RICE PRICE CONTROLS POLICY OF VIETNAM AND ITS COMPETITION WITH THAILAND: A PRACTICAL APPLICATION OF SPATIAL EQUILIBRIUM MODELS

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DISCLAIMER

I, Pham Thi Huong Diu, hereby certify that this dissertation has been written by the author under the doctoral program at Humboldt University of Berlin. This is an expression of personal views on Vietnamese rice Price Controls policy and do not necessarily reflect the political views. The result from Spatial Equilibrium Models in the thesis was analysed in a poster at Tropentag 2012 by the author, but the whole thesis is not currently being submitted for any other degrees. That is the best of my knowledge. Any help received in preparing this work and all the reference material used have been acknowledged.

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ABSTRACT

Vietnam and Thailand are the top two rice exporters who contribute more than 50 per cent of market shares in the international market. Therefore, any changes in their rice policies have a strong influence on the world market.

Currently, one of the strongest and most often impacts on the Vietnamese rice industry is the Price Controls Policy that regulates the competition in rice market. It restricts the volume of r rice export in order to ensure national food security. This policy keeps Vietnamese rice production under its full potential compared with the rice industry in Thailand. Many experts suggest that Vietnam pays more attention on national food security than necessary. This causes market distortion and weakens Vietnam's competitiveness with Thailand.

In order to examine the effects of the Price Controls Policy with a quantitative method, we build and run a spatial equilibrium model with 3 different scenarios: (1) Price Controls Policy updated every week; (2) Price Controls Policy updated every month; (3) Price Controls Policy updated quarterly. Base on the available data of production, consumption, domestic price, transportation cost and elasticities of demand and supply function of Vietnamese and Thai rice industry, the model shows the following result. With less changes in the Price Control policy, the competitiveness in terms of export quantity of the Vietnamese rice on international markets rises without having negative effects on the national food security goal. Non-rice farmers will be in disadvantage position due to higher domestic prices for rice, but the majority of the population who are rice farmers, accounting for more than 70 per cent of the population, will benefit from the higher volume and turnover of rice export, and so the net social revenue will increase also. Therefore, we highly recommend that the Price Controls Policy should not be revised on regular to serve the purpose of achieving better competitiveness of Vietnamese rice

Keywords: Price Controls; Effect of Policy; Spatial Equilibrium Models; Vietnamese rice industry; Competitiveness.

Zusammenfassung

Vietnam und Thailand sind zwei der führenden Exporteure für Reis. Zurzeit hat die staatliche Preispolitik den stärksten und meisten Einfluss auf die vietnamesische Branche für Reis. Es beschränkt die Exportmenge, um die Menge für den nationalen Nahrungsmittelbedarf sicherzustellen. Diese Regulierung hält die vietnamesische Produktion unter ihrem vollständigen potenzial, im Vergleich zu der Reisproduktion in Thailand, zurück. Viele Experten unterstellen, dass Vietnam mehr Aufmerksamkeit der nationalen Strategie zur Ernährungssicherung schenkt als es notwendig wäre. Das verursacht Marktverzerrung und schwächt den landeseigenen Reisexport im Vergleich zu Thailand.

Um die Auswirkungen der staatlichen Preispolitik mit einer quantitativen Methode zu untersuchen, wird über ein Gleichgewichtsmodell drei verschiedenen Szenarien eruiert: (1)Die Regulierungsrichtlinie für Reispreise wird wöchentlich aktualisiert; (2)Die Regulierungsrichtlinie für Reispreise wird monatlich angepasst; (3)Die Regulierungsrichtlinie für Reispreise wird quartalsweise überabeitet.

Basierend aus den Produktionsdaten, dem Konsum, inländischen Preis, Transportkosten, der Elastizität der Nachfrage und der Angebotsfunktion der vietnamesischen und thailändischen Reisbranche zeigt dieses Modell Resultat: Mit kleinen Anpassungen in der Preispolitik wächst der Wettbewerb in Bezug auf der vietnamesischen Exportmenge auf dem internationalen Markt ohne negative Auswirkungen auf die Ziele der nationalen Ernährungssicherung. Nicht-Reisbauern werden in eine nachteilige Position gestellt aufgrund von höheren Preisen auf dem inländischen Markt. Jedoch Bevölkerung, welche Reisbauern sind, werden von den höheren Handelsmengen, den steigenden Umsätzen

und ebenfalls von dem steigenden Nettoeinkommen der Reisexporteure profitieren. Deshalb empfehlen wir nicht die staatliche Preispolitik regelmäßig zu überarbeiten, um das Ziel einer besseren Wetbewerbsfähigkeit von Vietnam zu erreichen

Schlüsselwörter: Preispolitik, Auswirkungen von Regulierungen, Gleichgewichtsmodell, vietnamesische Reisbranche, Wettbewerbsfähigkeit

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ABBREVIATION

FAO: Food and Agriculture Organization

GSOV: General Statistic Office of Vietnam

IFPRI: International Food Policy Research Institute

IRRI: International Rice Research Institute

MARD: Ministry of Agriculture and Rural Development

MRD: Mekong River Delta

MOIT: Ministry of Industry and Trade

MPI: Ministry of Planning and Investment

R.O.W: Rest of the world

RRD: Red River Delta

SEM: Spatial Equilibrium Models

UNCTAD: United Nations Conference on Trade and Development

USDA: United States Department of Agriculture

VASEM: Vietnam agricultural spatial equilibrium model

VLSS: Vietnam Living Standards Survey

VFA: Vietnamese Food Association

Chapter 1

INTRODUCTION

1.1. Introduction

In Vietnam, rice is the most dominant agricultural product. Lives of more than 70 per cent of the population are associated with paddy rice in rural areas. In the past, Vietnam was a large rice importer because of the consequences of war and the backwardness of farming system. However, since 1989 Vietnam began taking part in the international rice market with the first export of 1.42 million tonnes equivalent to $US290 million and the average free on board price of $US204/ton (VFA[1], 2010). Presently, rice industry is not only ensures national food security but also gains much foreign currency through exports. With an advantage of favorable weather, as well as the almost timely government policies on agriculture, Vietnamese farmers have responded in a dramatic way to become the world's second largest rice exporter with an increase in both quality and quantity. Historically, rice exports in 2011 were the largest in recent times with an export volume of 7.105 million tonnes and a value of $US3.507 billion (VFA, 2012). Nowadays, rice has become a strategic commodity for the Vietnamese agricultural industry.

In the last few years, Vietnam has passed India to rank as the second largest exporter while the following exporter is always Pakistan but Thailand is number one in the international rice market. Thailand has a comparative advantage in rice production compared with Vietnam and this is reflected in terms of the cultivated area which is

[1] Vietnam Food Asscociation: The social-professional organization acting in production, processiong and trading of agroproducts and food-stuffs.

about 9 million hectares, more than double that of Vietnam of about 4 million hectares. Moreover, the success of Thai rice reflects the adoption of new advanced varieties and the efficient marketing strategies used to successfully build an international brand under the trade-mark of 'Hom Mali' rice. Vietnamese rice has no known trademark leading to weak competition in comparison to Thai rice and many rice experts suggest that the quality of some Vietnamese rice varieties is as good as that of Thai rice varieties. The Thai rice price was generally $US50-70 per ton higher than Vietnam's rice price. In the last few years, the gap has been narrowing and it was about zero in 2008 with the price of Vietnamese, 25 per cent broken, rice now significantly higher than the Thai corresponding category of rice. This reflects a period in which "demand exceeds supply" for rice in the foreign markets but is unlikely to persist for any length of time.

For Vietnam, an important question is how to strengthen the competitive position of Vietnamese rice production relative to other rice producers? Along with many comprehensive solutions proposed, such as, adoption of improved high quality varieties, improving rice farming practices, investment in irrigation infrastructure, support for agricultural research and enhancing the marketing activities in building a brand-based trade, there is universal interest in the export policy mechanisms. The focus is on easing the Price Controls Policy on rice. The well-known impacts would be an increase in the domestic and a fall in the international prices of rice if the policy is effective. This will harm the rice consumers and non-farming, low-income consumers in Vietnam and benefit producers. As well, Vietnam will gain more foreign currency as a whole and Vietnamese rice will be more competitive in the export markets.

In the research reported in this thesis, the effects of alternative scenarios in relation to

the Vietnamese rice export volume are examined by using a spatial equilibrium model. The different strategies for the Vietnamese rice industry are traced out to see how effectively Vietnamese rice can compete with Thai rice and which regions in Vietnam will gain and which areas would lose under the different scenarios.

