and farmers' welfare at farm household level. The results indicate that even if free trade would increase poverty measured in terms of income, it would decrease poverty measured in terms of rice consumption. This is because of a lower price of rice after the introduction of free trade, which would also benefit non-farm rice consumers in Malaysia. However, a farm-household welfare measure shows that free trade does make rice farmers worse off as their welfare falls, albeit minimally. With affordability as a key pillar of food-security, free trade plays a significant role in Malaysia's food security as it leads to more affordable rice prices.

1. Introduction

The livelihood of Malaysian farmers is an important issue in Malaysian policy since rice remains the key staple food and a vital commodity in addressing national food security. However, the majority of rice farmers, who are indigenous locals, remain poor rural households. The economic discrimination and ethnic segregation during British colonial rule is a major cause of many farmers' socio-economic problems and a motivating factor for the government to continuously attempt to mitigate poverty and improve local farmers' welfare. As a result, numerous programs, from output support to the marketing level of supply chains, have been created to support rice farmers. Other support programs include public irrigation and infrastructure management, input and output subsidies, credit facilities, research and development, and extension support services. These programs are designed to help rice farms recuperate costs and thus increase the farmers' incomes. In fact, rice farmers are among the highest subsidy recipients in the Malaysian agricultural food sector as rice has been deemed a priority and has received special attention from the government for decades. In addition to the subsidies, the government has also imposed high rice import tariffs[23] to protect the domestic rice market and local farmers from the international market. Nevertheless, the current socio-economic status of rice farmers has remained controversial because poverty levels of farmers have been stagnant. It was reported that 54% of the total Malaysian rice-farming households were below the national income poverty line due to low returns, which has resulted in rice farmers being among the poorest agricultural producers in Malaysia (IRRI, 1985). In addition, the majority of rice farmers were below the national average income (Malaysian Agricultural Research and Development Institute, 2013). Previous studies found that farmers' welfare largely

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[23] The most recent tariff schedule for rice imports ranges from 20% to 40% depending on the bilateral trade agreement (Ministry of International Trade and Industry, Malaysia, 2016)

drives food security in Malaysia (Siwar et al., 2013). However, rice farm activities were not able to generate sufficient incomes for farmers, and thus, farmers need other sources of income to sustain their livelihood[24] (Rabu and Mohd Shah, 2013). The most recent government policy focused on achieving complete rice self-sufficiency under the rationale of food security, which would result in a substantial public investment to support domestic rice producers. Given the renewed focus on self-sufficiency in rice, it is timely to evaluate and determine the consequences of current rice trade policies on Malaysian rice farmers.

The Malaysian rice industry provides employment to approximately 300,000 farmers. In fact, rice was the main source of income for the majority of rice farmers[25] (92.7%). While farm sizes range between 0.2 and 21.4 hectares, 81.6% of farmers are small scale as they operate on less than three hectares. Since the 1980s, many farmers have adopted mechanized farming to reduce production costs, labor inputs, and the production period due to a rapid increase in labor supply for land preparation, seeding, and harvesting, which resulted in higher labor costs. Notwithstanding, mechanization did not increase yield although it reduced labor demand[26] (World Bank, 2012). The range of household monthly incomes showed quite a large gap between RM -99 to RM11, 397.6 (included subsidies), while the average household size was five persons (Malaysian Agricultural Research and Development Institute, 2013). The small-scale farmers are still struggling to survive. A lack of productive assets and small farm size were identified as primary reasons that lead to the poverty of many local rice farmers (Fahmi et al, 2013). Hence,

[24] The data for the study was collected in two of the eight granary areas (BLS and MADA) in production year 2012/2013.
[25] Data was obtained from household survey in 2012/2013.
[26] During the economic structural change in 1980s, the rice sector was faced with higher wages and sharply reduced labor supply.

the Malaysian rice policy plans to increase farmers' incomes through support programs has not been an effective strategy.

Heterogeneity in Malaysian-rice farm households is manifest in differences in land quality, managerial skills, input application, and consumer preferences. For example, the large standard deviation (sd) relative to the mean for the share of total expenditures for seed (sd=0.0362 and mean=0.0898), fertilizer (sd=0.0377 and mean=0.2757), and rice consumption (sd=0.0306 and mean=0.0434) reveal substantial differences in production and consumption expenditures among Malaysian farm households. The analysis in this chapter explicitly accounts for this heterogeneity, which plays a key role in determining the impact of trade policies on poverty rates and welfare of these farmers. It is crucial to evaluate the effectiveness of the rice trade policies at the household level as this population plays an important role in realizing the national self-sufficiency and food security goals of Malaysia. This chapter focuses on the impact of free trade policy at the rice farmers' household level to provide useful economic insights for the direction of the rice sector in Malaysia.

This study analyzes the effect of free trade policy using producer and consumer prices from two scenarios—base year 2020 and free trade scenario—from the RICEFLOW[27] model and a farm household model to create a realistic policy evaluation at the micro level. Thus, this study builds on the national-level RICEFLOW analysis in the previous chapter by studying the impact of free trade for farm households. The goal of this study is to apply a farm household model and utilize farm-level survey data to evaluate the impact of trade policy on individual rice farmers' poverty levels, welfare, and rice production in Malaysia. The specific objectives are:

[27] RICEFLOW is a partial, spatial equilibrium model which is analyzed in Chapter III.

1) To develop a household model of individual rice farms.

2) To calibrate the model to heterogeneous rice farmers in major producing areas – MADA, KADA, PBLS, IADA Penang, IADA Kemasin, and KETARA.

3) To implement the model through simulation analysis to quantify the impacts of a change in trade policy on a) production and consumption, b) income and rice consumption poverty measures, and c) the welfare of Malaysian rice farmers.

4) To provide an economic perspective of liberalizing the rice market to the government and policymakers.

This research contributes to the literature by providing detailed analysis of the impact of international trade policies on poverty rates and welfare among Malaysian rice farmers. With rice largely excluded from regional trade agreements such as TPP (Trans-Pacific Partnerships) and ATIGA (ASEAN Trade in Goods Agreement), this analysis provides key insights for Malaysian policymakers that pursue the autarky approach to achieve food security in rice and those that negotiate regional trade agreements.

2. Farm Household Model of Malaysian Rice Farmers

The farm household model, associated with both demand and supply factors of household farms, is widely applied to agricultural rural economies (Taylor and Adelman, 2003; De Janvry et al., 1991; Singh et al., 1986). Agricultural production is mostly undertaken by a large number of farm households that engage in production, consumption, and factor supply activities. These households supply agricultural commodities at multiple levels such as local, regional, national, and/or international. Therefore, it is fundamental to the analysis of farm household behavior to identify the production, consumption, and market strategies such that farmers derive maximum utility (De Janvry and Sodulet, 2016).

A household model of heterogeneous rice farms in Malaysia is developed to analyze the impact of free trade policy on farmers' production and consumption decisions, poverty rates, and welfare. Farmers generate utility from consumption of rice, consumption of non-rice composite good (i.e., manufacturing goods), and non-working hours (i.e., leisure). The farmers' budget constraint sets expenditures of consumption goods equal to income which consists of profits from rice farming and government transfers. Rice production depends on important inputs such as seeds, fertilizers, pesticides, and labor. Additional assumptions for the model include:

i. Because this model uses the results from RICEFLOW on the impact of trade policies on market prices to analyze the effect of these price changes on poverty rates and the welfare of rice farmers, we assume the households are price takers, i.e., from the household perspective, prices are exogenous. Consequently, all farm-level consumption and production decisions are endogenously influenced by changes in market prices.

ii. The total time endowment for each household is exogenous.

iii. The supply of inputs is perfectly elastic which implies farmers can purchase as much of the inputs as is optimal at the given market prices.

    a. Majority of farmers own[28] their land, which is a fixed factor of production.

    b. Most farmers use hired laborers to help with main farm activities[29].

[28] Owned farmland defines as owned, partially owned with rented, and partially owned with sharing contract.

[29] Main farm activities refer to land preparation, seed preparation, planting, plowing, fertilizing, pest and weed controls, and harvesting.

iv. The household sells all paddy rice at the farm-gate price (i.e. regulated minimum price) to rice millers, while purchasing milled rice at the consumer prices for their own consumption.

v. All subsidized inputs and outputs are implicitly included in market prices.

vi. Rice is a normal good in Malaysia as income elasticities of demand for rice is positive (i.e., the greater per capita income would induce higher demand for rice) (Tey et al., 2009; FAPRI, 2007; Ishida et al., 2003).

The household utility function, U which is quasi-concave with positive partial derivatives is:

$$U\left(c_R^i,\ c_M^i,\ c_L^i; \boldsymbol{\alpha^i}\right), \qquad [1]$$

where c_R^i is consumption of rice, c_M^i is consumption of a composite non-rice goods, c_L^i is leisure or non-farming activities, $\boldsymbol{\alpha^i}$ is a vector of utility parameters, and $i = 1,2, \dots, n$ represents n heterogeneous rice farmers. The utility function is maximized subject to three constraints:

1. The cash income constraints:

$$\tilde{p}_R c_R^i + p_M\, c_M^i \leq p_R\, F_R\left(x_S^i,\ x_F^i,\ x_P^i,\ x_L^i; \boldsymbol{\beta^i}\right) - r_S\, x_S^i - r_F\, x_F^i - r_P\, x_P^i$$

$$- r_L\, l_H^i - T, \qquad [2]$$

where $\tilde{p}_R$ is the consumer price of rice, p_M is the price of composite non-rice goods, p_R is the farm-gate price of rice, $F_R\,(.)$ is the production function, $x_S^i,\ x_F^i,\ x_P^i,$ and x_L^i are seed, fertilizer, pesticide and total labor inputs, respectively, $\boldsymbol{\beta^i}$ is a vector of parameters, $r_S,\ r_F,\ r_P,$ and r_L are the respective input prices, and T are government transfers. Since the majority of rice farmers own their farmland, land is held as a constant fixed factor of production.

2. The total labor constraints:

$$x_L^i = l_H^i + l_F^i, \qquad [3]$$

where total labor used in production (x_L^i) is equal to hired labor l_H^i plus family labor l_F^i; and

3. The total available time to household:

$$\bar{t} = l_F^i + c_L^i, \qquad [4]$$

where $\bar{t}$ is the total exogenous endowment of time to the household is equal to l_F^i is household family labor used in rice production plus leisure c_L^i.

Equations [2] and [3] are combined:

$$\tilde{p}_R c_R^i + p_M c_M^i \leq p_R F_R\left(x_S^i, x_F^i, x_P^i, x_L^i\right) - r_S x_S^i - r_F x_F^i - r_P x_P^i - r_L l_H^i - T,$$

$$\widetilde{p}_R c_R^i + p_M c_M^i \leq p_R F_R\left(x_S^i, x_F^i, x_P^i, x_L^i\right) - r_S x_S^i - r_F x_F^i - r_P x_P^i -$$

$$r_L l_H^i\left(x_L^i - l_F^i\right) - T.$$

Then substituting equation [4] into the above expression yields (the simplification of the model is provided in Appendix 4.1):

$$\widetilde{p}_R c_R^i + p_M c_M^i \leq p_R F_R\left(x_S^i, x_F^i, x_P^i, x_L^i\right) - r_S x_S^i - r_F x_F^i - r_P x_P^i - r_L$$

$$\left(x_L^i - (\bar{t} - c_L^i)\right) - T.$$

The full income constraint can be simplified by explicitly expressing profits as

$$\widetilde{p}_R c_R^i + p_M c_M^i + r_L c_L^i \leq r_L \bar{t} + \pi_i - T \qquad [5]$$

$$\pi = p_R F_R \left(x_S^i, x_F^i, x_P^i, x_L^i\right) - r_S x_S^i - r_F x_F^i - r_P x_P^i - r_L x_L^i \qquad [6]$$

The left-hand side, $\widetilde{p}_R c_R^i + p_M c_M^i + r_L c_L^i$, is total household expenditures on the household's purchase of rice, the composite non-rice good, and leisure (i.e., the opportunity cost of not working on the farm). The right-hand side denotes full income; the total value of time $r_L \bar{t}$, profits π_i, and government transfers. Both time and profits are evaluated at market wages and prices.

By substituting equation [6] into [5], results in the Lagrangian for this framework:

$$\mathcal{L} = \max_{c_R, c_M, c_L, x_S, x_F, x_P, x_L} U\left(c_R^i, c_M^i, c_L^i\right) + \lambda\left(r_L^i \bar{t} + p_R F_R \left(x_S^i, x_F^i, x_P^i, x_L^i\right) - r_S x_S^i - r_F x_F^i - r_P x_P^i - r_L x_L^i - T \right). \qquad [7]$$

With Constant Elasticity Substitution (CES) utility and Cobb-Douglas production functions the Lagrangian is:

$$\mathcal{L} = \max_{c_R, c_M, c_L, x_S, x_F, x_P, x_L} (\alpha_R^i (c_R^i)^\rho + \alpha_M^i (c_M^i)^\rho + \alpha_L^i (c_L^i)^\rho)^{\frac{1}{\rho}}$$

$$+ \lambda \Big(r_L \bar{t} + p_R A^i (x_S^i)^{\beta_S^i} (x_F^i)^{\beta_F^i} (x_P^i)^{\beta_P^i} (x_L^i)^{\beta_L^i} - r_S x_S^i - r_F x_F^i - r_P x_P^i$$

$$- r_L x_L^i - (\widetilde{p}_R c_R^i + p_M c_M^i + r_L^i c_L^i) - T \Big), \qquad [8]$$

where α_R^i denotes the share parameter of rice and non- rice consumption, α_M^i is share parameter of composite non-rice goods, α_L^i is share parameter of non-working hours or leisure, ρ is the CES parameter with elasticity of substitution $\sigma = \frac{1}{1-\rho}$, β_S^i, β_F^i, β_P^i, , and β_L^i are the share parameters for seed, fertilizer, pesticides, and labor, respectively, and A^i is the productivity parameter which represents land quality and farmers' ability to manage the farms.