1.2. Background

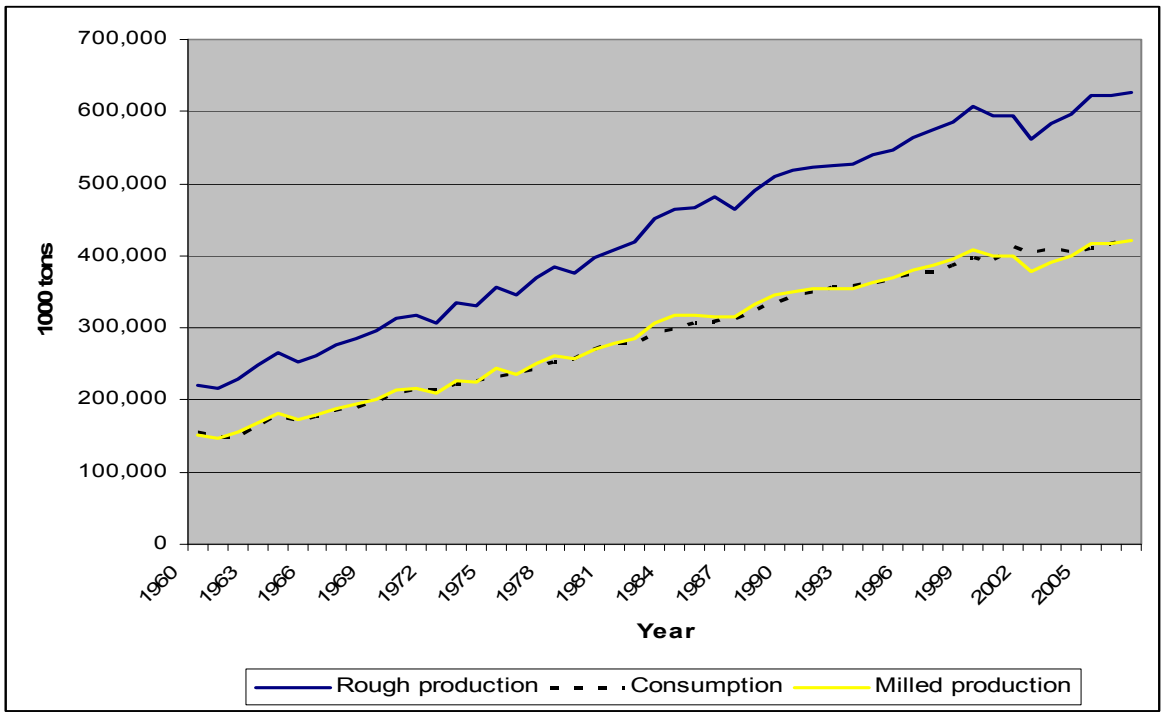
Rice is a dominant staple food and is used in the everyday meals of more than three billion people around the world. It provides over 50 per cent of the daily calories for human consumption and is a source of magnesium, thiamin, niacin, phosphorus, vitamin B6, zinc and copper (UNCTAD[2], 2008). Moreover, some types of rice can also provide iron, potassium and folic acid (UNCTAD, 2008). Rice is the second largest cereal consumed in the world after wheat.

It has been discovered that the first paddy rice was cultivated in many regions more than 6,500 years ago (UNCTAD, 2008). The first sign of rice production was in China about 5,000 B.C and about 4,500 B.C in Thailand (UNCTAD, 2008). After many years of variety improvement, the number of rice varieties grown is now more than 2,000 in which there are over 83,000 rice varieties in the gene bank of the International Rice Research Institute (IRRI) in Philippines (UNCTAD, 2008). These days, rice is popularly grown in temperate regions and the tropics with the two main types being Japonica and Indica. Japonica rice grows well in temperate conditions with a short or medium grain, so-called round grain. Whereas, Indica grows well in warm tropical areas with the shape of a long, thin and flat grain. Although rice can be cultivated in diverse conditions, it grows faster and more vigorously in wet and warm environments.

[2] UNCTAD: United Nations Conference on Trade and Development

There are some special characteristics of the rice industry compared with others. Firstly, it is highly risky due to being susceptible to environment changes such as land condition, weather change, temperature and water level. Several tropical zones in Asia and America possess the most favorable environments but some irregularity of monsoon, floods or drought have negative effects on rice production and productivity. Secondly, growth of rice needs special care and is labour intensive with multiple plantings and growing periods in a year. A great amount of work is required in transplantation. The beginning of a crop, for instance, involves intensive work but after that there is often spare time for the farmer. It therefore leads to the seasonal nature of work during a crop year.

The second important attribute of the rice sector is that due to international trade, the price of rice is not only influenced by domestic trade policies but also by the international support programs and regulations of other countries and the changes which often occur in these policies. What is more, it is not easy to predict the value of prices because of the residual nature of much trade. That is, that rice producing countries maintain, first and foremost, their domestic market consumption before trading their production surplus into overseas markets. The share of the international market for rice is, as a result, somewhat narrow when compared with other cereals such as wheat and corn. In periods of shortage or poor crops, there is an increase in the price of rice and vice versa. Moreover, the price of rice is impacted by fluctuations in exchange rates and the oil prices because almost all the major rice importers have their main source of income from oil exports. The above factors therefore affect the instability of the world rice prices.



Source: Foreign Agricultural Service, USDA[3]

Figure 1.1: The trend of rice production and consumption in the world, 1960-2008

As is shown in Figure 1.1, world rice production has increased in line with the rice consumption over many years. Due to increasing use of the high-productivity varieties, rice production has continued to increase. In 2007, the world average productivity was approximately 4.08 tonnes per hectare, the maximum was about 10.50 tonnes per hectare in Australia and the minimum was roughly 0.79 tonnes per hectare in the Congo Republic (USDA, 2008). Since the increase in productivity combined with the changes in sown area is about that of the increase in the world population who eat rice, the world rice production is growing at a rate close to that of the world consumption. Among the rice exporters, Vietnam and Thailand are the two leading nations providing approximately

[3] USDA: United States Department of Agriculture

45 per cent of the total rice in world trade with the Thai rice exports about double the volume of Vietnamese rice exports.

It is true that there is an increase in the rice price from year to year. According to the Vietnamese press agency, from February 2008, the Vietnamese export rice price has risen by about 53 per cent more than the corresponding period last year. The 5 per cent broken rice is sold at a price of $US460/ton and the 25 per cent broken rice which is seen as low-quality sold at $US430/ton, a higher price than the same type of Thai rice. The price of almost all the Vietnamese rice types in this year reached the new record prices, which are almost equal to that of Thailand. The result provides an encouraging market signal for the Vietnamese rice industry.

However, the Vietnamese Government has adjusted price of export rice quota on rice exports at 4.5 million tonnes in 2008 while the rice exporting enterprises are asking for a larger export quota. This is because that, Vietnamese policy makers have predicted a decrease in rice production in 2008. Firstly, a considerable risk of brown-hopper diseases has been indicated and this may result in a lean harvest in the Mekong delta, which usually has surplus rice production. All provinces in the region have been seriously requested to destroy the diseased crops if more than 10 per cent are infected so as to protect other rice crops. The second reason is that the long and damaging cold weather in January and February had negative effects on the winter-spring crops in the North killing 5,000 ha of rice seeding and 60 thousand hectares of rice crop. The most important reason is perhaps the target of national food security and stability for the domestic price. At this period of time with the world stocks at their lowest levels in many years there is an implicit rice shortage in the world.

At that time it would seem appropriate for the Vietnamese policy makers to restrict rice exports based on such grounds but it is also apparent that the benefits from the complete liberalization of rice exports would result in an increase in export volumes benefiting the country in terms of larger foreign currency earnings and the rice farmers and rice export enterprises as well. Moreover, many critics believe that the rice consumption for animals and seed at the current level is still high and needs to be adjusted. If so, the rice quota should be more than 4.5 million tonnes but still designed to ensure the food security goal.

At the pressure of current situation, the Vietnamese government has decided to remove the quota policy since 2008. Rice industry, however, is always sensitive and political content for Vietnam. This is expressed in the rice export contract when most of them are government contract that is an excuse to strengthen the diplomatic relationship and also the national trade exchange with others countries. The Price Controls Policy and others were come from such purposes and are regarded as an invisible hand of state for management. In other words, with the goal of stabilizing rice export markets, anti-dumping while ensuring national food security target countries, rice Price Controls Policy and others contained much government ambition for a developed and sustainable rice industry.

However, the fact in some recent years is that the more quantity of export rice, the less profit per unit Vietnam gains. In rice chain value, profit for farmers who directly produce grains is still not proportionate to what they spend for. This policy is also seen as beneficial for rice export enterprises and other intermediary stakeholders. Most of all, however, Vietnam’s rice prices are always cheaper than Thai rice prices in the same category. This is driving a downward trend in unit profit since 2008. Many researchers

firmly believed that the current Price Controls Policy on export rice creates a barrier to rice export businesses. In a lot of cases, it happens a loss of opportunity to keep current customers and seek new ones. The point is that the frequency of price intervention is too high and inappropriate at a give time. This thereby keeps Vietnamese rice competitiveness under its real potential.

1.3. Objectives

What are the grounds for a decision-making process in relation to the rice Price Controls Policy? Is analysing the economic gains and loses sufficient grounds on which to base a policy? The answer would be “No”. This is because the approval of a new policy depends on its purposes. One purpose might be to provide an appropriate compensation to a given social group, another may be to pursue a national sustainability goal or a humanitarian aim. The expectation for this paper is to provide some economic grounds in term of economic efficiency for policy makers, even if this is not the only basis for such policy making. The main objectives are as follows:

- To analyze characteristics of Vietnamese rice industry, especially rice export aspect;
- To review the advantages and disadvantages of Vietnamese rice industry;
- To develop three hypothesis connecting to frequency’s level of adjusting the rice export price in Vietnam;
- To build the spatial equilibrium model for rice industry;
- To build the supply function and demand function with known elasticities for five different rice markets;
- To figure out who will benefit and lost in three level of frequency of Price Controls

Policy;

- To general the rationale for spatial equilibrium model as a policy analysis tool;
- To predict the changes in trade flows in three regions of Vietnam, Thailand and Rest of the World if changing Vietnamese rice export volume;
- To analyze Vietnamese rice's competition with Thailand in 3 different scenario;
- To enrich the policy makers' information set in evaluating the previous and future policies.

1.4. Methodologies and data requirements

To meet the main objective of evaluating the competitive position of Vietnamese rice with Thailand if less control in price, the first task is to build the supply and demand functions for each market with known elasticites. The research focuses on three markets in Vietnam (North, Central and South), Thailand and Rest of the world. The supply and demand functions are developed from a set of domestic prices, production and consumption, and assumed elasticities. The next step is to determine the restrictions on the price of rice. The last step is to develop the spatial equilibrium model for the five markets and then to present the policy's impact on the domestic price of rice in Vietnam and its competition power with Thailand

There are several methodologies, which can be applied to forming the supply and demand functions, both with advantages and disadvantages. The econometric method, for example, depends on historical data at the household level being available. Moreover, it seems to be very difficult in the case of complicated supply equations (Batterham and MacAulay, 2006). While the limitation of the producer panels is on the disparity between farmers' answers and their actual behaviours (Batterham and MacAulay, 2006). The linear

programming method is seen as an expensive one due to data collection activity from several fields from land science and biological science (Batterham and MacAulay, 2006). Additionally, there is a need to have experienced experts to construct the model and understand the solution and the strategy which makes the method more costly.

On the other hand, the linear programming method is considered to be quite flexible in favour of modelling behavioural hypotheses which are consistent with the models and are easy to use to estimate the effects of alternative policies (Batterham and MacAulay, 2006).

The method used to produce the rice supply and demand functions for Vietnam (North, Central and South), Thailand and the rest of the world was using price and quantity points and elasticities. These were then incorporated in a spatial equilibrium model. Afterwards, the spatial equilibrium model was then applied to examining the connection among the markets and evaluating the effects of the Price Controls Policy.

The objective function was based on the maximisation of the net social revenue function. This goal was constrained by five main factors. First, that rice production in each region must be greater than or equal to the total import demand from the other regions plus the regions' own domestic demand. Secondly, the demand volume in each market must be less or equal to the total shipments to that market including domestic production and imports. The third constraint is, that for each region, the supply price is less than or equal to the demand price. Fourth, the difference between the supply and demand prices between each region should be less than or equal to the transfer cost to that region. Finally, all of the prices and supply and demand quantities, the transfer costs, shipments, and shadow prices are non-negative.

The data used for each region is a set of production volumes, opening stock, closing stock, imports, exports, prices (usually export or import unit values), and transfer costs in the five markets. The elasticities of the supply and demand functions were obtained from the empirical studies wherever possible. Also, all data were for 2010 wherever possible.

1.5. Outline of paper

After the first chapter introducing the rationale of the study, an outline of some of the theory of the spatial equilibrium model will be given in chapter 2. The overview of comparative advantage and tariff and Price Controls Policy will be mentioned in chapter 3 along with some economic arguments behind using price controls for rice export and the expected effects on Vietnam's rice industry. The characteristics of Vietnam's rice system will be discussed in the next chapter, including the policy and institutional environment, rice ecosystems, weather and climate features, cropping systems, some outcomes in rice production and exports and some advantages and disadvantages of Vietnam's rice industry. The chapter 5 will present a practical application of spatial equilibrium model to examine the competition of Vietnamese rice with Thai rice with different scenario of price control's frequency and the results of this analysis are presented. The last chapter has some recommendations and strategy for the future prospects of Vietnam's rice industry as a whole. The conclusion to the study will be also provided in chapter 6.

Chapter 2

SPATIAL EQUILIBRIUM MODELS

In an economy where demand and supply functions and the value of prices, consumption and production are known for each geographical region, the spatial equilibrium model can be used to determine the optimum set of prices and geographical flows. It is also true for more than two regions and multiple commodities, which may substitute or complement each other.

In the case of Vietnamese rice price control policy, the spatial equilibrium model is an appropriate tool so that some detail of the model will be presented in this chapter.

2.1. What is a spatial equilibrium model?

Definition

The spatial equilibrium model has been defined by Mihoko Shimamoto (1993) as "a model which solves the simultaneous equilibria of plural regional markets under the assumption of the existence of transportation costs between two regions. This complicated proposition can be arranged into a simpler style by applying the theorem that the solution of the competitive equilibrium is equal to one of the maximization of social surplus under perfectly competitive market conditions."

In the middle of the 20th century, Hitchcock (1941) and Koopmans (1949) solved the problem of trading between regions with minimum transport costs. They developed a model in which the supplies and demands were fixed.

Then first spatial equilibrium model was constructed by Enke in 1951 in which the trade flows of a homogenous commodity in two, or more than two, regions took place at a given transportation cost. The equilibrium level of prices, production, consumption and shipments for given commodities could be traced out if the demand and supply functions in each geographical region were known and varied with price.

Depending on the "net social payoff" or "net quasi welfare", Samuelson (1952) showed that an equivalent model could be formulated as a maximisation problem. The objective function he used was maximization of net quasi welfare which is the total of the consumer and producer surplus minus the transfer costs.

Takayama and Judge (1971) developed and proved that the model could be solved by maximizing the "net social monetary gain" or the "net social revenue" which is the net revenue from trade in commodities after calculating the gross revenue and subtracting the production costs and transfer costs. This seems to be a more general model in terms of the coefficient matrices and is a self-dual form. The optimal solution still satisfies the conditions for a competitive market solution (MacAulay, 2008). Moreover, this problem can be solved as a complementarity problem (Takayama and Judge, 1971, p. 255)

Purpose and application

The prime purpose of a spatial equilibrium model is to find the optimal set of prices, quantities and trade flows among geographical areas (Batterham and MacAulay, 2006). The model may include a number of policy specifications and a number of situations can be handled by these specifications (Krishnaiah, 1995). The prices and trade flows could be found with known supplies and demands and transfer costs. Conversely, the competitive prices and allocation outcomes could be determined by the known prices and demands

(Krishnaiah, 1995). Moreover, the specifications could be modified or some more constraints could be added to reflect diversified kinds of behaviour and policies such as import quotas, export quotas, trading agreements, subsidies and tariffs, and the behaviour of a selling and/or buying monopolist and also oligopolists or oligopsonists. In the case of the imposition of Vietnamese rice Price Controls Policy, this is the redirect way to dominate the number of export rice. This element thus can be put into the spatial equilibrium model as an additional restriction to particular trade flows or if the shadow price on the policy were known it could be a value added to the transport costs. Also, the producer revenue and consumer expenditure from internal geographical trade within Vietnam can be evaluated in the model along with the trade with other external regions.

In the special case of perfectly inelastic demand and supply functions, the problem turns out to be a conventional transportation problem.

Due to the frequent application of spatial equilibrium models, a considerable number of research studies have used spatial equilibrium models to handle many different socio-economic problems such as the impact of tariffs and price controls. The simplest version of the spatial equilibrium model is developed under the assumption of a perfectly competitive market where supply and demand functions and transfer costs are known.

However, there is a number of extensions to the model that can be applied. Firstly, the spatial equilibrium model can be developed for multiple commodities. Secondly, the markets may be subject to imperfectly competitive behaviour. For example, in Chi Chung Chen's study, he and his colleagues have tested the international rice trade for imperfect competition between the United States, Thailand, Vietnam and some other countries due to the imposition of government interventions and other policies.

Approach and technique

In terms of the approach used in solving a spatial equilibrium model, there are two conventional types of approach: the geometrical approach and the mathematical approach.

The geometrical approach is only useful when there are two regions and one commodity. Otherwise, the mathematical methods should be used. The programming approach depends on the objective function. If it is a linear function in the decision variables, the linear programming approach is appropriate. On the other hand, if the objective function contains a quadratic term, the quadratic programming approach would be appropriate.

Although, a simple problem could be solved by the geometric approach, modern computer software seems to be a very effective and time-saving method for solving spatial equilibrium models. For moderate-sized problems the software known as SOLVER in MS-Excel is effective for problems of maximizing a quadratic objective function subject to a set of linear constraints. It is equivalent to solving the problem of quadratic programming using primal-dual Kuhn-Tucker conditions and the software known as LINDO. The constraints in the second method are equations while they are inequalities in the first method.

2.2. Simulation models

Normally the simultaneous equation method of solving models can be used to simulate various types of econometric models. They could consist of linear equations, definitional equations; bilinear, non-stochastic and dynamic competitive equilibrium conditions. The most usual approach for simulation is to determine the effects of policy changes (or

adoption of a high productivity crop) on price, quantities produced and consumed and the revenue for producers.