The first order conditions (FOCs) are specified as:

$$\frac{\partial \mathcal{L}}{\partial c_R^i} = \frac{1}{\rho} (\alpha_R^i (c_R^i)^\rho + \alpha_M^i (c_M^i)^\rho + \alpha_L^i (c_L^i)^\rho)^{\frac{1}{\rho}-1} \alpha_R^i (c_R^i)^{\rho-1} - \lambda \widetilde{p}_R = 0 \qquad [9]$$

$$\frac{\partial \mathcal{L}}{\partial c_M^i} = \frac{1}{\rho} (\alpha_R^i (c_R^i)^\rho + \alpha_M^i (c_M^i)^\rho + \alpha_L^i (c_L^i)^\rho)^{\frac{1}{\rho}-1} \alpha_M^i (c_M^i)^{\rho-1} - \lambda \widetilde{p}_M = 0 \qquad [10]$$

$$\frac{\partial \mathcal{L}}{\partial c_L^i} = \frac{1}{\rho}(\alpha_R^i (c_R^i)^\rho + \alpha_M^i (c_M^i)^\rho + \alpha_L^i (c_L^i)^\rho)^{\frac{1}{\rho}-1} \alpha_L^i (c_L^i)^{\rho-1} - \lambda\, r_L = 0 \qquad [11]$$

$$\frac{\partial \mathcal{L}}{\partial x_S^i} = p_R\, \beta_S^i A (x_S^i)^{\beta_S^i - 1} (x_F^i)^{\beta_F^i} (x_P^i)^{\beta_P^i} (x_L^i)^{\beta_L^i} - r_S = 0 \qquad [12]$$

$$\frac{\partial \mathcal{L}}{\partial x_F^i} = p_R\, \beta_F^i A (x_S^i)^{\beta_S^i} (x_F^i)^{\beta_F^i - 1} (x_P^i)^{\beta_P^i} (x_L^i)^{\beta_L^i} - r_F = 0 \qquad [13]$$

$$\frac{\partial \mathcal{L}}{\partial x_P^i} = p_R\, \beta_P^i A (x_S^i)^{\beta_S^i} (x_F^i)^{\beta_F^i} (x_P^i)^{\beta_P^i - 1} (x_L^i)^{\beta_L^i} - r_P = 0 \qquad [14]$$

$$\frac{\partial \mathcal{L}}{\partial x_L^i} = p_R\, \beta_L^i A (x_S^i)^{\beta_S^i} (x_F^i)^{\beta_F^i} (x_P^i)^{\beta_P^i} (x_L^i)^{\beta_L^i - 1} - r_L = 0 \qquad [15]$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = r_L \bar{t} + p_R\, A (x_S^i)^{\beta_S^i} (x_F^i)^{\beta_F^i} (x_P^i)^{\beta_P^i} (x_L^i)^{\beta_L^i} - r_S\, x_S^i - r_F\, x_F^i - r_P\, x_P^i - r_L\, x_L^i$$

$$- \left(\tilde{p}_R c_R^i + p_M\, c_M^i + r_L^i\, c_L^i \right) - T \qquad [16]$$

Eliminating λ by dividing $\frac{\partial\mathcal{L}}{\partial c_R^i}$ and $\frac{\partial\mathcal{L}}{\partial c_M^i}$ by $\frac{\partial\mathcal{L}}{\partial c_L^i}$:

After eliminating λ (the FOCs of eliminating λ is provided in Appendix 4.2)

and simplification, the FOCs are as follows:

$$\frac{\frac{\partial\mathcal{L}}{\partial c_R^i}}{\frac{\partial\mathcal{L}}{\partial c_L^i}} = \frac{\frac{1}{\rho}\left(\alpha_R^i\left(c_R^i\right)^\rho + \alpha_M^i\left(c_M^i\right)^\rho + \alpha_L^i\left(c_L^i\right)^\rho\right)^{\frac{1}{\rho}-1}\alpha_R^i\left(c_R^i\right)^{\rho-1}}{\frac{1}{\rho}\left(\alpha_R^i\left(c_R^i\right)^\rho + \alpha_M^i\left(c_M^i\right)^\rho + \alpha_L^i\left(c_L^i\right)^\rho\right)^{\frac{1}{\rho}-1}\alpha_L^i\left(c_L^i\right)^{\rho-1}} - \frac{\lambda\,\widetilde{p}_R}{\lambda\,r_L} = 0 \qquad [17]$$

$$\frac{\frac{\partial\mathcal{L}}{\partial c_M^i}}{\frac{\partial\mathcal{L}}{\partial c_L^i}} = \frac{\frac{1}{\rho}\left(\alpha_R^i\left(c_R^i\right)^\rho + \alpha_M^i\left(c_M^i\right)^\rho + \alpha_L^i\left(c_L^i\right)^\rho\right)^{\frac{1}{\rho}-1}\alpha_M^i\left(c_M^i\right)^{\rho-1}}{\frac{1}{\rho}\left(\alpha_R^i\left(c_R^i\right)^\rho + \alpha_M^i\left(c_M^i\right)^\rho + \alpha_L^i\left(c_L^i\right)^\rho\right)^{\frac{1}{\rho}-1}\alpha_L^i\left(c_L^i\right)^{\rho-1}} - \frac{\lambda\,\widetilde{p}_M}{\lambda\,r_L} = 0 \qquad [18]$$

$$\frac{\partial\mathcal{L}}{\partial x_S^i} = p_R\,\beta_S^i A\left(x_S^i\right)^{\beta_S^i-1}\left(x_F^i\right)^{\beta_F^i}\left(x_P^i\right)^{\beta_P^i}\left(x_L^i\right)^{\beta_L^i} - r_S = 0 \qquad [19]$$

$$\frac{\partial\mathcal{L}}{\partial x_F^i} = p_R\,\beta_F^i A\left(x_S^i\right)^{\beta_S^i}\left(x_F^i\right)^{\beta_F^i-1}\left(x_P^i\right)^{\beta_P^i}\left(x_L^i\right)^{\beta_L^i} - r_F = 0 \qquad [20]$$

$$\frac{\partial\mathcal{L}}{\partial x_P^i} = p_R\,\beta_P^i A\left(x_S^i\right)^{\beta_S^i}\left(x_F^i\right)^{\beta_F^i}\left(x_P^i\right)^{\beta_P^i-1}\left(x_L^i\right)^{\beta_L^i} - r_P = 0 \qquad [21]$$

$$\frac{\partial \mathcal{L}}{\partial x_L^i} = p_R \, \beta_L^i A \left(x_S^i\right)^{\beta_S^i} \left(x_F^i\right)^{\beta_F^i} \left(x_P^i\right)^{\beta_P^i} \left(x_L^i\right)^{\beta_L^i - 1} - r_L = 0 \quad [22]$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = r_L \bar{t} + p_R \, A \left(x_S^i\right)^{\beta_S^i} \left(x_F^i\right)^{\beta_F^i} \left(x_P^i\right)^{\beta_P^i} \left(x_L^i\right)^{\beta_L^i} - r_S \, x_S^i - r_F \, x_F^i - r_P \, x_P^i - r_L \, x_L^i$$

$$- \left(\widetilde{p}_R c_R^i + p_M \, c_M^i + r_L \, c_L^i \right) - T = 0 \quad [23]$$

Further simplification of FOCs yields:

$$\frac{\alpha_R^i}{\alpha_L^i} \left(\frac{c_R^i}{c_L^i} \right)^{\rho - 1} = \frac{\widetilde{p}_R}{r_L} \quad [24]$$

$$\frac{\alpha_M^i}{\alpha_L^i} \left(\frac{c_M^i}{c_L^i} \right)^{\rho - 1} = \frac{\widetilde{p}_M}{r_L} \quad [25]$$

$$p_R \, \beta_S^i A \left(x_S^i\right)^{\beta_S^i - 1} \left(x_F^i\right)^{\beta_F^i} \left(x_P^i\right)^{\beta_P^i} \left(x_L^i\right)^{\beta_L^i} = r_S \quad [26]$$

$$p_R \, \beta_F^i A \left(x_S^i\right)^{\beta_S^i} \left(x_F^i\right)^{\beta_F^i - 1} \left(x_P^i\right)^{\beta_P^i} \left(x_L^i\right)^{\beta_L^i} = r_F \quad [27]$$

$$p_R \, \beta_P^i A \left(x_S^i\right)^{\beta_S^i} \left(x_F^i\right)^{\beta_F^i} \left(x_P^i\right)^{\beta_P^i - 1} \left(x_L^i\right)^{\beta_L^i} = r_P \quad [28]$$

$$p_R\ \beta_L^i A\left(x_S^i\right)^{\beta_S^i}\left(x_F^i\right)^{\beta_F^i}\left(x_P^i\right)^{\beta_P^i}\left(x_L^i\right)^{\beta_L^i-1} = r_L \qquad [29]$$

$$r_L\bar{t} + p_R\ A\left(x_S^i\right)^{\beta_S^i}\left(x_F^i\right)^{\beta_F^i}\left(x_P^i\right)^{\beta_P^i}\left(x_L^i\right)^{\beta_L^i} - r_S\, x_S^i - r_F\, x_F^i - r_P\, x_P^i - r_L\, x_L^i$$
$$= \left(\tilde{p}_R c_R^i + p_M\, c_M^i + r_L\, c_L^i\right) - T. \qquad [30]$$

Equations [24] – [30] represent a system of seven equations in seven endogenous variables $c_R, c_M, c_L, x_S, x_F, x_P, x_L$. To simplify the empirical analysis, analytical solution for the input demand function, income, and consumer demand functions are solved for using this system of seven equations. Solving equations [26] – [29] simultaneously yields input demand functions:

$$x_S^i(p_R,\, r_S,\, r_F,\, r_P,\, r_L) = (p_R A)^{\frac{1}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}}\left(\frac{\beta_S^i}{r_S}\right)^{\frac{1-\beta_F^i-\beta_P^i-\beta_L^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}}\left(\frac{\beta_F^i}{r_F}\right)^{\frac{\beta_F^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}}$$
$$\left(\frac{\beta_P^i}{r_P}\right)^{\frac{\beta_P^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}}\left(\frac{\beta_L^i}{r_L}\right)^{\frac{\beta_L^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}} \qquad [31]$$

$$x_F^i(p_R,\, r_S,\, r_F,\, r_P,\, r_L) = (p_R A)^{\frac{1}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}}\left(\frac{\beta_F^i}{r_F}\right)^{\frac{1-\beta_S^i-\beta_P^i-\beta_L^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}}\left(\frac{\beta_S^i}{r_S}\right)^{\frac{\beta_S^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}}$$
$$\left(\frac{\beta_P^i}{r_P}\right)^{\frac{\beta_P^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}}\left(\frac{\beta_L^i}{r_L}\right)^{\frac{\beta_L^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}} \qquad [32]$$

$$x_P^i(p_R,\, r_S,\, r_F,\, r_P,\, r_L) = (p_R A)^{\frac{1}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}} \left(\frac{\beta_P^i}{r_P}\right)^{\frac{1-\beta_S^i-\beta_F^i-\beta_L^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}} \left(\frac{\beta_F^i}{r_F}\right)^{\frac{\beta_F^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}}$$

$$\left(\frac{\beta_S^i}{r_S}\right)^{\frac{\beta_S^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}} \left(\frac{\beta_L^i}{r_L}\right)^{\frac{\beta_L^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}} \qquad [33]$$

$$x_L^i(p_R,\, r_S,\, r_F,\, r_P,\, r_L) = (p_R A)^{\frac{1}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}} \left(\frac{\beta_L^i}{r_L}\right)^{\frac{1-\beta_S^i-\beta_F^i-\beta_P^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}} \left(\frac{\beta_F^i}{r_F}\right)^{\frac{\beta_F^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}}$$

$$\left(\frac{\beta_P^i}{r_P}\right)^{\frac{\beta_P^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}} \left(\frac{\beta_L^i}{r_L}\right)^{\frac{\beta_S^i}{1-\beta_S^i-\beta_F^i-\beta_P^i-\beta_L^i}} \qquad [34]$$

With analytical solutions for the input demand functions, income Y is fully defined by left-hand side of equation [30] for given output and input prices:

$$Y(p_R,\, r_S,\, r_F,\, r_P,\, r_L) = r_L \bar{t} + p_R\, A \left(x_S^i(\cdot)\right)^{\beta_S^i} \left(x_F^i(\cdot)\right)^{\beta_F^i} \left(x_P^i(\cdot)\right)^{\beta_P^i} \left(x_L^i(\cdot)\right)^{\beta_L^i}$$

$$-\ r_S\, x_S^i(\cdot) -\ r_F\, x_F^i(\cdot) -\ r_P\, x_P^i(\cdot) -\ r_L\, x_L^i(\cdot). \qquad [35]$$

Then given income, solving equations [24], [25], and [30] simultaneously yields consumer demand functions:

$$c_R^i(\widetilde{p}_R, p_M,\, r_L, Y) = \left(\frac{\alpha_R^i}{\widetilde{p}_R}\right)^{\rho} \frac{Y(p_R,\, r_S,\, r_F,\, r_P,\, r_L)}{\left(\alpha_R^i\right)^{\rho} (\widetilde{p}_R)^{1-\rho}} +$$

$$\left(\alpha_M^i\right)^{\rho}(p_M)^{(1-\rho)} + \left(\alpha_L^i\right)^{\rho}(\,r_L)^{(1-\rho)} \qquad [36]$$

$$c_M^i(\,\widetilde{p}_R, p_M,\, r_L, Y) = \left(\frac{\alpha_M^i}{p_M}\right)^{\rho} \frac{Y(p_R,\, r_S,\, r_F,\, r_P,\, r_L)}{\left(\alpha_R^i\right)^{\rho}(\,\widetilde{p}_R)^{1-\rho}} +$$

$$\left(\alpha_M^i\right)^{\rho}(p_M)^{(1-\rho)} + \left(\alpha_L^i\right)^{\rho}(\,r_L)^{(1-\rho)} \qquad [37]$$

$$c_L^i(\,\widetilde{p}_R, p_M,\, r_L, Y) = \left(\frac{\alpha_L^i}{r_L}\right)^{\rho} \frac{Y(p_R,\, r_S,\, r_F,\, r_P,\, r_L)}{\left(\alpha_R^i\right)^{\rho}(\,\widetilde{p}_R)^{1-\rho}} +$$

$$\left(\alpha_M^i\right)^{\rho}(p_M)^{(1-\rho)} + \left(\alpha_L^i\right)^{\rho}(\,r_L)^{(1-\rho)} \qquad [38]$$

The above model defines a system of 8 equations (equations [31] – [38]) in 8 endogenous variables ($x_S^i(\cdot)$, $x_F^i(\cdot)$, $x_P^i(\cdot)$, $x_L^i(\cdot)$, $Y(\cdot)$, $c_R^i(\cdot)$, $c_M^i(\cdot)$, $c_L^i(\cdot)$) that are implemented to quantify the effect of free trade policy—through changes in the producer price of paddy rice (p_R) and consumer price of milled rice ($\widetilde{p}_R$)—on individual rice farmers' production and consumption. With production and consumption impacts quantified, we can analyze how free trade affects the poverty and welfare of farmers, which are defined next.