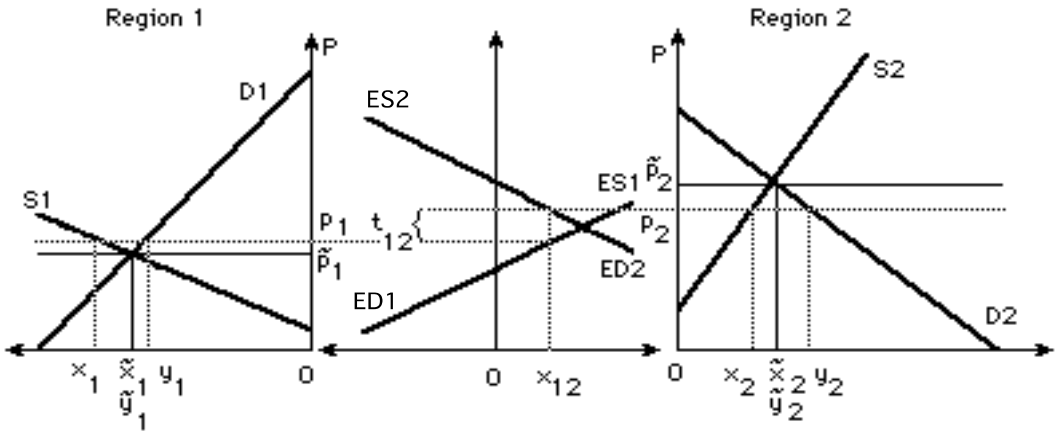
For the standard spatial equilibrium model, the objective function is quadratic and the supply and demand functions are in linear form. The analysis of trade flows among multiple areas is based on the implicit introduction of excess demand and excess supply functions. The excess supply curve in a market is defined as the horizontal difference between supply and demand functions while the excess demand is defined as a horizontal difference between demand and supply functions. If the internal demand is larger than the internal supply then the excess demand will be positive and the rest of the world equilibrium price will be lower than the domestic equilibrium price. It is also true for the opposite to be the case in that if the domestic supply is larger than domestic demand, then excess supply will be positive and the world equilibrium price will be greater than the domestic equilibrium price (can be seen in Figure 2.1)

2.3. Formulation or Construction

As stated, the spatial equilibrium model requires maximization or minimization of the objective function, which is constrained by a set of conditions. The solutions values for the price and quantity variables in the problem should also satisfy the condition of being non-negative.

The standard model has an objective function that has a quadratic part and a linear part which is based on either a measure of consumer surplus plus producer surplus less transfer costs or net social revenue. The optimal quantities and prices for a competitive market are at the point where the net social welfare is at a maximum. The constraints are

generally linear in form and usually structured with inequalities. A representation of a spatial equilibrium is given in Figure 2.1.



Source: MacAulay, 2008.

Figure 2.1: Representation of spatial equilibrium models with transfer cost $t_{12.}$

The variables used in this study are largely reflected in Figure 2.1 and are as follows:

x_1: supply in region 1

x_2: supply in region 2

$y_{1:}$ domestic demand in region 1

$y_{2:}$ domestic demand in region 2

ES_1, ES_2: excess supply for region 1 and 2

ED_1, ED_2: excess demand for region 1 and 2

P_1, P_2: price in region 1 and 2

$P^a_{1,}$ P^a_2: autarky price in region 1 and 2

x_{11}: shipment within region 1

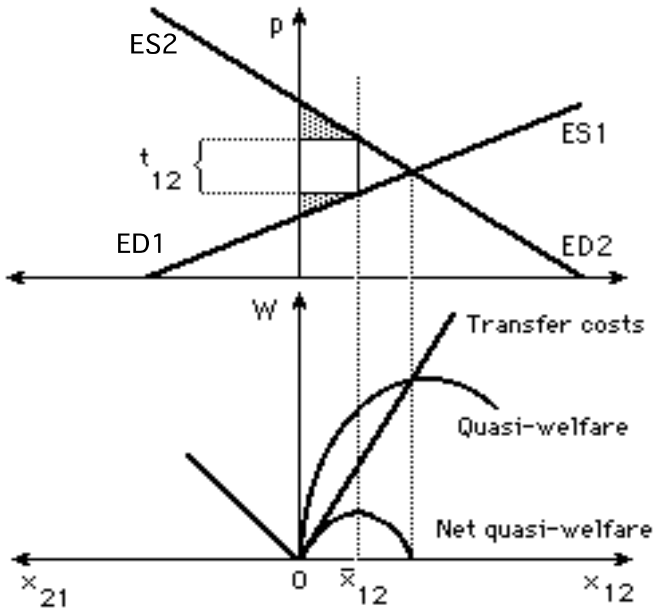
x_{12}: shipment from region 1 to region 2

x_{21}: shipment from region 2 to region 1

x_{22}: shipment within region 2

t_{12}: transfer cost from region 1 to region 2

As in the Enke-Samuelson model the markets are separated but not isolated by known transfer costs and the commodities will be shipped from markets where its value is lower to the markets where its value is higher until the difference in value is not larger than the transportation costs (Drynan, Batterham, Perich and Whelan, 1994). As also shown in Figure 2.1, if the equilibrium or autarky price, P^a_1 in region 1 is lower than that in region 2, P^a_2, there should be shipments from region 1 to region 2. This means that, region 1 could export the commodity to region 2 (or region 2 could import from region 1) at the lower cost than it could be done in its home region. The trade flow and world price can therefore be set at the point where the excess supply and excess demand functions intersect if there were to be no transfer cost. However, with introduction of a transfer cost, t_{12} in Figure 2.1, region 1, as the exporter sells at the lower price and region 2 who is the importer has to purchase at the higher price



Source: MacAulay, 2008.

Figure 2.2: Representation of the maximum "net quasi-welfare" solution

As can be shown in Figure 2.2, the objective function to be maximized is the "net social

welfare". It is the area under the excess demand function and the area above the excess supply functions less the area of the transfer cost. In the other words, the "net social welfare" or "net social pay-off" is the two shaded areas (Samuelson, 1952). The optimal solution is determined by maximizing these areas under the given constraints.

Following Samuelson (1952), the maximisation problem is subject to three constraints. Firstly, the inflows to one region (who is the importer) must be equal to or greater than the quantities demanded in the region. Secondly, the outflows from one region (who is the exporter) must be equal to or less than the quantities supplied in such a region. The third condition is the arbitrage requirement that the prices between any two regions must be less than or equal to the transport cost (all quantities must also satisfy the non-negativity requirement.

Therefore, the problem could be written as:

(2.1a) Maximize $NQW = W - T'X$

or (2.1b) Maximize $NQW = \sum_i \left[\int_0^{q_{d_i}} f_{D_i}(q_{d_i}) - \int_0^{q_{s_i}} f_{S_i}(q_{s_i}) \right] - \sum_{ij} t_{ij} x_{ij}$

Subject to:

(2.2) $\sum_j x_{ij} - q_{d_j} \geq 0$

(2.3) $\sum_i x_{ij} - q_{s_i} \geq 0$

(2.4) q_{d_i}, q_{s_i} and $x_{ij} \geq 0$

where: QW is net quasi welfare

W is quasi welfare or overall welfare

q_{d_j} is quantities demanded in region *j*

q_{s_i} is quantities supplied in region *i*

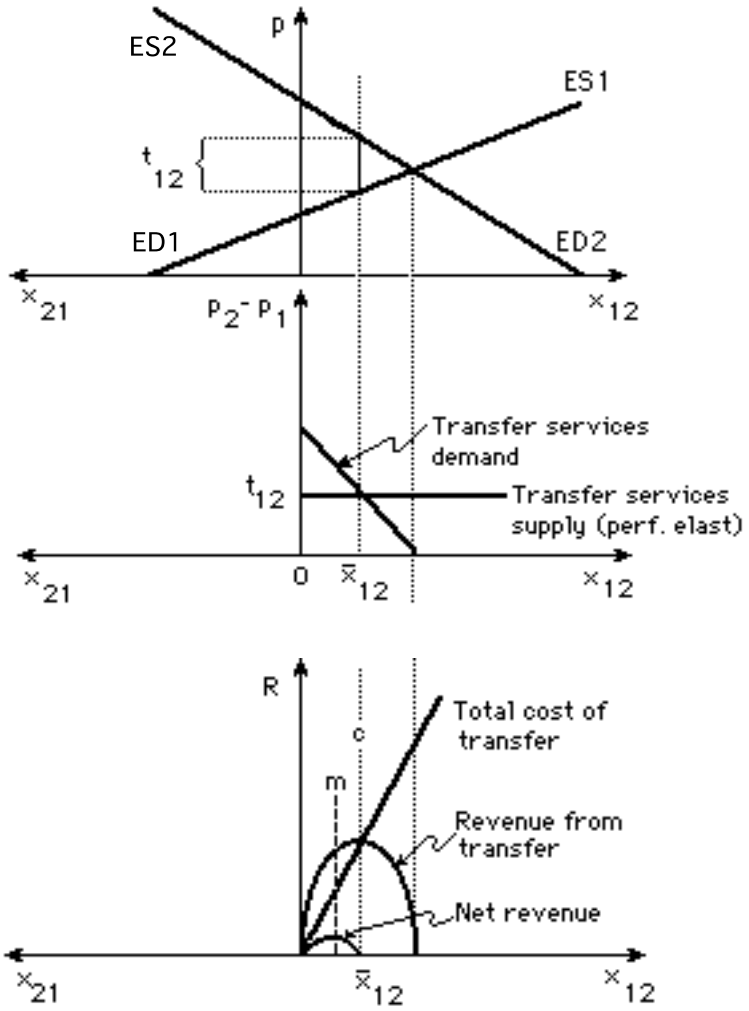
t_{ij} is the transfer costs from region *i* to region *j*

x_{ij} is the shipments from region *i* to region *j*.