Poverty is defined using both monetary and non-monetary measures through examining household incomes and rice consumption. Individual household income levels are compared to Malaysia's current national Poverty Line Income (PLI) which is specified, for a household of six, as a total annual income of RM 9,600 (US$ 2,238) for poor and RM 5,520 (US$ 1,287) for extreme poor. However, a sole income indicator will not capture the household's standard of living when the price of rice falls under free trade; these drawbacks indicate that consumption is a better predictor of derivation than income (Meyer and Sullivan 2003, 2011). Thus, as a compliment to the income-based poverty measure, a consumption-based measure is defined as the quantity of rice consumed per person that is below the per capita consumption average of 88.9 kg. We quantify the percentage of households with: a) earnings below the two income levels and b) per person rice consumption below the per capita average before and after free trade. The poverty measurements among rice farm households help Malaysia, as a developing country, to gauge farm program effectiveness and guide policy development strategy. Since neither of the individual poverty measures fully represent a household's welfare, a complete welfare measurement is considered next.

With the CES utility function defined in equation [8] being homogeneous of degree one,[30] it gives the real income index of rice farmer household i. Calculating the percentage change in real income before and after the free trade policy provides the equivalent variation

[30] The utility function is homogeneous of degree one if it satisfies the condition: $U\left(Sc_R^i,\, Sc_M^i,\, Sc_L^i\right) = S^1 U\left(c_R^i,\, c_M^i,\, c_L^i\right)$, where S is a constant. Thus, scaling utility in equation [8] by S gives:

$$U\left(Sc_R^i,\, Sc_M^i,\, Sc_L^i\right) = \left(\alpha_R^i\left(Sc_R^i\right)^\rho + \alpha_M^i\left(Sc_M^i\right)^\rho + \alpha_L^i\left(Sc_L^i\right)^\rho\right)^{\frac{1}{\rho}}$$

$$= \left(S^\rho\alpha_R^i\left(c_R^i\right)^\rho + S^\rho\alpha_M^i\left(c_M^i\right)^\rho + S^\rho\alpha_L^i\left(c_L^i\right)^\rho\right)^{\frac{1}{\rho}}$$

$$= S^{\rho\frac{1}{\rho}}\left(\alpha_R^i\left(c_R^i\right)^\rho + \alpha_M^i\left(c_M^i\right)^\rho + \alpha_L^i\left(c_L^i\right)^\rho\right)^{\frac{1}{\rho}}$$

$$= S^1\left(\alpha_R^i\left(c_R^i\right)^\rho + \alpha_M^i\left(c_M^i\right)^\rho + \alpha_L^i\left(c_L^i\right)^\rho\right)^{\frac{1}{\rho}}.$$

Thus, the utility function is homogeneous of degree one.

welfare measure for each household. Equivalent variation measures the change in wealth under baseline prices that would have the same consumer welfare effect with free trade prices holding income constant at the baseline level.

3. Data and Model Calibration

This section discusses data and sources, estimation of probability density functions, sampling technique for utility and production share parameters, and calibration method for the remaining parameters.

3.1 Data Integration

To parameterize and calibrate the model, this study integrates and utilizes three different farm household surveys on rice farming and production in Malaysia that were conducted by the Malaysian Agricultural Research and Development Institute (MARDI). These surveys were designed with different research objectives and in different production periods to help researchers analyze the rice policy issues of self-sufficiency and food security. In doing so, the studies provide key information on the heterogeneity among rice farmers. Since one of goals of this study is to analyze farm incomes and expenditure, these surveys are useful to calibrate the individual-specific parameters in the model. Focusing on major rice production areas, each survey details different aspects of rice farmers' finances: farm household income and expenditures and farm household production expenditures.

3.1.1 Farm Household Expenditure and Income Survey

The Farm Household Expenditure and Income Survey (HIES) was conducted by research associates from MARDI and trained enumerators from Muda Agriculture Development Authority (MADA) and Kemubu Agriculture Development Authority (KADA) in 2012/2013 production years (Rabu and Mohd Shah, 2013). This survey covered 123 rice farmers represented as the head of the household in three (IADA Barat Laut Selangor, MADA, and KADA) out of eight major areas of rice production in Malaysia. Summary statistics from this survey are reported in Table 4.18. From this survey, the number of household members, household incomes, and household expenditure are important variables used in the model calibration discussed in detail below.

Table 4.18: Selected variables on farm household expenditure and income survey.

Regions	Mean	Min.	Max.	Std. Dev.
	Household Size			
PBLS	6	1	9	2
MADA	5	1	5	1
KADA	5	1	9	1
Average	5	1	8	2
	Household Gross Income from Rice Activities (RM/Month)			
PBLS	1,401	500	7,000	1,110.2
MADA	1,267	250	7,000	1,214.3
KADA	1,358	350	3,000	723.6
Average	1,342	367	5,667	1,016.0
	Household Income from Other Sources (RM/Month)			
PBLS	600	260	764	160.3
MADA	300	180	539	130.7
KADA	350	170	450	140.6
Average	417	203	584	143.9
	Household Expenditure for Food (RM/Month)			
PBLS	625.5	120	2,000	317.2
MADA	590.4	250	1,500	277.2
KADA	578.7	100	1,200	286.8
Average	598.2	157	1,567	293.7

Source: Malaysian Agricultural Research and Development Institute.

3.1.2 Farm Production Expenditure Survey

The Farm Production Expenditure Survey was conducted in the 2016 production year and focused on major production areas including MADA and the Integrated Agriculture Development Area (IADA) Penang. A total of 120 rice farmers from these regions were randomly selected. The main objective of the survey was to obtain the production costs and expenditures from the sampled rice farms (Table 4.19). From this survey, acreage, yield, production input costs for seed, fertilizer, pesticide, herbicide, labor, and land were used in the model calibration.

Table 4.19: Selected variables on farm production expenditure survey.

Regions	**Mean**	**Min.**	**Max.**	**Std. Dev.**
	Acreage (Ha)			
MADA	2.09	0.29	17.40	2.46
IADA Penang	3.47	0.20	21.40	4.50
Average	2.78	0.25	19.40	3.48
	Yield (MT/Ha)			
MADA	6.36	2.96	8.68	1.37
IADA Penang	6.57	2.25	11.22	2.02
Average	6.47	2.61	9.95	1.70
	*Seed Cost (RM/Ha) **			
MADA	282.48	122.50	347.22	29.90
IADA Penang	629.20	223.20	1,125.00	233.92
Average	455.84	172.85	736.11	131.91
	*Fertilizer Cost (RM/Ha) **			
MADA	85.50	30.00	156.39	35.66
IADA Penang	87.50	38.00	156.00	49.43
Average	86.50	34.00	156.20	42.54
	*Pesticide Cost (RM/Ha) **			
MADA	298.49	207.00	478.01	95.96
IADA Penang	447.99	200.00	953.00	237.08
Average	373.24	203.50	715.50	166.52

Table 4.19 (Cont.)

Regions	Mean	Min.	Max.	Std. Dev.
	Herbicide Cost (RM/Ha)			
MADA	256.47	0.00	555.00	137.30
IADA Penang	142.65	48.00	480.00	109.22
Average	199.56	24.00	517.50	123.26
	Labor Cost (RM/Ha)			
MADA	566.20	250.00	1,014.50	239.20
IADA Penang	722.56	250.00	2,030.00	448.40
Average	644.38	250.00	1,522.25	343.80
	Land Rental Cost (RM/Ha)			
MADA	1,733.78	1042.50	2,780.00	372.75
IADA Penang	883.00	159.00	1,574.00	305.67
Average	1,308.39	600.75	2,177.00	339.21

* Costs are excluded subsidies.
Source: Malaysian Agricultural Research and Development Institute.

3.1.3 Farm Household Income Survey

The Farm Household Income Survey (HIS) sampled 250 rice farmers from MADA, Integrated Agriculture Development Area (IADA) Penang, IADA Kemasin, IADA KETARA, and KADA and was conducted in 2015/16 production years. Key variables collected include the main sources of farm household income and working hours on rice farm activities, which are also the essential variables for model calibration (Table 4.20).

Table 4.20: Selected variables of farm household income survey.

Regions	Mean	Min.	Max.	Std. Dev.
	*Main Source of Income**			
MADA	1	1	6	1.218
IADA Penang	2	1	6	1.612
IADA Kemasin	1	1	4	0.761
IADA KETARA	1	1	4	0.636
KADA	1	1	5	1.039
Average	1	1	5	1.053

Table 4.20 (Cont.)

Regions	Mean	Min.	Max.	Std. Dev.
	Working Hours of Rice Activities (Hrs.)			
MADA	5.1	1.0	10.0	1.635
IADA Penang	5.5	0.0	9.0	2.351
IADA Kemasin	5.6	2.0	8.0	1.752
IADA KETARA	6.2	2.0	11.0	1.861
KADA	6.4	2.0	11.0	2.164
Average	5.7	1.4	9.8	1.953

*1=Rice farms, 2=Non-rice farms, 3=Own business, 4=Public service, 5=Private Service.
Source: Malaysian Agricultural Research and Development Institute (2015/16).

3.2 Distribution Estimations of Share Parameters

For individual farmers, the data from the three surveys are used to calibrate the share parameters in the utility function (α_R^i and α_M^i) and production function (β_S^i, β_F^i, β_P^i, and β_L^i). Share parameters in the utility function are household expenditures on consumption goods (rice or non-rice) divided by total consumption expenditure. Share parameters in the production function are farm expenditures on individual input (seed, fertilizer, pesticide, and labor) divided by total farm expenditures. Since observations across surveys do not track the same rice farmer (i.e. households) with different sample sizes, the data cannot be used directly from the surveys to calibrate these share parameters for each individual farmer. Therefore, the survey data is used to estimate the distributions for each share parameter using maximum likelihood estimation (MLE). MLE, which finds the parameter values that maximize the likelihood of given the observed sample, is applied to estimate the parameters for a univariate probability density function (PDF) of each of the utility and production share parameters. Then, utilizing correlation matrices, the multivariate simulation approach developed by Phoon et al. (2004) is applied to randomly draw correlated share parameters from the univariate distribution to accurately reflect the survey data.

3.2.1 Probability Density Function and Maximum Likelihood Estimation

For both utility and production share parameters, distributions are estimated using log-likelihood functions and the MLE procedure. The log-likelihood functions are derived for the Normal, Log-normal, Beta, Gamma, truncated, and mixture distributions. Then, AIC and BIC statistics and graphical analysis, are employed to determine the distribution that best fits the data. The PDF used to estimate share parameters are as follow:

(i) Normal Density Function:

For the random variable $x \in [-\infty, \infty]$, the equation for the normal distribution is:

$$f(x) = \frac{1}{\sqrt{2\pi^2}} e^{\frac{-(x-\mu)^2}{2\sigma^2}},$$

where $\mu \in [-\infty, \infty]$ is the mean and $\sigma^2 > 0$ is the variance.

(ii) Log-normal Density Function:

For the random variable $x \in [0, \infty]$, the equation for the log-normal distribution is:

$$f(x) = \frac{1}{x\sigma\sqrt{2\pi}} e^{\frac{-(lnx-\mu)^2}{2\sigma^2}},$$

where $\mu \in [-\infty, \infty]$ is the mean and $\sigma > 0$ is the variance.

(iii) Beta Density Function:

For the random variable $x \in [0,1]$, the equation for the Beta distribution is:

$$f(x) = \frac{(x)^{\alpha-1} (1-x)^{\beta-1}}{B(\alpha, \beta)},$$

where $\alpha > 0$ and $\beta > 0$ are both shape parameters.

(iv) Gamma Density Function:

For the random variable $x \in [0, \infty]$, the equation for the Gamma distribution is:

$$f(x) = \frac{1}{\Gamma(k)\theta^k} x^{k-1} e^{-\frac{x}{\theta}},$$

where $k > 0$ is shape and $\theta > 0$ is scale.

(v) Truncated Density Function:

A truncated distribution results from a restriction on the support of a probability density function. Since share parameters are restricted to values between zero and one (i.e., 0 < x < 1), truncated distributions are used to limit support of the densities with supports outside this range. Truncated distributions are also a mathematically defensible way to preserve the main features of distribution while avoiding extreme values for random samples where the support is infinite at one or both ends (Burkardt, 2014). All PDFs can be truncated between *a* and *b* using the following formula:

$$Tr(x) = \begin{cases} \frac{f(x)}{F(b) - F(a)} & \text{for} \quad a < x \leq b \\ 0 & \text{otherwise,} \end{cases}$$

where $f(x)$ is the PDF and $F(\cdot)$ is the corresponding cumulative distribution function.