The two first conditions are to ensure that there is no excess demand over the quantities shipped in and there is no shortage of supply to meet the out-shipments in each region (Drynan, Batterham, Perich and Whelan, 1994). The last condition is the non-negativity requirement for the variables.

Another more general approach was also introduced by Takayama and Judge in 1971, and then summarized by Martin in 1981 with a simplified version. They were able to show that the 'net social monetary gain' objective function could be used to finding the same optimal solution as in the 'net social welfare' spatial equilibrium models (MacAulay, 2008?). The trade flows and the transfer costs between the two regions are also indicated in Figure 2.1

Transportation costs are assumed to be perfectly elastic and represented by the rectangle area within the excess demand and excess supply curves. This area depends on the transport services per unit cost of shipment and the shipments demanded. In the other words, the total of transportation costs is calculated by the shipments times the average per unit cost. The net revenue is obtained from the revenue after subtracting the total of transportation costs and as is shown in Figure 4.3 (MacAulay, 2008).



Source: MacAulay, 2008.

Figure 2.3: Representation of the "net social revenue" solution

Following MacAulay (2008), to maximize the net social revenue of a given commodity, the objective function is of the following form:

(2.5a) $NR = p'_y Y - p'_x X - T'X$

Where: NR is net revenue;

$p'_y Y$ is revenue from the commodity;

$p'_x X$ is production costs; and

$T'X$ is total transfer costs.

If the price form of the supply functions, $p_y = \lambda - \Omega' y$, and demand functions, $p_x = \nu - \mathrm{H}' x$, are substituted into the objective function, it can be rewritten as:

(2.5b) NR = (λ'y - ν'x - T'X) – (y$\Omega' y$ - x$\mathrm{H}' x$)

where (λ'y - ν'x - T'X) is a linear form and (y$\Omega' y$ - x$\mathrm{H}' x$) is a quadratic form.

An alternative expression that is represented in MacAulay (2008) is given if the supply and demand functions are expressed in matrix form, they have the following forms respectively:

(2.6) $$p_y = \begin{bmatrix} p_1 \\ p_2 \\ p_3 \end{bmatrix} = \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{bmatrix} + \begin{bmatrix} \omega_{11} & 0 & 0 \\ 0 & \omega_{22} & 0 \\ 0 & 0 & \omega_{33} \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix}$$

(2.7) $$p_y = \begin{bmatrix} p^1 \\ p^2 \\ p^3 \end{bmatrix} = \begin{bmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{bmatrix} + \begin{bmatrix} \eta_{11} & 0 & 0 \\ 0 & \eta_{22} & 0 \\ 0 & 0 & \eta_{33} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

where i and are n x 1 column vectors of the intercepts of the demand and supply functions respectively; and are n x n matrices of demand and supply slope coefficients $_{ii}$ and $_{ii}$ for region i and p_i is the demand price for region i and p^i is the supply price for region i.

In vector form the transfer costs may be represented as:

$$(2.8)\ T'X = \begin{bmatrix} t_{11} & t_{12} & t_{13} & t_{21} & t_{22} & t_{23} & t_{31} & t_{32} & t_{33} \end{bmatrix} \begin{bmatrix} x_{11} \\ x_{12} \\ x_{13} \\ x_{11} \\ x_{21} \\ x_{22} \\ x_{31} \\ x_{32} \\ x_{33} \end{bmatrix}$$

In matrix form for a three-region problem, the net revenue can be written as:

$$(2.9\ NR = [p_1, p_2, p_3] \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} - [p^1, p^2, p^3] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} - [t_{11} \quad t_{12} \quad t_{13} \quad t_{21} \quad t_{22} \quad t_{23} \quad t_{31} \quad t_{32} \quad t_{33}] \begin{bmatrix} x_{11} \\ x_{12} \\ x_{13} \\ x_{11} \\ x_{21} \\ x_{22} \\ x_{31} \\ x_{32} \\ x_{33} \end{bmatrix}$$

The problem is subject to three sets of conditions to satisfy the characteristics of a competitive spatial equilibrium (Takayama and Judge 1971; Martin 1981). The supply and demand functions must hold; and the quantities supplied and demanded and shipments must balance; and the arbitrage conditions must hold

As an example, the three types of constraint may be illustrated as:

Firstly, the supply and demand equations must hold:

$p_1 \leq$ □ - □ y_1 or - □ y_1 - $p_1 \leq$ - □

$p^1 \leq$ □ + □ x_1 or - □ x_1 + $p^1 \leq$ □

□□□

etc.

Secondly, the supply and demand quantity must balance which means the shipments to region i should be equal or greater than the quantities demand in region i and the outflow of shipments from region i should be equal to or less than the quantities demanded in each region:

$y_1 \leq x_{11} + x_{21} + x_{31}$ or $y_1 - x_{11} - x_{21} - x_{31} \leq 0$

$x_1 \geq x_{11} + x_{12} + x_{13}$ or $-x_1 + x_{11} + x_{12} + x_{13} \leq 0$

□□□□

etc.

Thirdly, prices are related between markets taking into account the transfer costs (Samuelson, 1952) so as to ensure the condition of perfect competition are met and that the commodity in one region is a perfect substitute for that in another region and that no one can control prices by the use of market power. The relationship is that the difference between the demand and supply prices is less than or equal to the transfer cost as follows:

$p_1 - p^1 \leq 0$

$p_1 - p^2 \leq t_{21}$

$p_1 - p^3 \leq t_{31}$

□□□□

etc.

Therefore, the full constrained maximization problem can be written as:

Maximize NSR = $p_Y'y - p_X'x - T'X$

Subject to (illustrated for three regions)

$p_i \leq \alpha_{ii} - \beta_{ii} y_i$ (i = 1, ..., 3)

$p_j \leq \alpha_{jj} + \beta_{jj} x_j$ (j = 1, ..., 3)

$y_i \leq x_{1i} + x_{2i} + x_{3i}$ (i = 1, ..., 3)

$x_j \geq x_{j1} + x_{j2} + x_{j3}$ (j = 1, ..., 3)

$p_i - p^j \leq t_{ji}$ (i = 1, ..., 3, j = 1, ..., 3)

$y_i, x_i, p_i, p^i, x_{ij} \geq 0$

2.4. Limitations of the model

As is the case with any model, spatial equilibrium models involve the use of assumptions and so if the assumptions were to be violated in the real world then the results will suffer from the use of inappropriate assumptions.

One of the assumptions for standard spatial equilibrium models is that the supply and demand functions are usually linear in form while they are likely to be non-linear in the real world. Also, they may depend not only on the prices, quantities produced and consumed and their elasticities but also on some other factors such as changes in income, weather, preferences, and trends in consumption patterns and culture. However, these factors are not represented in the model leading to a need to qualify the conclusions.

In addition, one market could be both an exporter and an importer so that trading occurs in both directions in the same time period rather than in a single direction as in the spatial equilibrium models for one commodity. Moreover, if a “net quasi welfare” objective function is used, it is not an appropriate formulation in the case of multiple commodities, which have non-symmetric supply and/or demand coefficients in the model. In this case it is appropriate to use a ‘net social revenue’ model (Takayama and Judge 1971).

It is obvious that each method contains advantages and disadvantages and thus the results need to be carefully evaluated and qualified where necessary. In this study, it was assumed that all the requirements for the spatial equilibrium model were satisfied. The model will be solved by maximizing net social revenue of Vietnamese rice industry as an objective function. However before solving such a problem, some other literature need to be reviewed in next two chapters.

Chapter 3

LITERATURE OF COMPETITIVE ADVANTAGES AND GOVERNMENT'S INTERVENTIONS

It is commonly said that Vietnam has plenty of advantages in producing rice such as favourable weather conditions and low cost of production. Of which human skills and knowledge are considered as key factors contributing to the Vietnamese success. However, there are still some constraints on the competitiveness of the rice industry such as the Price Controls Policy. The concepts of competitive advantage and the main interventions (a tariff and Price Controls Policy) will be intensively analysed in this chapter in order to provide an overview of these policies' impacts on the rice economy

3.1. Absolute advantage

The principle of absolute advantage was first raised by Adam Smith in his trade theory. He stated that the development of international trade was created based on a country's absolute advantage in the production of goods and services. A country has an absolute advantage in producing goods and services if it can produce greater volumes with the same amount of resources or it consumes less resource to produce the same amount of goods or services. Adam Smith believed that such a country will engage in international trade in this circumstance because it can export the surplus to other markets (Tuffley *et al* 1998, pp.26-8).