(vi) Mixture Density Function:

A mixture distribution refers to a probability distribution of random variables that is derived from a mixture of two or more PDFs. Since some share parameters are bimodal (see histograms presented below), mixture density in the PDF is used. For PDFs $f_1(x), \dots, f_n(x)$ and weighting parameters $w_1, \dots, w_n$ where $w_i > 0$ for all *i* and $\sum_{i=1}^{n} w_i = 1$, the mixture distribution is defined as:

$$fm(x) = \sum_{i=1}^{n} w_i \, f_i(x).$$

Next, the MLE procedure is discussed. After the likelihood function is defined based on joint density functions, Newton's method is applied to find the parameter values that maximize the likelihood function given the data. The joint density function for an independent and identically distributed sample is:

$$f(x_1, x_2, \dots\dots, x_n \mid \theta) = f(x_1 \mid \theta) \times f(x_2 \mid \theta) \times \dots\dots \times f(x_n \mid \theta),$$

where $x_1, x_2, \dots\dots, x_n$ are observed values and θ is a parameter vector. The likelihood function is defined by considering the values $x_1, x_2, \dots\dots, x_n$ to be fixed observations and allowing θ to change freely. The likelihood function is:

$$\mathcal{L}\ (\theta;\ x_1, x_2, \dots\dots, x_n) = \prod_{i=1}^{n} f(x_i \mid \theta).$$

The likelihood function is often applied in natural logarithm (*ln*), which yields the log-likelihood function:

$$ln\,\mathcal{L}\ \ (\theta;\ x_1, x_2, \ldots\ldots, x_n) = \sum_{i=1}^{n} ln\, f\,(x_i |\, \theta).$$

This MLE procedure is applied to estimate the parameters of the probability distribution functions for Normal, Log-normal, Beta, Gamma, truncated, and mixture distributions for the utility and production function share-parameter data.

From the results of the MLE estimation procedure, the maximized distribution estimates are selected using the Akaike Information Criterion[31] (AIC) – the lowest AIC value represents a the best model (i.e., minimize the information loss). The two lowest AIC coefficients were identified for utility and production share parameters.

3.2.2 Distribution Estimation of Utility Share Parameters

Share parameters of the utility function are α_r for rice consumption, α_a for non-rice food consumption, and α_m for manufacturing goods consumption. On average, the household expenditures are 4.3%, 37.1%, and 58.6% for rice, non-rice food, and manufacturing goods, respectively. However, visual inspection of histograms of the data (see Figures 4.13, 4.14, and 4.15 below) indicate these share parameters are non-normal. In order to determine the "best-

[31] The Akaike Information Criterion (AIC) is a measure of the relative quality of statistical models for a given set of data. Given a collection of models for the data, AIC estimates the quality of each model, relative to each of the other models. Hence, AIC provides a means for model selection.

fitting" distribution for each utility share parameters, the other distributions are also estimated: Log-normal, Gamma, Beta, truncated, and mixture distributions (Table 4.21).

Table 4.21: Distribution estimates of utility share parameters.

Utility Parameters	Normal		Log-normal		Gamma		Truncated Normal	
	μ	σ	μ	σ	K	θ	μ	σ
α_r	0.0434	0.0306	-3.3669	0.7065	2.3133	0.0188	0.0176	0.0453
α_a	0.3706	0.1417	-1.0757	0.4288	6.1568	0.0602	0.3683	0.1446
α_m	0.5859	0.1534	-0.6673	1.2196	4.5417	0.1290	0.5877	0.1560
	Truncated Log-normal		**Truncated Gamma**		**Beta**			
	μ	σ	k	θ	α	β		
α_r	-3.3670	0.7065	2.3156	0.0187	2.2133	48.603 0		
α_a	-1.0662	0.4405	6.09	0.061	3.8987	6.5982		
α_m	164.6002	10.053	2.5997	0.3779	3.1148	2.4088		
	Mixture Normal							
	λ_1	λ_1	μ_1	μ_2	σ_1	σ_2	**Log-likelihood**	
α_m	0.9752	0.0247	0.5851	0.6212	0.1552	0.002	57.4045	

Source: Results are simulated using R.

The Akaike Information Criterion[32] (AICs) are calculated for each of the different distributions. The two distributions with lowest AIC values are selected for each share parameter. For α_r the Gamma and Log-Normal,[33] for α_a the Beta and truncated Gamma distributions, and for α_m the normal and mixture normal have the lowest AIC and are selected for the analysis (see Table 4.22).

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[32] Akaike (1973) provides a way to select the "best" model determined by an AIC score: $AIC = 2K - 2\ln(\hat{L})$, where K is the number of parameter estimates (degree of freedom) and the log-likelihood at its maximum points of the estimated model. Note that Bayesian Information Criterion results are consistent with the AIC results. AIC can only be used to assess whether a model fits the data better relative to another model.

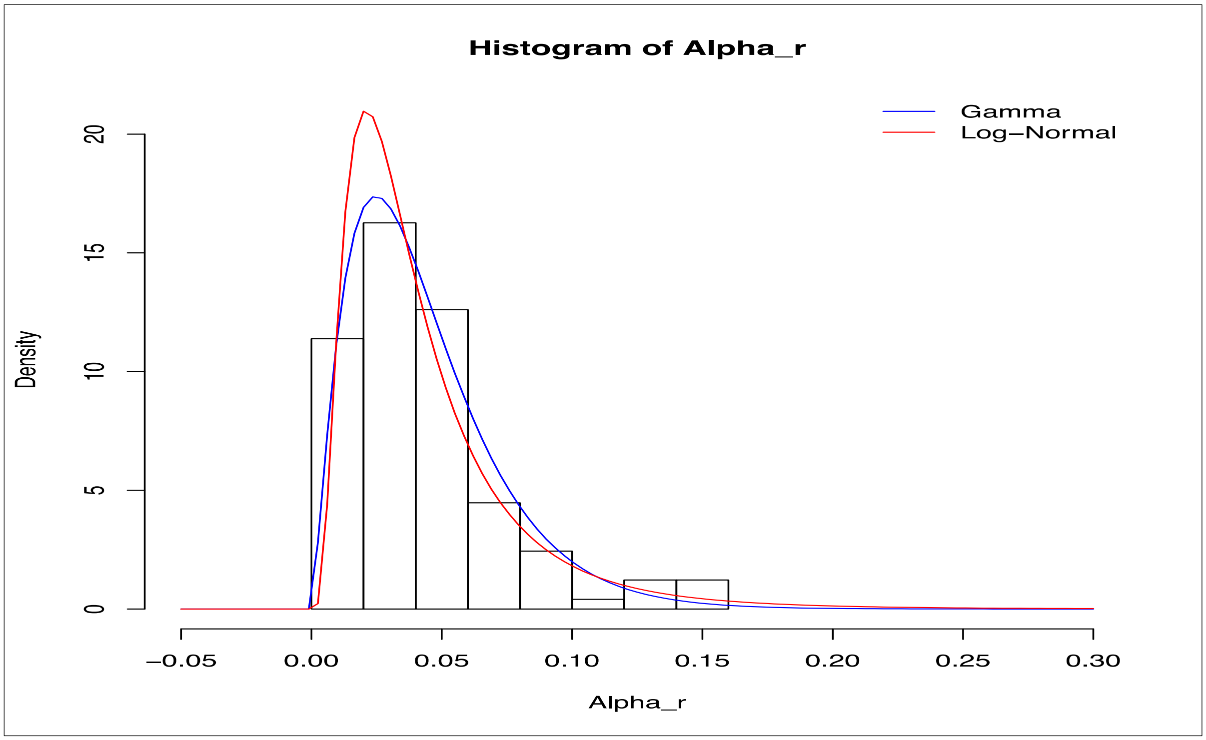
[33] Note that the truncated and non-truncated distributions of Gamma and Log-Normal have equal AIC coefficients; for simplicity, the Gamma and Log-Normal are selected while the truncated distributions are omitted.

Table 4.22: Results of AIC coefficients for utility share parameters.

Share Parameters	AIC and Distribution Estimations						
α_r	Truncated Gamma	Gamma	Truncated Log-normal	Log-normal	Beta	Truncated Normal	Normal
	-561.27	-561.27	-560.65	-560.65	-560.29	-540.28	-504.12
α_a	Beta	Truncated Gamma	Truncated Normal	Gamma	Normal	Truncated Log-normal	Log-Normal
	-130.47	-128.99	-128.85	-128.72	-127.64	-121.52	-119.84
α_m	Truncated Normal	Normal	Mixture Normal	Beta	Truncated Log-normal	Gamma	Truncated Gamma
	-109.01	-108.06	-102.80	-57.42	-15.16	16.30	16.30

Source: Results are simulated using R.

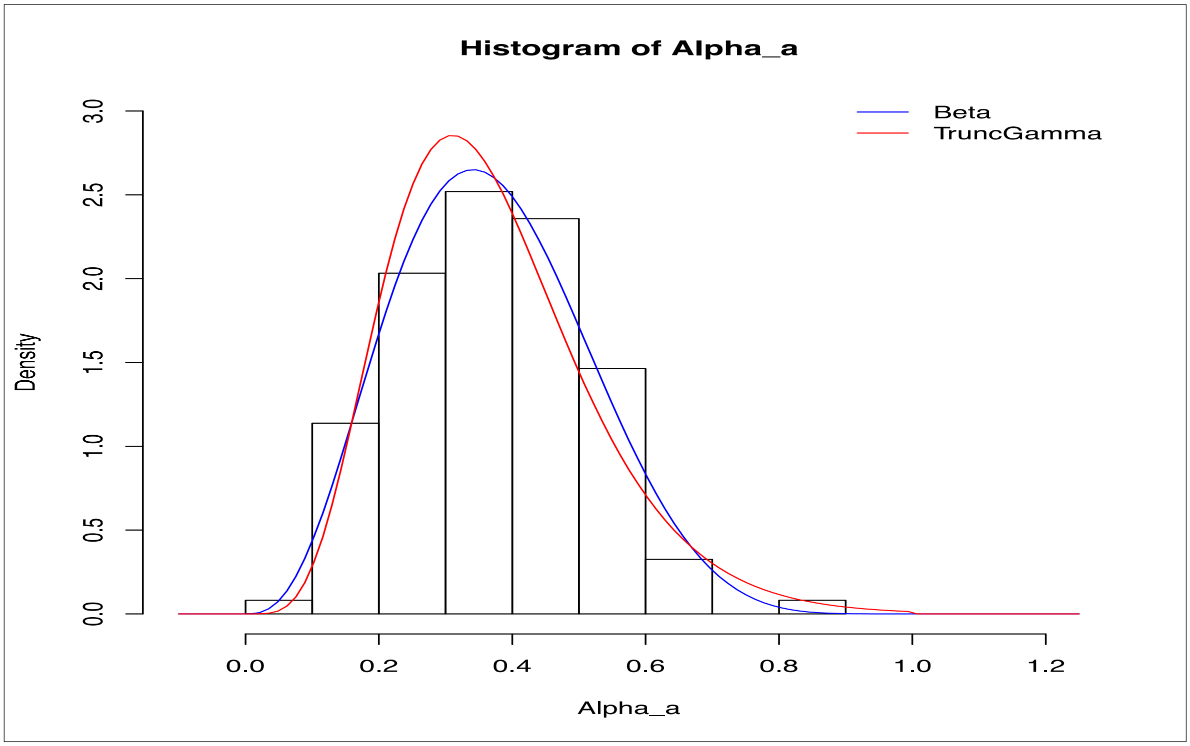
Finally, to assure the most precise distribution estimation for each share parameter, graphical analysis is employed. Using the estimated parameters, the two probability density functions (PDFs) with the lowest AICs are superimposed onto the histogram of the data. The distribution that visually fits the data most accurately is used for the simulation analysis. Figure 4.13 provides the graphical analysis for α_r. Based on this figure, the Gamma distribution (blue curve) most accurately fits the histogram, which is consistent with the AIC analysis. Therefore, the Gamma is selected over the Log-normal (red curve) for the rice consumption share parameter.



Source: Results are simulated using R.

Figure 4.13: Probability density function for α_r.

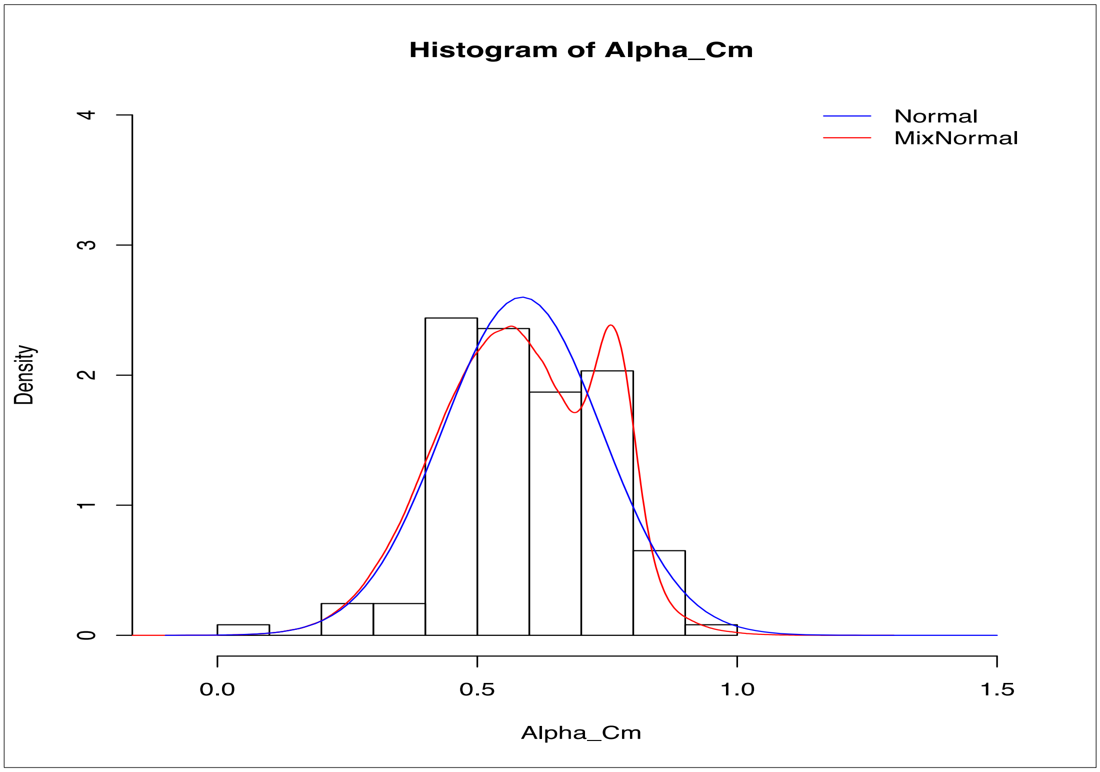
Figure 4.14 presents the PDFs analysis for α_a. The analysis reveals that the Beta distribution (blue curve) fits the histogram more precisely relative to the truncated Gamma distribution (red curve), which also is consistent with the AIC. Thus, Beta distribution is selected for the non-rice consumption share parameters.



Source: Results are simulated using R.

Figure 4.14: Probability density function for α_a.

Figure 4.15 displays the PDFs for the α_m share parameter. The histogram indicates bimodal distributions; thus, the analysis of PDFs requires a mixture distribution. Although the Normal distribution (blue curve) has the lowest AIC, the mixture Normal (red curve) better reflects the histogram. Therefore, the mixture Normal is selected for manufacturing good consumption share parameter.



Source: Results are simulated using R.

Figure 4.15: Probability density function for α_m.

3.2.3 Distribution Estimation of Production Share Parameters

For the rice production function, the share parameters are β_S for seed, β_F for fertilizer, β_P for pesticides, and β_L for labor. Yield (y) is also used in calibrating the productivity parameter and its distribution is estimated. On average, farmers spend 8.9% on seeds, 27.5% on fertilizers, 9.3% on pesticides, 16.2% on labor, and 37.8% on land for rice production expenditure. Each farmer is assumed to own farmland passed on from previous generations, so land expenditure is excluded in the model. However, graphical analysis of histograms of the data (see Figures 4.16, 4.17, 4.18, and 4.19 below) indicate the share parameters are non-normal. Therefore, other distributions are also estimated: Log-normal, Gamma, Beta, truncated, and mixture distributions

(Table 4.23) so that the "best-fitting" distribution for each production share parameters can be determined.

Table 4.23: Distribution estimates of production share parameters.

Parameters	Normal		Log-normal		Gamma	
	μ	σ	μ	σ	k	θ
y	6.4614	1.7159	1.8241	0.3045	12.1589	0.5314
β_S	0.0898	0.0362	-2.4986	0.4451	5.6745	0.0158
β_F	0.2757	0.0377	-1.2976	0.1370	56.5	0.005
β_P	0.0932	0.0286	0.2845	-2.4142	10.8085	0.0086
β_L	0.1621	0.0533	-1.8737	0.3331	9.1149	0.0177
β_{Land}	0.3789	0.0755	-0.9895	0.1948	23.1814	0.0164
	Truncated Normal		**Truncated Log-Normal**		**Truncated Gamma**	
	μ	σ	μ	σ	k	θ
β_S	0.0889	0.0373	-2.4986	0.4451	5.6768	0.0158
β_F	0.2757	0.0376	-1.2976	0.1370	29.5	0.0094
β_P	0.0932	0.0287	-2.4141	0.2845	11.0095	0.0085
β_L	0.1619	0.0536	-1.8737	0.3331	9.1165	0.0178
β_{Land}	0.3789	0.0755	-0.9895	0.1948	23.1813	0.0164
	Beta					
	α	β				
β_S	5.2815	53.4964				
β_F	38.8578	102.0567				
β_P	10.7790	104.6902				
β_L	7.8203	40.3921				
β_{Land}	15.7777	25.8290				
	Mixture Normal					
	λ_1	λ_1	μ_1	μ_2	σ_1	σ_2
β_S	0.9882	0.0117	0.0895	0.1135	0.0363	0.0001
β_F	0.0000	0.9999	0.2743	0.2757	0.0375	0.0376
β_P	0.0211	0.9789	0.0755	0.0936	0.0005	0.0287
β_L	0.9753	0.0246	0.1603	0.2316	0.0528	0.0006
β_{Land}	0.9795	0.0204	0.3780	0.4219	0.0760	0.0002
	Mixture Gamma					
	λ_1	λ_1	μ_1	μ_2	σ_1	σ_2
β_S	0.6978	0.3021	14.7611	21.2282	0.0048	0.0066
β_F	0.0629	0.937	7.1201	8.9121	0.0037	0.0105
β_P	0.0046	0.9953	5145.0314	10.7694	0.0001	0.0086
β_L	0.9876	0.01234	11.5887	63.0113	0.0138	0.0049
β_{Land}	0.0000	1.000	1632.0971	25.1842	0.0001	0.0150

Source: Results are simulated using R.

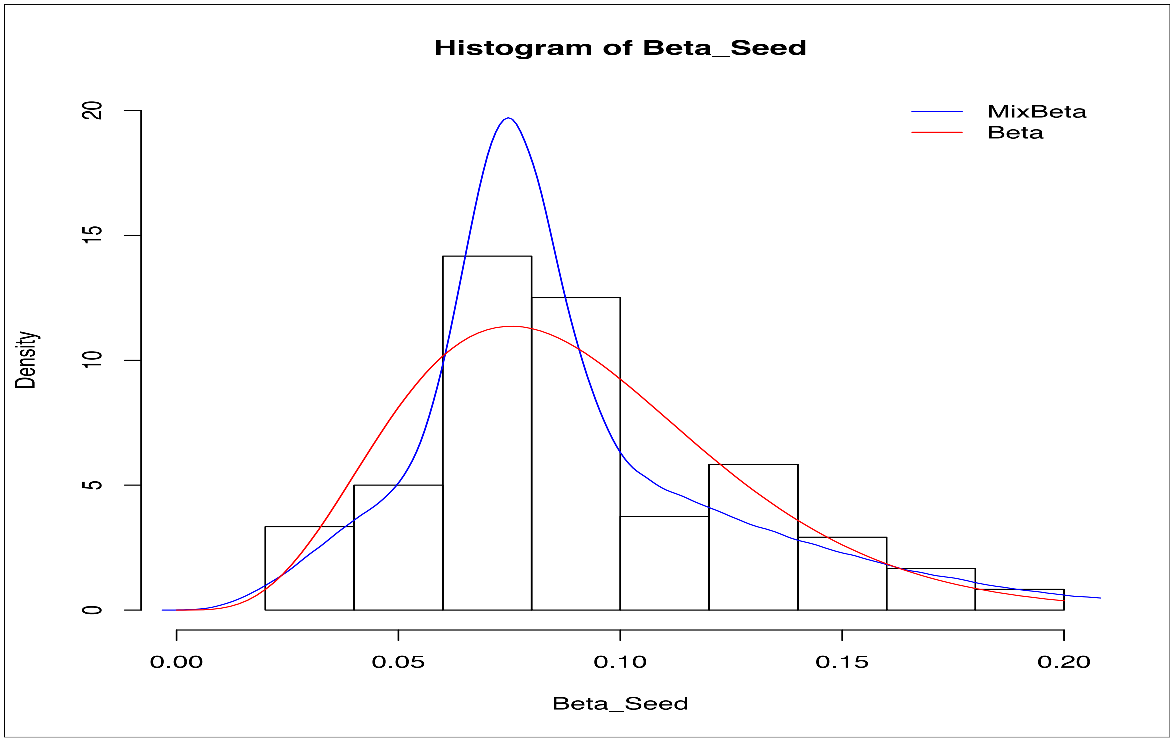
Similar to the utility share parameters, the two distributions with lowest AICs are selected for each production share parameter. For β_S the mixture Beta and Beta, for β_F the Beta and Log-Normal, for β_P the mixture Beta and Log-Normal, and for β_L Log-Normal and Gamma distributions have the lowest AIC and are selected for the analysis (see Table 4.24).

Table 4.24: Results of AIC coefficients for production share parameters.

$\boldsymbol{\beta_S}$		$\boldsymbol{\beta_F}$		$\boldsymbol{\beta_P}$		$\boldsymbol{\beta_L}$	
Distribution	**AIC**	**Distribution**	**AIC**	**Distribution**	**AIC**	**Distribution**	**AIC**
Mixture Beta	-467.9297	Beta	-443.8854	Mixture Beta	-541.612	Truncated Log-Normal	-368.9981
Beta	-458.9038	Log-Normal	-443.8471	Log-Normal	-536.5031	Log-Normal	-368.9981
Truncated Gamma	-458.2715	Truncated Log-Normal	-443.8471	Truncated Log-Normal	-536.5031	Truncated Gamma	-368.9339
Gamma	-458.2699	Normal	-442.494	Truncated Gamma	-529.2981	Gamma	-368.9334
Truncated Normal	-453.3346	Truncated Normal	-442.494	Gamma	-529.119	Beta	-368.4992
Normal	-451.5359	Gamma	-439.7351	Beta	-528.1057	Truncated Normal	-359.2013
Truncated Log-Normal	-449.3757	Mixture Beta	-435.8854	Mixture Gamma	-521.1742	Normal	-358.9058
Log-Normal	-449.3757	Mixture Gamma	-434.6736	Truncated Normal	-508.531		
Mixture Normal	-445.5912	Mixture Normal	-434.494	Normal	-508.3945		
Mixture Gamma	-431.3286	Truncated Gamma	-425.9884	Mixture Normal	-502.1872		

Source: Results are simulated using R.

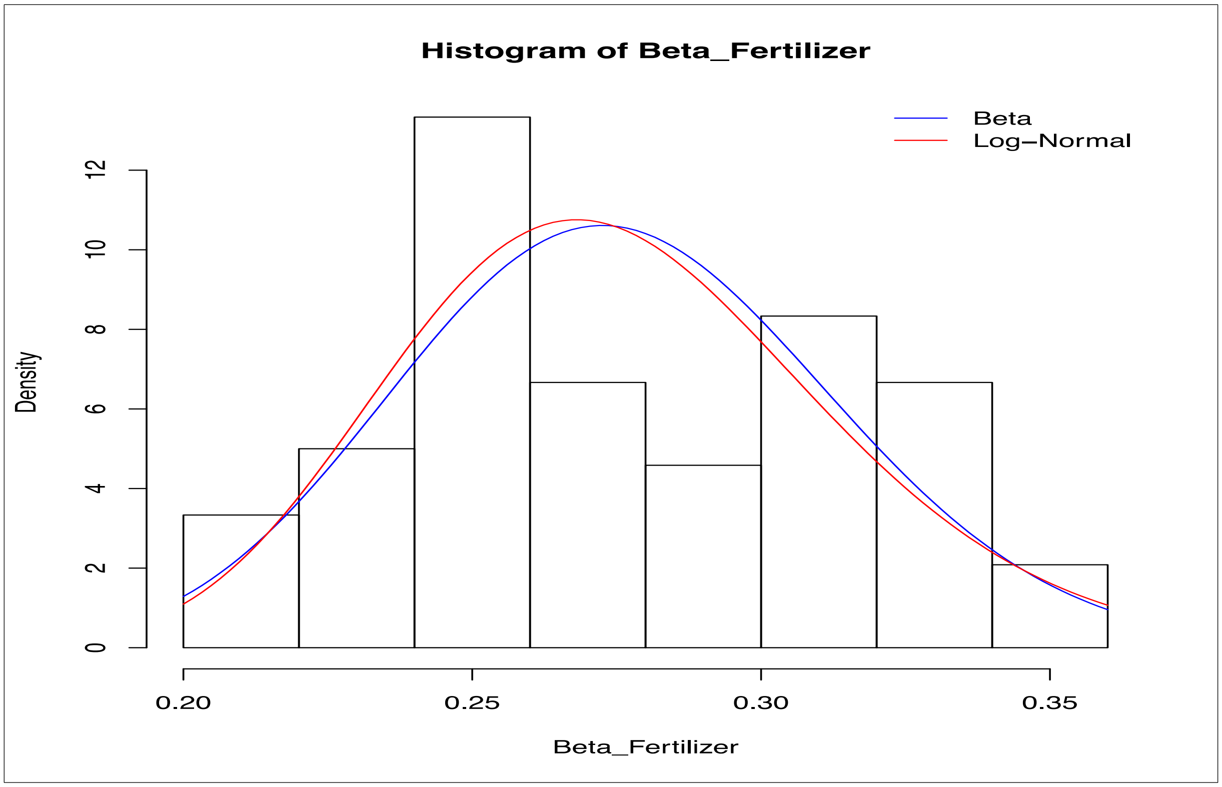
Figure 4.16 provides the graphical analysis for β_S. Based on this figure, the mixture Beta distribution (blue curve) accurately fits the histogram, which is consistent with the AIC analysis. Therefore, the mixture Beta is selected over the Beta (red curve) for the seed expenditure share parameter.



Source: Results are simulated using R.

Figure 4.16: Probability density function for β_S.