However, it is easy and simplistic to see why one country who has an absolute advantage should be involved in trading but the principle of absolute advantage cannot explain many cases where a country has an absolute advantage over its trading partner in many

goods or services. That is, for example, country 1 can produce 70 units of rice and 60 units of soybean, whereas country 2, its trading partner, can produce 65 units of rice and 50 units of soybean. It is common sense that country 1 has an absolute advantage for both rice and soybean and therefore it should produce both of them. However, in the real world, country 2 still has an opportunity to be involved in international trade. To explain why this still happens, comparative advantage is introduced, based on the opportunity cost. This idea is attributed to David Ricardo in the book named *The Principles of Political Economy and Taxation* (1817).

3.2. Comparative advantage

The principle of comparative advantage of Ricardo is an expansion on the absolute advantage. He said that comparative advantage in production of a given good or service is that a country is able to produce it at lower opportunity cost than its trading partner. Therefore, it is not necessary to have absolute advantage to join and gain from trading, only comparative advantage, provided that the country can produce the good or service with lower opportunity cost.

This approach arises from there being scarce materials. It is necessary to look at comparative advantage to discover who can each best allocate their effort to a particular good or service. A country should specialize and produce the goods and services which have lower cost and then purchase other goods and services cheaper from its partner than what they can do so at home. This is because trying to produce everything is an inefficient strategy and this trade is a mutual benefit as a whole.

However, Ricardo introduced the concept of comparative advantage that arose from differences in only the productivity of labour, the so-called Ricardian model (Paul and

Maurice 1997, p15). An expansion on Ricardo's theory is then illustrated in the Heckscher-Ohlin model of trade based on the statement that the gains and incentives from trade arise due to differences in factor endowments between countries (Markusen *et al* 1995, pp. 98-124). Production of a given good or service having a comparative advantage will take place if it consumes plentiful material relatively intensively. This is because when looking at the opportunity cost of using the abundant factor it is lower than using a scarce material. This leads to higher costs of production for goods using the scarce factor intensively than those using the abundant factor intensively (Markusen *et al* 1995, pp. 98-124). The prices are therefore different (Markusen *et al* 1995, pp. 98-124) and as a result, the best arrangement is that of producing and selling the good with the abundant factor and buying the good using the scarce factor at lower price from its trading partner.

3.3. Government's interventions

The Vietnamese government has used a number of tools to intervene in the rice market to satisfy given goals in a given period of the development of the rice industry. Although, almost all of the interventions have had positive effects (as analysed at the previous chapter) such as "land consolidation" and other key policies, there are controversial policies, for example, the rice export Price Controls Policy. The critics of the introduction of the Price Controls Policy believe that the Vietnamese government should impose a revenue tax on the rice export enterprises and control less on price of export rice. To further understand the Government's intervention, the effects of a tariff and quota and Price Controls Policy will be discussed in this part.

3.3.1. Tariff

A tariff is one kind of tax that is placed on the volumes imported in order to allow them to enter into a country. A tariff could be calculated as a percentage of the price, so-called "ad valorem tariff", or as a fixed charge on a given weight or measures of each commodity, a so-called "specific tariff". The effect of a specific tariff is moderate, it is simple and there is no need for experts on valuing the value of commodities at all custom stations. However, it contains a considerable disadvantage in that in many cases, there seems to be no particular relation between the value of a commodity and the duty. The tariff tends to become more protective for inferior-quality commodities than for superior-quality commodities. For example, if the value of a particular article improves, the old duty may become proportionately smaller than it should be later, conversely, if the value of such an article declined for any reason, the old duty may become much larger. Therefore, the "ad valorem tariff" is widely applied as a levy on the value of the imported goods.

Purpose

Normally, tariffs are imposed to raise domestic prices higher than the world price and thus provide a better opportunity for domestic industries to compete with the imports (Pindyck and Rubinfeld, 1998). However, adoption of tariffs and their level is dependent on the Government's purposes.

It is obvious that all the various kinds of tariffs can raise the Government's revenue, after all, even though revenue is not always the first priority of a tariff. In the developing countries where there are still a number of the weak or infant home industries tatriffs may be used to protect these industries. They are used in the face of losing out to foreign

competition particularly jobs. In this case a protective tariff might be very necessary as a suitable protection tool. For instance, if one commodity can be produced in the home country and sells at a price of $50 per item, and the price of imports (assumed to be the same item and value) after a tariff is, say $60 per item, more than the domestic price, it would benefit the home manufacturers and would allow the domestic goods to be sold up to $59 per item. Through this method, a weak or infant industry, at least in the first period of its development, need not face the competition from foreign countries that are much more developed in regard to producing such items. A Government could also offer a prohibitive tariff which has a very high level, for example, a hundreds per cent, so that nobody would import any of that item. This is a very special case often related to the national security. According to the opponents, this is not a really good method for the long-term development of the home country, except the case of national security.

Losers and beneficiaries

In order to see who benefits and loses and how these are distributed among parties in an economy, the trade analysis can be shown as in figure 3.1.

Assume that P_w is denoted as the world price before imposing the tariff. In the case of no tariff, the domestic production is quantity Q_s and the domestic consumption is quantity Q_D. The lack of supply or excess demand, $Q_D - Q_S$ will be filled by imports. There will be no revenue for the Government. By imposing a tariff t, the world price would be increased at $P_{w'}$, resulting in an increase in the quantity produced to $Q_{S'}$, and a decrease in the amount demanded $Q_{D'}$ in the home country. The level of imports falls to $Q_{D'} - Q_{S'}$ as it is now relatively more expensive.

The welfare changes in response to the changes of producer and consumer behaviours

can be seen through figure 3.1. The total area of A, B, C and D is a decrease of the consumer surplus. One its part is considered as the redistribution effects, areas A and C, while the rest, areas B and D, is considered as the dead weight loss.

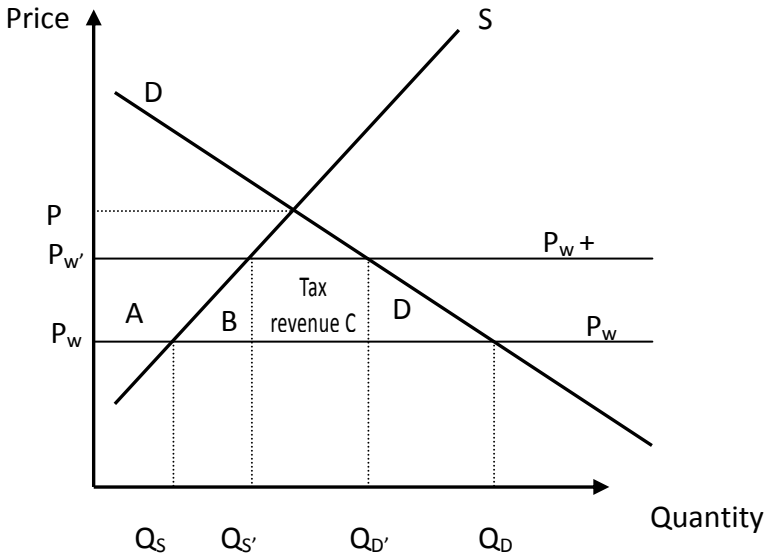


Figure 3.1: Effect of a tariff

The area A indicates the increase in producer surplus which is transferred from consumer surplus and does not show a loss in efficiency (Tisdell 1992, p.105). On the other hand, although the area B is also a loss from consumer surplus, it does not come to anyone. This is an offset to cover the increased cost. It means that at the higher price, the good is produced at a higher cost and some of the consumer surplus is transferred to compensate the cost's increase.

Like the area A, the area C is a transfer from consumer surplus to the Government. It is equal to the amount of tariff revenue on the total of quantities imported, QD' – QS' while the area D is the net loss in consumer surplus due to the higher price so that consumers no longer purchase the good at level QD instead they purchase QD'. In other words, at the new price PW', the cost of the good is greater than or equal to their marginal

willingness to pay, they will not buy more of the good. The area D is not transferred to any other parties in the economy.

It is transparent from the figure that local producers and Government would benefit from a tariff while consumers are losers. A Government always has to consider how long and which level of tariff is appropriate in terms of a moderate protection to home industry; revenue for Government and a suitable sacrifice from local customers. This is because an inappropriate tariff might have significant negative consequences. It is easy to see the increase in the price of the product subject to the protective tariff and this places a burden on other industries who want to use that good as an input for their production. For example, a tariff on food could create poverty or a tariff on gasoline could increase the price of transport services. Moreover, a country that levies a high level duty on foreign imports affects its trading partner. This country could be treated the same when exporting local products to its trading partner. This creates a trade war, which would harm both of them following the law of free trade.

3.3.2. Quota

A trade quota is a Government intervention on the amount of an imported product into a country or on an exported product out of the domestic market. A quota is considered as a protectionist trade restriction that normally limits the quantity of a good in terms of some kind of volume control in a given period of time, such as a limit on imported sugar to 100 tonnes per year. The impact of this restriction is to cause a fall in the total supply into a local market and a rise in the local price. Similarly to a tariff, a quota is used to benefit the local manufacturers who now could take advantage of the higher price to expand their production and sell at a higher price. Consequently, domestic consumers would purchase

less and their expenditure on such a good is partly transferred to the domestic producers.