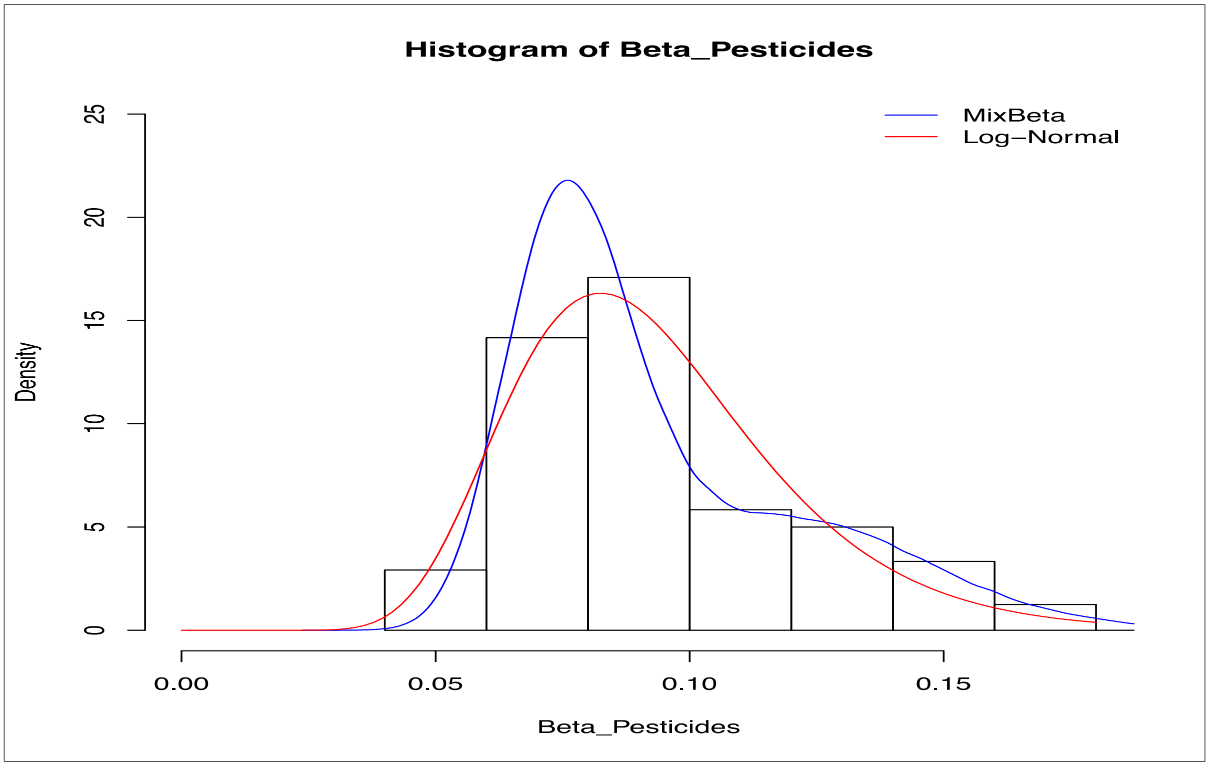
The PDF of β_F is shown in Figure 4.17. Because both the Beta (blue curve) and Log-Normal distributions (red curve) indicate precisely fit the histogram, we need to select the distribution with lower AIC. Therefore, the Beta is selected over the Log-Normal.



Source: Results are simulated using R.

Figure 4.17: Probability density function for $\boldsymbol{\beta_F}$.

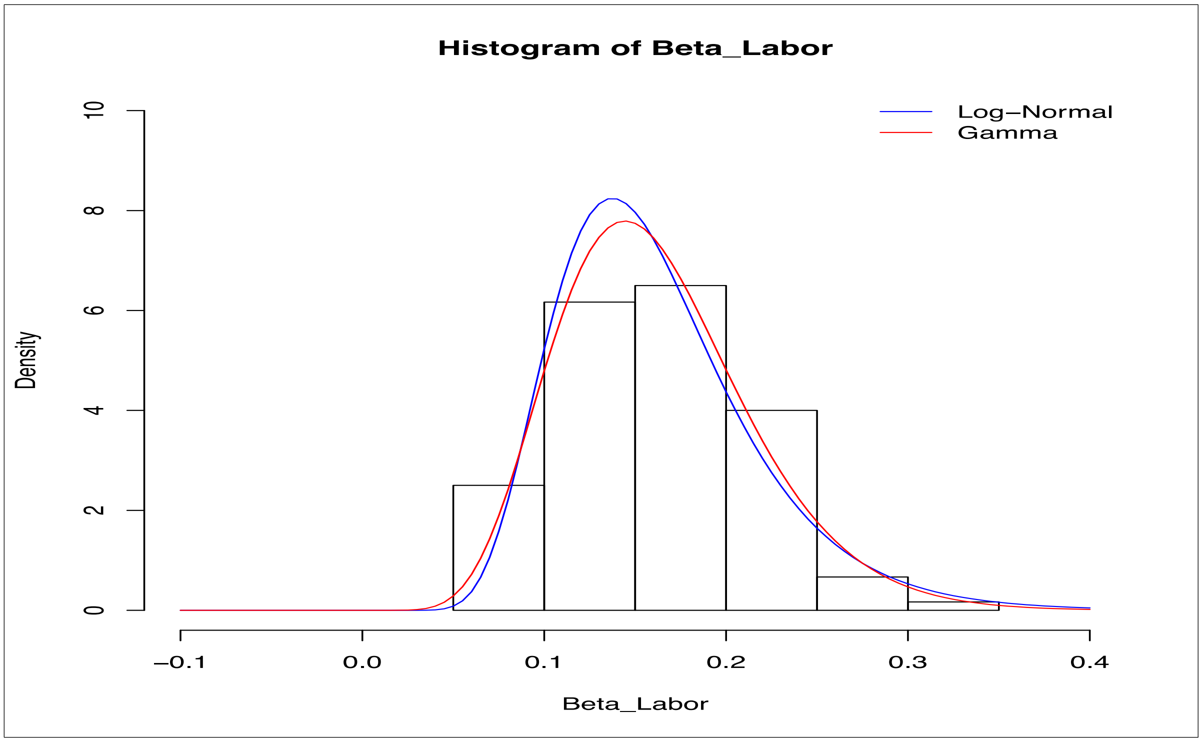
Figure 4.18 displays the PDFs of β_P, pesticides share parameter. The graphical analysis indicates the mixture Beta distribution (blue curve) accurately fits the histogram which is consistent with the AIC results. Therefore, the Mixture Beta is selected over the Log-Normal distribution (red curve).



Source: Results are simulated using R.

Figure 4.18: Probability density function for $\boldsymbol{\beta_P}$.

Figure 4.19 provides the graphical analysis for β_L. Based on this figure, both the Log-Normal (blue curve) and Gamma (red curve) distributions accurately fit the histogram. However, the Log-Normal is selected over the Gamma because it has a lower AIC coefficient.



Source: Results are simulated using R.

Figure 4.19: Probability density function for β_L.

Since drawing from individual distributions leads to uncorrelated draws, a multi-variate simulation approach is applied to obtain the correlated draws that accurately represent the correlation among variables in the three surveys. The Phoon, Quek, and Huang (PQH) (Phoon et al, 2004) algorithm is applied, which leads to random draws from univariate distributions mimicking random draws from multivariate distribution. The PQH method provides a very flexible simulation approach for correlated parameters and describes a procedure for simulating correlated variables from mixed marginal distributions based on eigen decomposition of the rank correlation matrix (Anderson, Harri, and Coble, 2009; Phoon, Quek, and Huang, 2002). The

PQH algorithm was followed to generate 1,000 correlated random draws for individual farmer yields (y_is), production share parameters (β_is), and consumption share parameters (α_js).

The correlation coefficients of utility and production parameters that present in Table 4.25 and 4.26 confirm each parameter is correlated.

Table 4.25: Correlation coefficients of utility share parameters.

Utility Parameters	$\boldsymbol{\alpha_r}$	$\boldsymbol{\alpha_a}$	$\boldsymbol{\alpha_m}$
α_r	1.0000	0.2902	-0.4679
α_a	0.2902	1.0000	-0.9815
α_m	-0.4679	-0.9815	1.0000

Source: Results are simulated using R.

Table 4.26: Correlation coefficients of production share parameters.

Production Parameters	$\boldsymbol{\beta_S}$	$\boldsymbol{\beta_F}$	$\boldsymbol{\beta_P}$	$\boldsymbol{\beta_L}$
β_S	1.0000	-0.1996	-0.0176	-0.1649
β_F	-0.1996	1.0000	0.1090	0.0882
β_P	-0.0176	0.1090	1.0000	-0.0212
β_L	-0.1649	0.0882	-0.0212	1.0000

Source: Results are simulated using R.

3.3 Model Calibration

With correlated random draws for individual farmer yields (y_is) and production (β_is) and consumption (α_is) share parameters from selected distribution estimates, the next step is to define and calibrate the remaining parameters in the model. Both the producer price of long-grain paddy rice and the consumer price of long-grain milled rice are obtained from RICEFLOW model. Other data such as minimum wage, average farm size, input prices (price of seed, fertilizer, pesticides), average of household members, total available hours in a year (average number of people times 24 hours in a day multiplies by 365 days in a year) are obtained from household surveys.

Given the correlated random draws for β_is and y_is, prices of long-grain paddy rice and inputs, and analytical solution for input demand functions equations [31] – [34], the productivity parameter A is calibrated as a residual: $A^i = \frac{y^i}{x_S^i(\cdot)^{\beta_S^i} x_F^i(\cdot)^{\beta_F^i} x_P^i(\cdot)^{\beta_P^i} x_L^i(\cdot)^{\beta_L^i}}$. The RICEFLOW analysis generates baseline results for the year 2020, and predicts domestic production will increase by 6.8% by 2020. Consequently, productivity parameter is increased by 6.856% over the calibrated values to match this rise in production. Therefore, the baseline year in RICEFLOW and the baseline year in the current study are consistent.

With the production parameters calibrated, government transfer T is calibrated such that income from rice production matches the current income-based poverty rates among rice farmers to 16.82% (HIS, 2016). The CES parameter ρ between rice, manufacturing, and leisure is assumed to be -2, which implies an elasticity of substitution $\sigma = \frac{1}{1-\rho}$ of 0.33 and the consumption goods are imperfectly substitutable[34]. With total expenditures on rice and composite non-rice consumption reported in HIS (2016), distributions of the expenditure share of these consumable goods are estimated in the preceding subsection 3.2.2 *Distribution Estimation of Utility Share Parameters*. However, data on the value of leisure (and thus expenditure share α_L^i) or the consumer price of the composite non-rice good $\tilde{p}_M$ does not exist. Therefore, assuming a common leisure share parameter among all households ($\alpha_L^i = \alpha_L$), α_L and $\tilde{p}_M$ are calibrated to match two facts: the average household spends 72% (HIS, 2016) of their time at leisure and consumes 88.9 kg/person of rice per year (MARDI, 2014). With α_L and $\tilde{p}_M$

[34] The estimation and assumption of CES parameter ρ can be referred to Constant Elasticity Functions (Rutherford, 2002).

parameterized, all exogenous variables are defined, and the model can be simulated to quantify the effects of free trade on farm households.

4. Empirical Results and Discussions

With the prices and exogenous parameters defined in the Data and Model Calibration section 3, equations [30] – [37] are simulated for the empirical analysis. The simulation analysis is run for each of the 1,000 individual farmers randomly drawn using the estimated univariate distributions and the PQH algorithm. Two scenarios are run for each farmer to quantify the effects of free trade policy: First, in the baseline scenario, all prices are maintained at the levels specified in the calibration, which results in the model closely reproducing the survey data for input demands, production, income, and farmers' demand for rice, composite non-rice, and leisure. Second, in the alternate scenario, the effects of free trade in the Malaysian rice sector from the RICEFLOW analysis on the producer price of long-grain paddy rice (p_R) and consumer price of long-grain white rice ($\widetilde{p}_R$) are imposed on the system of equations. Specifically, p_R is decreased by 11.9% and $\widetilde{p}_R$ is reduced by 14.74%, as reported in the free-trade scenario in Chapter 3. The solutions of the baseline and alternate scenarios are then used to calculate the poverty and welfare measures for both scenarios. Finally, the solutions of the endogenous variables, poverty, and welfare measures in the baseline and alternate scenarios are compared to quantify the effects of free trade in the Malaysian rice sector on rice farmers.

4.1 Production

The impacts of free trade policy on rice production are quantified as the percent change in inputs and rice yield from the baseline to the alternate scenario for each rice farmer. The income is then computed for each farmer and compared to the poverty level to find the proportion of farmers that are poor under both scenarios.

4.1.1 Production Impact

The decline in producer price for long-grain paddy rice after the implementation of free trade, results in the factors of production (seeds, fertilizers, pesticides, and labor) decreasing on average by 16.16% with standard deviations of 0.77, which indicates the varied effect of the free trade policy among the rice farmers. While the Cobb-Douglas structure of the production function results in the same percentage decline in inputs, the absolute differences in input use vary. From the baseline, seed, fertilizer, pesticide, and total labor per hectare decline to a level of 198.68 kg, 4.76 kg, 27.88 liters, and 22.10 hours, respectively. The reduction of inputs leads to a decline in rice yield by 4.84%, from 6.96 Mt/Ha to 6.62 Mt/Ha. However, the estimated yields effect is divergent between rice farms as the standard deviation of the percent change is 0.88 (Table 4.27). Hence, these results show that rice farmer's production declines from the free trade policy, which is consistent with the trade theory of a small country effect.

Table 4.27: The impacts of free trade policy on domestic production.

Parameters	**Baseline 2020**	**Free Trade Policy Scenario**	
		Level	**% Change (Std. Dev.)**
Seed (Kg)	236.98	198.68	-16.16 (0.77)
Fertilizer (Kg)	5.68	4.76	-16.16 (0.77)
Pesticide (Liter)	33.25	27.88	-16.16 (0.77)
Labor (Hrs)	26.36	22.10	-16.16 (0.77)
Yield (Mt/Ha)	6.96	6.62	-4.84 (0.88)

Source: Results are simulated using R.

4.1.2 Income Poverty Measure

The significant decrease in production inputs and rice yield leads to a decline in domestic production after the implementation of free trade. This causes rice farmers' household income to fall relative to the baseline. As a result, the percent of rice farmers who generate monthly household income below RM 800 (the average national poverty line for poor) increased from 16.40% to 33.20%, while those earning below RM 460 (the average national poverty line for extreme poor) surged from 11.30% to 22.30% (Table 4.28). Because free trade leads to more rice imports, the international competition for domestic rice farmers is stronger. Thus, for the rice farmers, free trade will negatively affect incomes leading to escalating poverty rates of both poor and extreme poor. However, while the farm gate price of rice and production falls, leading to lower income, the consumer price of rice also declines. While rice farmers experience a negative income shock, they could actually consume more of the staple food with a lower consumer price for rice.

Table 4.28: Income poverty measures for baseline and free trade.

Parameters	Baseline (%)	Free Trade (%)
Monthly household income < RM 800	16.40	33.20
Monthly household income < RM 460	11.30	22.30

Source: Results are simulated using R.