In order to more understand the effects of a quota, consider the case of the introduction of free international trade through figure 3.2. Assume the world price of a good is lower than the domestic price. If free international trade is introduced, the domestic market, consumers could now buy that good at the world price which is lower than the domestic price. Therefore the quantities they demand could increase to Q_4 from Q^* while the domestic suppliers would reduce their production to Q_1. The difference between Q1 and Q_4 is met by importing.

The welfare is now redistributed among the participants in the economy toward benefiting the consumers the most. From the area A in a purely local market, consumer surplus increases by the total areas of A, B, C, D, E, F, G, H and I whereas the areas B and E come from producer surplus (as can be seen in figure 3.2).

With introduction of an import quota, the quantity of a good to enter a country is limited. Domestic manufacturers are faced with less foreign competition and the world price would increase to P_2 which is higher than it is with free trade. This encourages them to expand their production to Q_2 from Q_1 but is insufficient to encourage them to produce at the level of a purely domestic market. Simultaneously, consumers have to re-manage their budgets due to the higher price down to Q_3 while the local producers are just able to supply Q_2 and thus an amount of $Q_3 – Q_2$ of that good will be imported to meet the local demand. In other words, an import quota is set up to $Q_3 – Q_2$ to raise the good's price. Once more, the welfare is redistributed. The domestic manufacturers have an opportunity to recover some of their surplus lost in free trade. The re-gained surplus is the area E which is taken back from consumer surplus while the total loss of consumer

surplus is the area E, F, G, H and I. Of which, the area G and H is transfer to the foreign producer and the area F and I is deadweight because they are not shipped to any one in the economy. For the domestic market, the area E is gained, whereas the area F, G, H and I are lost as a whole.

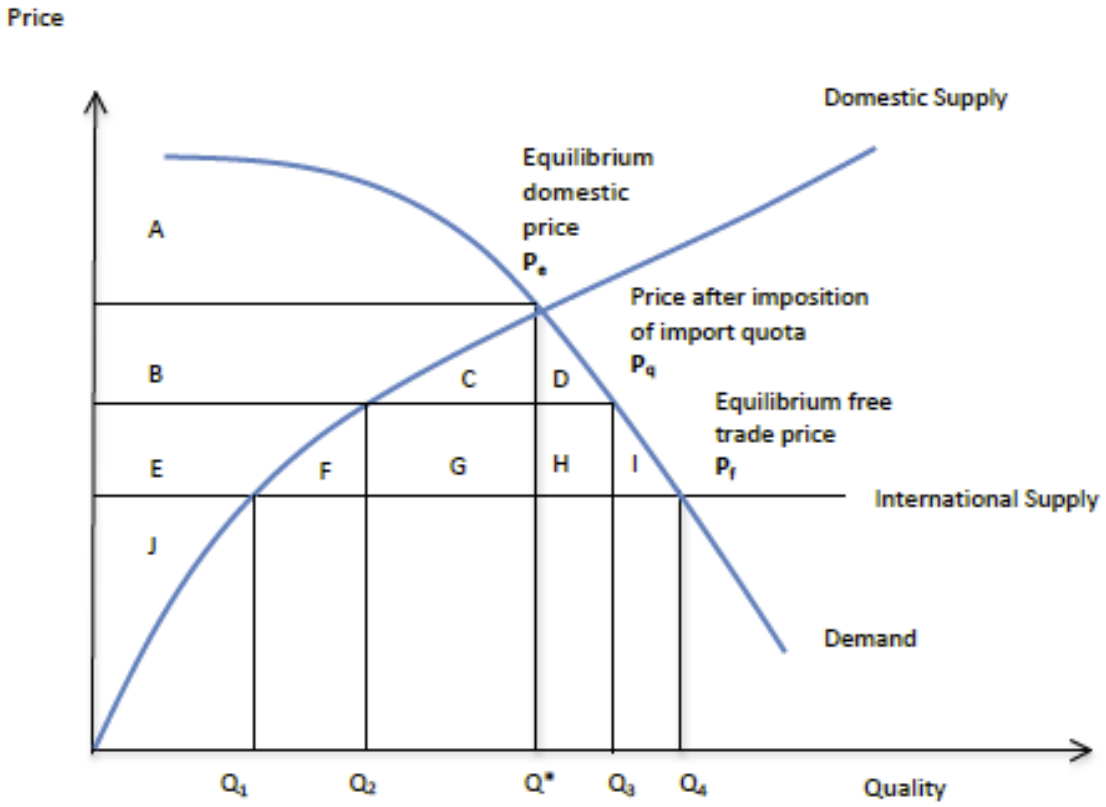


Figure 3.2: Effects of an import quota

Where:

P^*, Q^* are the equilibrium price and quantity in domestic market

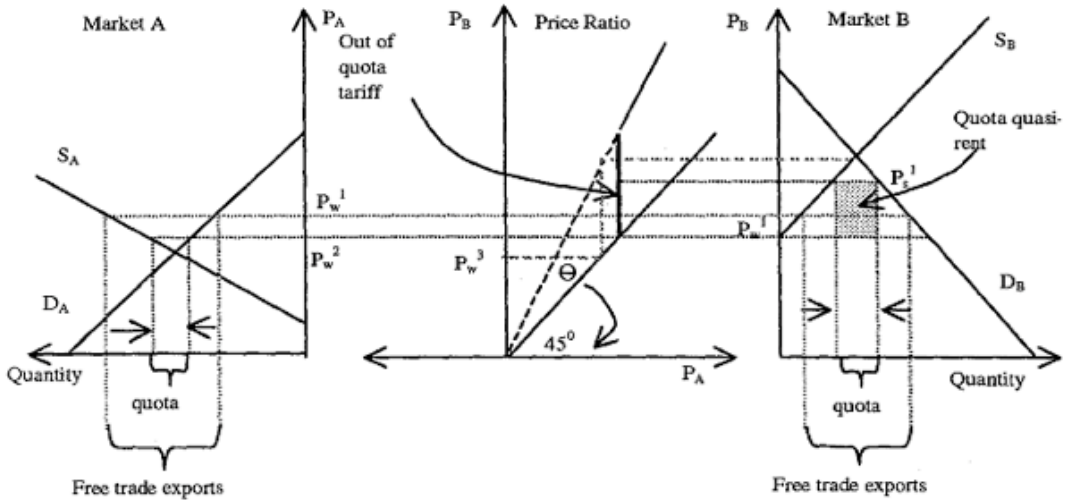
P_2 the world price in free international trade

P_1 the world price with quota

Q_1 and Q_4 are the quantities supplied and demanded in the domestic market in free trade

Q_2 and Q_3 are the quantities supplied and demanded in the domestic market with a quota

However, the effects of an import quota in a large market are not the same as the effects of a tariff. If a tariff is imposed by a large country, its possible effect is to decrease the world price of such a good. This leads to a rise in the support price which is less than if the tariff had been imposed by a small country. But an increase in volume of the domestic production is expected to be less than it otherwise would have been. The tariff therefore has a less distorting effect on resource allocation within the economy. This is the opposite case with a quota in that the effect of a quota is a decrease in the world price which has no feed back effects on the domestic market since they are prevented by the quota if it is effective.



Source: Tariffs and Steel: US safeguard Actions, Greenville J. (2005)

Figure 3.3: Tariff Rate Quota

where:

D_i is Demand in region i; where i = A,B;

S_i is Supply in region i, where i = A,B;

P_w is World price; and

P_s is Support price

In the case of Vietnamese rice, the Government has used the export quota to control the domestic price of rice. The result is that the consumption price index of food has increased not much over 10 per cent per year (except for an abnormal phenomenon in early 2008). Besides this goal, national food security is now of a lower order of importance. The Government has to continuously control the amount of rice exports in any one year based on the volume of the national rice-stock and an estimation of the next crops. In some periods of time, the rice contracts were frozen to ensure this goal even though the demand for Vietnamese rice was still very high.

The annual amount of rice exported is approximately 4.5 million tonnes accounting for about 16 per cent of the total world trade. This is a sufficiently large proportion to have effects on the world rice market in response to a significant change in the Vietnamese rice policy. According to many economists, if the export quota is removed in Vietnam, there should be a rise in export volume. If this restriction is released and replaced by an opportunity for more successful trade in the international market then an increase in exports could be expected. On the other hand, this could lead to an increase in the domestic rice price and vulnerability in relation to national food security

3.4.3. Price Controls Policy

Price Controls is the Government's tool to set maximum or minimum prices of specific products (Hugh Rockoff, 2008). Usually price controls are applied for prices of essential items. For example the apartment rent in New York city or the food price in Vietnam. The most significant application of price controls was on gasoline by Nixon and Carter during the period of 1970s. (Hugh Rockoff, 2008)

When Government set the minimum price for one product, then it is called as “Floor Price”. This price is greater than the equilibrium price. If not, Floor Price will be ineffective because the market already accepts at a higher price. The popular example is the minimum wage.