4.2 Consumption

The impacts of free trade policy on households' consumption are measured as the percent change in the average per capita rice consumption, non-rice consumption, and leisure hours, from the baseline to the alternate scenario for each household. The rice consumption is then computed for each household and compared to the poverty level to find the proportion of households that are below the subsistence level of rice consumption per person under both scenarios.

4.2.1 Consumer Demand Effect

The decrease in consumer price for long grain rice after free trade implementation leads to an increase in rice consumption by 5.01% on average with a standard deviation of 0.11. The consumption increases from 533.40 to 560.12 Kg per household of six (or 88.9 per person) from the baseline to the alternate scenario level, respectively. Since rice becomes more affordable due to the lower market rice prices, consumers have higher purchasing power after free trade implementation. Both composite non-rice consumption and leisure (non-working hours) decline slightly by 0.42%. These results indicate that farmers reduce consumption of composite non-rice, but extend family working hours on the rice farm, which partially offsets the reduction in income.[35] From the baseline, composite non-rice consumption and leisure decrease to a level of 147.91 and 37,736.60, respectively (Table 4.29). On the consumption side, the results suggest that rice farmers are better off with the implementation of free trade. With affordability as a key pillar of food-security, free trade plays a significant role in Malaysia’s food security as it leads to a lower price and more rice consumption.

[35] If total working hours are falling while family working hours are rising, then hired labor hours on the farm must be declining.

Table 4.29: The impacts of free trade on farm household consumption (per household per year).

Parameters	Baseline 2020	Free Trade Policy Scenario	
		% Change	Level (Std. Dev.)
Rice consumption (Kg)	533.40	5.01	560.12 (0.11)
Composite non-rice Consumption index	148.53	-0.42	147.91 (0.10)
Leisure (Hr)	37,895.76	-0.42	37,736.60 (0.10)

Source: Results are simulated using R.

4.2.2 Rice Consumption Poverty Measure

The rice consumption poverty line is measured at 70 Kg per person (i.e. the minimum rice consumption per Kg per year from HIES). Free trade results in the proportion of farmers below 70 Kg per person to decline from 18.40% in baseline to 14.10% after the implementation of free trade. This suggests that poverty—measured in terms of rice consumption—will be alleviated for rice farmers when free trade is allowed.

4.3 Farmers' Welfare Measure

With the income and rice consumption poverty measures leading to opposing conclusions about the poverty of rice farmers, a comprehensive welfare analysis for rice farmers is conducted by calculating equivalent variations for each household before and after free trade. This welfare measure is more comprehensive than the poverty estimates because it accounts for both income and price effects simultaneously. Note that the equivalent measure is for rice farm households only and is not a national welfare measure of free trade. After the implementation of the free trade policy, the index of equivalent variation welfare measure for farm households declines marginally by -0.42 from the baseline. Since the decrease is very marginal, less than one, the results suggest that free trade causes no significant impact on individual farmers' income and welfare.

From a policy perspective, free trade will lead to a substantial increase in consumer surplus in rice consumption—not just for rice farmers but for all Malaysian rice consumers. Therefore, opening the rice market to free trade, while providing compensation to rice farmers to alleviate the negative impacts of free trade, could still be welfare improving for Malaysia as a whole. While free trade hurts rice farmers in terms of income and equivalent variation, there are policy combinations that can allow for free trade while leaving farmers equally well off.

5. Conclusions

Poverty alleviation, especially for rural rice farmers, has been a long-standing goal in Malaysian national rice policy, as reflected in the government's efforts to embark on various support and protective policies to enhance farmers' livelihoods and welfare. One of the key trade policies that has been in place for decades is large tariffs on rice imports. In fact, the most recent policy review suggests prohibitive barriers in rice trades to pursue an autarky rice economy. Despite having participated in both bilateral and regional free trade agreements (FTA), Malaysia excluded rice from the FTAs since it is classified as a sensitive commodity.

This study analyzes the impact including rice in the FTAs would have on rice farmers by developing a farm household model for individual rice farmers in Malaysia. The model is simulated to evaluate the impacts of free trade—through changes in producer and consumer prices from the RICEFLOW analysis in Chapter 3—on rice farmers' production, consumption, poverty, and welfare. The results indicate that even though free trade would hurt rice farmers in Malaysia due to increasing the percentage of farmers' living below the national poverty line, farmers would increase their rice consumption due to the lower rice prices after the free trade, which also benefits non-farm rice consumers in Malaysia. However, the equivalent variation (a complete welfare measure that combines both the effects of income and rice consumption) shows that free trade does make rice farmers worse off as their welfare falls, albeit minimally. While rice farmers are highly protected in Malaysia, the impacts of free trade are often misconstrued to focus only on the negative effects on the domestic production side and rice farmers' incomes and welfare. This study provides key insights on the economic assessment of moving to a more liberalized rice market to the Malaysian government and policy makers.

The welfare measures from this study focuses on rice farmers, and thus the results do not represent the entire rice consumer's population and the whole economy. Given the negative welfare effect, an important extension of this analysis will modify the model to study the most efficient government transfer to make farmers equally well off, while still allowing for free trade. Specifically, this extension could evaluate whether bolstering current production subsidies or shifting to decoupled direct payments would be the most cost-effective policy.

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Appendix 4.1: The simplification of utility functions.

$$\widetilde{p}_R c_R + p_M c_M \leq p_R F_R (x_S, x_F, x_P, x_L) - r_S x_S - r_F x_F - r_P x_P - r_L (x_L - \bar{t} + c_L)) - T$$

$$\widetilde{p}_R c_R + p_M c_M \leq p_R F_R (x_S, x_F, x_P, x_L) - r_S x_S - r_F x_F - r_P x_P - r_L x_L + r_L \bar{t} - r_L c_L - T$$

$$\widetilde{p}_R c_R + p_M c_M + r_L c_L \leq r_L \bar{t} + p_R F_R (x_S, x_F, x_P, x_L) - r_S x_S - r_F x_F - r_P x_P - r_L x_L$$

Appendix 4.2: The first order conditions (FOCs) of eliminating $\boldsymbol{\lambda}$.

$$\frac{\partial \mathcal{L}}{\partial c_R} = \frac{\alpha_C \alpha_R c_R^{\alpha_R - 1} c_M^{\alpha_M} (c_C^{\alpha_C}\ c_M^{\alpha_M})^{\alpha_C - 1}\ c_L^{\alpha_L}}{\alpha_L (c_R^{\alpha_R}\ c_M^{\alpha_M})^{\alpha_C}\ c_L^{\alpha_{L-1}}} - \frac{\lambda\, \widetilde{p}_R}{\lambda r_L} = 0$$

$$\frac{\partial \mathcal{L}}{\partial c_M} = \frac{\alpha_C \alpha_M c_R^{\alpha_R}\ c_M^{\alpha_M - 1} (c_R^{\alpha_R}\ c_M^{\alpha_M})^{\alpha_C - 1}\ c_L^{\alpha_L}}{\alpha_L (c_R^{\alpha_R}\ c_M^{\alpha_M})^{\alpha_C}\ c_L^{\alpha_{L-1}}} - \frac{\lambda p_M}{\lambda r_L} = 0$$

$$\frac{\partial \mathcal{L}}{\partial c_L} = \alpha_L\ (c_R^{\alpha_R}\ c_M^{\alpha_M})^{\alpha_C}\ c_L^{\alpha_L - 1} - \lambda r_L = 0$$

$$\frac{\partial \mathcal{L}}{\partial x_S} = p_R\ \beta_S\ A x_S^{\beta_S - 1}\ x_F^{\beta_F}\ x_P^{\beta_P}\ x_L^{\beta_L}\ -\ r_S = 0$$

$$\frac{\partial \mathcal{L}}{\partial x_F} = p_R\ \beta_F\ A x_S^{\beta_S}\ x_F^{\beta_F - 1}\ x_P^{\beta_P}\ x_L^{\beta_L}\ -\ r_F = 0$$

$$\frac{\partial \mathcal{L}}{\partial x_P} = p_R\ \beta_P\ A x_S^{\beta_S}\ x_F^{\beta_F}\ x_P^{\beta_P - 1}\ x_L^{\beta_L}\ -\ r_P = 0$$

$$\frac{\partial \mathcal{L}}{\partial x_L} = p_R\ \beta_P\ A x_S^{\beta_S}\ x_F^{\beta_F}\ x_P^{\beta_P}\ x_L^{\beta_L - 1}\ -\ r_L = 0$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = (\ r_L \bar{t} + p_R\ A x_S^{\beta_S}\ x_F^{\beta_F}\ x_P^{\beta_P}\ x_L^{\beta_L} - r_S x_S - r_F x_F - r_P x_P - r_L x_L - (\widetilde{p}_R c_R + p_M c_M + r_L c_L)$$

$$- T = 0$$

Chapter V
Economic Insights into Malaysian Rice Policy: Concluding Remarks

1. Dissertation Summary

This dissertation research demonstrates the integration of agricultural economics and public policy to comprehensively evaluate and analyze a deep-rooted rice policy in Malaysia, primarily the impact of self-sufficiency and international trade policies at both the macro and micro levels. It consists of three sequential empirical studies using different quantitative methodologies that applies economic frameworks as the major mode of analysis. The fact that the Malaysia's rice policy is a strategy of achieving self-sufficiency while the status quo of the national rice economy remains ambiguous, motivates this research to initially measure the competitiveness and comparative advantage of the domestic rice production and analyze the efficiency policies at the farm level. Therefore, prior to the major evaluation and analysis on self-sufficiency and international free trade policies, we determine the current efficiency of domestic rice production with the self-sufficiency policy emphasis and provide foundational evidences on the current situation of policy consequences at the farm level. Further, the major analysis evaluates the impact of self-sufficiency and international trade policies on the rice sector at the national level in light of food security concerns. Finally, the study presents deeper evaluation and analyzes the impacts of the international trade policy at the farm-household level, on the heterogeneous rice farmers in Malaysia. While limited studies have attempted to analyze the Malaysian rice policies, these empirical studies establish the crucial rice policy concerns in Malaysia; self-sufficiency, international free trade, and food security. The specific research encompasses: 1) measuring the competitiveness and efficiency of rice production policy using a Policy Analysis Matrix, 2) evaluation and impact of self-sufficiency and international free trade policies using a RICEFLOW model, and 3) evaluation and impact of international free trade on rice farmers using a Farm-Household model. The results of these studies also address food security concerns.

1.1 The Competitiveness and Efficiency of Rice Production

This study evaluates and analyzes domestic rice production system at farm level in Malaysia since the competitiveness and comparative advantage of domestic rice production has been distorted through high levels of intervention, protection, and subsidy supports provided by the government for many years. A wide range of policy programs have been implemented, most of which include input and output subsidies and regulated producer price with the goal being to achieve total self-sufficiency in rice. Even though the rice sector contributes a relatively small share to the national income, rice still receives special attention and has been given priority in a series of the national development policies in Malaysia. While subsidies have become a permanent policy strategy for decades and have involved substantial public investment, the domestic rice outcomes remain stagnant and only satisfy between 60-65% of the growing demand each year. In fact, the recent revised national rice policy provides more additional input and output subsidies which will continue to burden government expenditure. Recently, the government decided to more seriously pursue self-sufficiency, aiming to eliminate all rice imports in the future.

This study applies policy analysis matrix approach to measure the competitiveness and comparative advantage of the domestic rice production system in Malaysia. The results indicate that while receiving substantial efforts and attention by the government, especially through realizing various production support programs, domestic rice is still lacking comparative advantage relative to rice imports. Currently, the total rice production subsidy is RM 2,571.3 (per hectare) which accounts 59.1% of the total production cost (per hectare). With these substantial subsidies and producer price support, the average farmers' net income is significantly low, RM 703.36 (per hectare), which is below the national poverty line, RM 800 per household of six. If all subsidies and price support are removed, rice farmers would suffer from significant losses (RM 2,984.33 per hectare) due to high production costs for rice at the farm level.

In addition, the protection measures also imply that the current policies are reducing the actual input costs while increasing the revenue through subsidizing inputs and imposing higher domestic prices than world market prices. The divergence is caused by the government policies that distort the pattern of production, moving it away from the most efficient use of domestic resources and international trading opportunities. The competitiveness analysis verifies that the government decision in pursuing self-sufficiency through highly protecting the domestic rice industry leads to significant policy distortion since the international rice price is lower than domestic rice. This study provides foundational information that domestic rice production in Malaysia is not competitive since the protectionist policies have failed to achieve self-sufficiency.

1.2 The Impact of Self-sufficiency and International Trade

Self-sufficiency, often misinterpreted as food security, has become a permanent policy goal in the national rice development plan in Malaysia. This primarily concerns addressing the national food security over the past decades. The government's mandate under the national agro-food policy, 2010-2020, is to pursue self-sufficiency in rice and achieve total self-sufficiency by the year 2020. With this mandate, the government aims to close all trading borders and eliminate rice imports coming from international markets and suppliers. As Malaysia is not a competitive rice producer, this extreme policy decision would lead to massive additional expenditures at the production and farm levels. This study evaluates and analyzes the impact of self-sufficiency policy in rice at the national level using the RICEFLOW model.

A self-sufficiency policy scenario is defined as the removal of rice imports for long grain rice by the year 2020. With elimination of rice imports, domestic rice production would increase as well as the producer price. This increase also implies the increase in cost of production that is mostly derived from a constraint in land factor. The higher production cost of paddy rice and consequential increase in the market price of paddy rice transfers to higher consumer prices. As a result, the domestic demand for consumption of long grain rice declines. These results imply that self-sufficiency improve rice producers' welfare which would benefit them, however the policy punishes all rice consumers, which also include the rice producer as consumer, due to a substantial increase in consumer price. Hence, rice self-sufficiency entails significant welfare shifts from consumers to producers and will likely adversely affect food security objectives since the policy increases prices and limits consumption, especially by the poor. As affordable food prices are the key pillars of food security, self-sufficiency does not guarantee food security at the national level. The government would suffer from losses of the import tariff revenues. In addition, self-sufficiency burdens the government with substantial additional expenditure for the required output subsidies, production inputs, and technological efficiency to realize self-sufficiency in rice while maintaining consumer prices.

In contrast, liberalizing rice trade, which has been found to provide positive effects on food security, would be an alternative policy strategy, since Malaysia is a member of ASEAN, WTO, and has actively participated in both bilateral and regional free trade agreements for other commodities. With free trade, although rice producers are worse off, albeit to a marginal degree, and though the government loses from import tariff revenues, consumers would be better off due to decreasing prices with a more competitive market environment from external rice suppliers. In addition, Malaysia could participate in a regional approach for strengthening food security to address its rice-deficit issue, and thus free trade could offer a more food secure economy. The results of these two policy scenarios correspond to economic theory that self-sufficiency greatly benefits rice farmers at the expense of consumers. On the other hand, the free trade showed opposite policy impacts since farmers' welfare worsens, yet consumers' welfare increases. From this study, these policy scenarios clearly represent the opposite direction in terms of welfare distribution. Further, the price effects of the free trade policy scenario are applied in the following study to measure the policy impacts at the household level among rice farmers in Malaysia.

1.3 The Impact of International Free Trade on Rice Households

While rice farmers are highly protected in Malaysia, the impacts of free trade are often misconstrued to focus only on the negative effects on the domestic production side and rice farmers' incomes and welfare. Therefore, this study analyzes the impact of free trade policy that would have on rice farmers by developing a farm household model for individual rice farmers in Malaysia. The model is simulated to evaluate the impacts of free trade—through changes in producer and consumer prices from the RICEFLOW analysis in Chapter 3—on rice farmers' production, consumption, poverty, and welfare.

The decline in producer price after the free trade policy reduces the production input use (seed, fertilizer, pesticide, and total labor) among rice farmers. The significant decrease in production inputs also causes in decrease rice yield and further leads to decline in domestic production after the implementation of free trade. These consequences cause rice farmers' household incomes to fall. Because free trade leads to more rice imports, the international competition for domestic rice farmers is stronger. Thus, for the rice farmers, free trade will negatively affect incomes leading to escalating poverty rates of both poor and extreme poor. However, the decrease in consumer price for long grain rice after free trade leads to an increase in rice consumption. This suggests that poverty—measured in terms of rice consumption—will be alleviated for rice farmers when free trade is allowed. The decrease in consumer price not only benefits rice farmers, but also the entire Malaysian consumers. A complete welfare measure that combines both the effects of income and rice consumption shows that free trade does make rice farmers worse off as their welfare falls, albeit minimally.

2. Policy Discussions

With the evaluations and analysis on the Malaysian rice policy, we identify crucial consequences of the protectionist production policy, the self-sufficiency policy, and the international free trade policy. The impacts of these policies provide key insights for the government and policy makers for future rice policy direction.

2.1 Protectionist Policy Consequences

The government's interventionist policy instruments have significantly distorted prices and resource use and failed to drive competitiveness in the Malaysian rice sector. These distortions have induced unnecessary efficiency losses in order to realize the national self-sufficiency goal. The government enacts distorting policies to favor particular interest groups, consciously trading off the consequent economic efficiency losses against equity concerns for special interests of rice farmers.

The dominant use of power in decision-making by asking how issues are suppressed, hence the scope of decision-making is restricted (Bachrach and Baratz, 1962). While “Agenda setting is not just about what issues government chooses to act on, they are also about competing interpretations of political problems and the alternative worldviews that underlie them” (Cobb and Ross, 1997). With implementing protectionist policy, the government does not only distort the rice market, but also each agricultural input market which includes seed, fertilizer, pesticide, and other chemicals. As rice in Malaysia is mostly operated by small farmers, it would be highly challenging to become a globally competitive industry and would require significant financial supports by the government. The government policies should lead to the economic development at the macro level instead of stimulating policies to largely focus on rice economy. To realize total national self-sufficiency goal, the rice sector is largely subsidized, protected and regulated by the government. The policy evaluation and analysis at the production level reveals that if domestic support policies are removed– input subsidies and producer price – rice would be unprofitable to produce in Malaysia, hence an uncompetitive industry, which leads to significant losses at farm level. However, one of the limitations of this study is that the issue of how rice farming resources would be redirected to other farming activities was not explored. A high protection by the government causes inefficient rice production due to policy distortions, since domestic rice production has no comparative advantage relative to rice imports, which can be purchased by consumers as much lower prices than domestic rice. Therefore, the government’s interventionist policy instruments significantly distort rice markets while inducing unnecessary efficiency losses to realize the national self-sufficiency goal.

2.2 Self-sufficiency Policy Consequences

Self-sufficiency has been upheld as a policy strategy in the Malaysian rice sector as a means to address the food security concerns of its population and to alleviate poverty among rice farmers, as well as their livelihoods and welfare, which have become permanent mandates in the national rice development policy. Although self-sufficiency is not a new strategy in Malaysian policy, having originated in the 1930s, the catastrophic effects of the recent global food crisis in 2007/08 has convinced the government to mandate total self-sufficiency in its primary food staple, rice, by the year 2020, which has been recently extended to 2050 in the National Transformation (2020-2050), the national masterplan, through closing borders for rice imports in the future. With Malaysia is not a competitive rice producer and has no comparative advantage relative to rice imports, self-sufficiency constantly forces domestic production through high subsidies for inputs, outputs, and producer prices, hence it is not an efficient approach to pursue. In fact, domestic production is significantly distorted. Self-sufficiency has also been identified as a costlier and a counterproductive path to food security. Instead to achieve the food security objective, self-sufficiency could essentially threaten the overall food security of the country. With the evidence presented in this study, self-sufficiency in rice is more likely to be considered as a more political strategy rather than a solution to poverty issues. Furthermore, the food self-sufficiency approach has been widely criticized as containing misguided policy decisions and seeks to achieve food security that places political priorities over economic efficiency (Clapp, 2017).

While the self-sufficiency policy would benefit and improve welfare to rice producers, albeit a minor group of the total population, the policy will not only worsen the majority of Malaysia's population of rice consumers, but require large government costs, hence burdening the government fiscal resources. The government's stance on self-sufficiency needs to be redefined as current policy decisions are misguided. The significant differences in welfare allocation between the self-sufficiency and free trade strategies described above imply that the political economy becomes even more crucial to decide the policy output. With the pursuit of self-sufficiency, the forces supporting a small group (rice farmers) of the population are "winning" the battle at the expense of the larger consumer group. Self-sufficiency could also be a political strategy for the country to become an independent region without relying other countries' food sources. Also, the policy decision might be connected to government favoritism of business interest groups. In fact, the policy decision might actually be shielding political interests over economic rationale. The policy agenda setting is associated with a process of conflict and most of politics revolve around the development and expansion of conflict surrounding evolving political issues (Schattschneider, 1960). Subsidy programs that are supposed to be an economic tool using substantial government expenditure to improve local rice industry might be misused as an "exchange" for political desires. In fact, members of government are "single minded seekers of reelection" (Mayhew, 1974).

2.3 International Trade Policy Consequences

The livelihood and welfare of rice farmers have been protected by the government since the majority of Malaysian rice farmers are among poor households. Other than a wide range of domestic support policies for rice farmers, the government also imposes high tariffs for rice imports. In fact, the most recent policy review suggests prohibitive barriers in rice trade to pursue an autarky rice economy. Both RICEFLOW and Farm-Household models are applied to evaluate and analyze the international free trade policy impacts at the macro and micro levels, respectively. The results indicate consistent impacts at both levels that the international free trade policy reduces producer prices, albeit at different magnitudes. At the national level, the producer price decreases by 11.9%, and even more at the household level, where it decreases by 16.2%. The reduction of producer price at the farm-household level causes in reduction of production inputs – seed, fertilizer, pesticide, and total labor – which decreases long grain rice yield by 4.84%, from 6.96 to 6.62 metric ton per hectare. As a result, the domestic rice production falls by 5.3%.

These free trade consequences further lead to a higher poverty rate of income among rice farmers in Malaysia. The poverty rate of farmers who generate monthly household income below RM 800 (the national poverty line for poor) increased from 16.40% to 33.20%, while those earning below RM 460 (the national poverty line for extreme poor) surged from 11.30% to 22.30%. Because free trade encourages more rice imports by 19.85%, the international competition facing local rice farmers would be much stronger. On the other hand, free trade reduces consumer prices of long grain rice by 14.7% which leads to higher growth of rice consumption by 4.4% at the national level and 5.01% at the farm-household level. Thus, the poverty rate of rice consumption (farmers who consume below 70 Kg per person/year) declines from 18.4% to 14.1% after allowing free trade.

While rice farmers experience a negative income shock, they actually consume more of the staple food with a lower consumer price for rice. In addition, the declining consumer price not only benefits the small population of rice farmers, but also to the majority population of rice consumers in Malaysia. A complete welfare measure that combines both the effects of income and rice consumption shows that free trade does make rice farmers substantially worse off as their welfare falls only by 0.42%. Since Malaysia has been a net rice importer, free trade will negatively affect local farmers. However, the government and policymakers must consider the impacts of free trade in the rice market for the overall economy and country by including the benefits for non-farm rice consumers. Eliminating all trade barriers while assisting farmers through income transfers could result in net gains from the implementation of free trade. Placing a heavier weight on the welfare of a small group of rice farmers (about 1% of the current total population) while disregarding the welfare of the majority of the population would be a discriminatory policy strategy. Disallowing free trade could be a political strategy to shield business interest groups and lobbyists that would be advantageous to political contributions, and hence influence policy outcomes. The institutional issues also are the main concern since the government largely administers the value chain of rice market, primarily in the subsidy flows, buffer stock policy, research and development grants, and extension services. Other than rice farmers, who would benefit from these public investments.

The significant differences in welfare allocation between self-sufficiency and free trade described above imply that the political economy becomes even more crucial to decide the policy output. With Malaysia currently pursuing total self-sufficiency, the forces supporting a small group of the population are winning the battle at the expense of the larger consumer group. Instead, free trade could be welfare improving to most of the population of the country as rice remains a primary food staple. Malaysian rice is mostly produced by smallholders and is not a significant contributor to the national income. and It is not a competitive industry and the government continues a subsidization policy strategy consuming substantial expenditure while implicitly using tax payers' dollars for decades. From public policy perspective, the combination of elitist, public choice, and social construction theories are strongly dominated in Malaysian rice policy decisions by the government and policymakers.

From this comprehensive policy evaluation, analysis, and impacts, this study concludes that the current self-sufficiency goal to be achieved in 2020 will lead to significantly detrimental effects to the overall rice economy in Malaysia, as the country is not only an uncompetitive rice producer, but also has no comparative advantage in producing rice. However, the government has recently extended the goal to the year 2050 under the national masterplan, therefore the country has another 30 years to improve primarily on research and development and technological efficiency to achieve self-sufficiency goal in rice while assuring welfare of both rice farmers and consumers. This study provides key economic insights and empirical measures for rice policy directions and policy decisions.

3. Reconciling the Differences of Studies

The empirical research presented in Chapters II, III, and IV use different data or databases with different methodological frameworks and therefore different model assumptions. In the Policy Analysis Matrix (PAM), the estimation at social price levels is based on the elimination of production input subsidies (seed price, fertilizers, pesticides, and chemicals) and producer price supports (i.e. guaranteed price). The data for the PAM have a base year of 2014/15. Therefore, the results are stationary and applicable to that particular year, given that the technology, market environment, and factor prices are assumed to be constant. Since this study focuses on rice, the result of comparative advantage in PAM is analyzed relative to only rice imports. The key assumption of this analysis is that domestic and imported rice are perfectly substitutable. The spatial, partial equilibrium analysis of the RICEFLOW model utilizes a database for the average market situation in 2013-2015. To simulate RICEFLOW, the production technology is specified as Leontief production functions, which implies that no substitution of production inputs are allowed. In addition, the model is restricted in the final consumption only to rice, and thus no substitution of resources to other crops and no substitution in consumption to other food is allowed. This is clearly a limiting assumption and must be considered in the evaluation of the results. The results in the PAM analysis show that the Malaysian production system is not competitive, with the implication that Malaysia should not produce rice on economic grounds. RICEFLOW on the other hand shows that 95 percent of domestic production remains in production when Malaysia removes tariff barriers on international rice imports. These differences in the outcome for domestic production occur for two reasons. First, the production subsidies are maintained in both the self-sufficiency and free trade scenarios for RICEFLOW, while the PAM analysis removes the producer's input and product price subsidies. Second, as noted above, imported rice and domestic rice are considered perfect substitutes in the PAM analysis, however in the RICEFLOW analysis, a preference for domestic rice relative to imported rice is specified. Although the Farm-Household model utilizes data from rice household surveys, the producers' and consumers' price effects are applied from the RICEFLOW estimates, therefore the results of the Farm-Household model and the RICEFLOW model are consistent.

4. Recommendations for Future Research

The Policy Analysis Matrix analysis can be extended to measure the comparative advantage of rice sector relative to other potential crops in Malaysia such as specific fruits and vegetables. In addition, with the changes in production input from the Farm-Household model, we could apply those changes to analyze policy transfers at the level of production. Given the negative welfare effect on local rice farmers, it is important to extend the farm-household model to identify the most efficient government transfers to make such that farmers are equally well off, while still allowing for free trade. Specifically, this extension could evaluate whether bolstering current production subsidies or shifting to decoupled direct payments would be the most cost-effective policy. One might also consider shifting the government expenditures toward a more robust research and development approach on improving rice productivity. Therefore, future research should focus on identifying the most applicable subsidy mechanisms for domestic rice producers in Malaysia, for example 1) pursuing self-sufficiency without punishing (decoupling) consumer prices, or 2) allowing free trade without hurting local rice farmers by providing direct income payments. This research would provide non-distortionary policy approaches for the government and policymakers for sequencing strategy of the national rice development in Malaysia. The results of this research will encourage the Malaysian government to continue to evaluate and rethink the current policy support framework for rice.

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