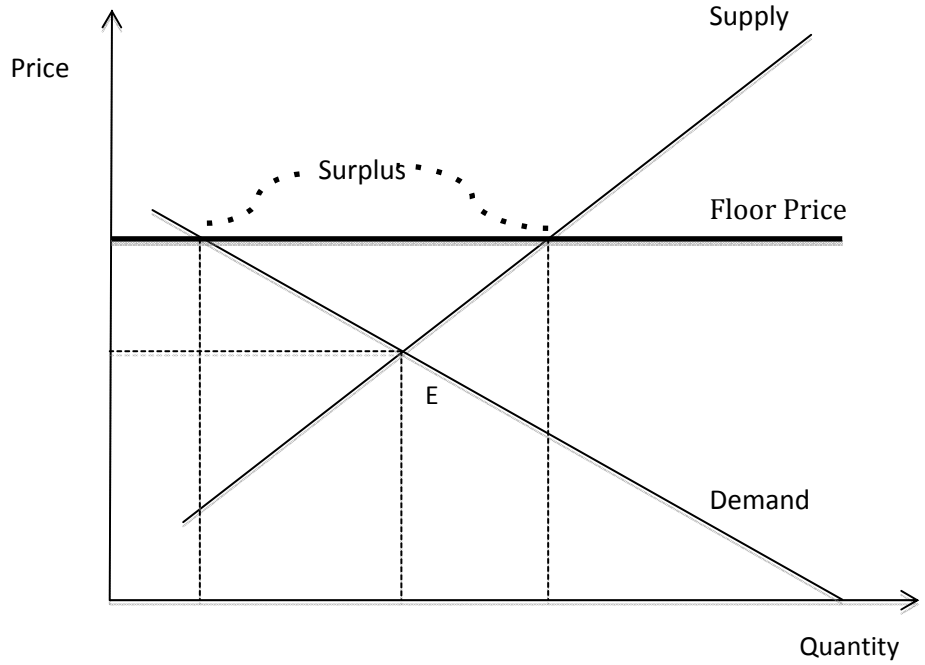


Figure 3.4: An effective Floor Price

The objective of Floor Price is to protect the producers and labour from the low market price (as can be seen in Figure 3.4). However they may fail to protect such a people and hurt others. For example, if the standard wage is increased, then the supply of labour will increase. This causes a higher cost in production, then the demand of labour will decrease. Following there will be a labour surplus in the market and a result is unemployment at the minimum wage. The best solution in this situation is to encourage the labour export to developed countries.

In the opposite way, when Government set the maximum price for one product, then it is called as “Ceiling Price". This price is smaller than the equilibrium price. If not, Ceiling Price is not effective because the market already accepts at the lower price. The popular example is the rent on house for low-income people.

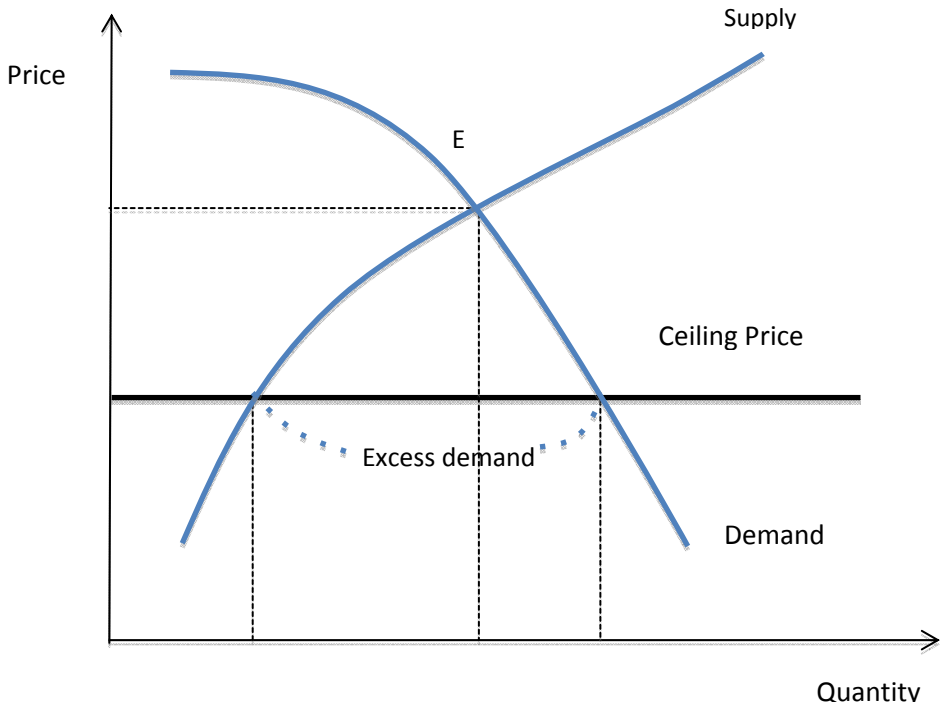


Figure 3.5: An effective Ceiling Price

The aim of Ceiling Price is to protect the consumers. However, the shortcoming of the policy is to raise the demand on such a product. In another hand, ceiling price take away the freedom in setting price strategy from enterprises. They lost initiatives one of the most important tools to run their business. Figure 3.5 shows that the ceiling price will lead to an increase in consumer surplus and a decrease in producer surplus.

In the market, supply and demand will find the equilibrium point by themselves. The equilibrium condition may be already effective but may not satisfy for everybodies. The Government will issues policies to re-arrange the market as their desire. Price Controls in

both ceiling price and floor price will be applied as the Government believe that the market price is unfair to buyers or to sellers.

Concluding Comments

Vietnam is commonly known as a country with a traditional rice culture and with a great number of advantages in rice production compared with other nations such as Indonesia, Philippines and some African nations. Taking this advantage to produce rice and sell it to the other markets who have no such advantage is a good strategy following the concept of comparative advantage. However in the modern life, one nation can not only compete based on absolute or comparative advantages but also the creation and assimilation of knowledge (Porter, 1990). In other words, this is the capacity of its industry in innovation and upgrade that called competitive advantages of the nation. Then, the basic of competition has shifted from absolute or comparative advantages that are natural endowments of a nation into competitive advantages or sustainable competitive advantages in a world of global competition (Porter, 1990)

In order to understand how Vietnamese rice can compete with others, we need to firstly understand its achievements in rice production and export over the recent period of 20 years which mentioned in the next chapter.

Chapter 4

CHARACTERISTICS OF THE VIETNAMESE RICE INDUSTRY

Vietnam's rice industry is characterized by favorable weather conditions, a multiple cropping capacity, labour-intensive practices and small-scale irrigated infrastructure with an innovative policy mechanism and a great potential for rice exports. The focus of this chapter is on a description of rice production as well as an analysis of the underlying reasons for the excellent performance in rice exports.

4.1. Policy and institutional environment

Prior to 1998, Vietnam was a net rice importer but in recent times has become the world's second largest rice exporter while at the same time meeting the domestic needs for rice. An acceptance is that Vietnam has become a rice export leader since 2012. Generally, the surplus is exported to foreign markets. The reason for this major shift was the timely reforms in Resolution 10 in 1988, the Land Law of 1993 and 2003 and other guidelines and policies promoting the development of agriculture, and especially the trend toward the sustainable development of rice associated with market demand.

4.1.1. Resolution 10[4] *and The Land Law*

A good example is Resolution 10, which was the context of the reforms in 1981. The key point was that the private ownership of farm assets was legalized and the cooperative land was leased to individual farmers. Household decision-making became the central decision point in the local economy following on from the contract system. Private sector trade in agricultural products was also legalized and promoted, thus expanding the scope

[4] Resolution 10-NQ/TW is about "Renovation in agricultural economic management" dated April 5th 1988, as known as Resolution "DOI MOI"

of agricultural markets. These changes created a remarkable set of incentives, which encourages farmers to raise production levels and the efficiency of farm production. As a result, there was a breakthrough increase in agricultural production as well as social and political stability.

This success has been partly attributed to the important innovation of the land laws. An expansion of the 1993 Land Law was made in the Land Law of 2003, which permitted the land ownership holders more freedom in transferring and agglomerating their land ownership. This resulted in greater autonomy for farmers in decision-making and further enhanced efficiency.

Recently, “land consolidation and re-location” plans are attracting attention from several parties. The objective of the plan is to to overcome the fragmentation of land parcels and create the larger scale plots. This will form the specialized areas towards commodity-purposed production. The program continues to be widely carried out in every provinces.

4.1.2. Resolution 09/2000

Additionally, Resolution 09/2000 on 15th June 2000, "Some guidelines and policies about transfer of economic structures and agro-product marketing ", contributed significantly to a growth in national rice production. This policy was a response to the situation of “supply exceeding demand” in both the domestic and international markets. As a result, there was a dramatic fall in food prices and thus reduced rice exports as a whole. Along with this policy, the Vietnamese Government gave compensation for loses in order to support rice export enterprises that had purchased paddy for their stock as the prices of rice became too low.

According to this resolution, there has been a rapid and widespread transfer from

planting crops to fruit, industrial crops and aquaculture with higher profits and away from low-yield and unstable rice crops. For example, dry crops were replaced by vegetable crops, lowland and coastal-land crops were replaced by aquaculture and the crops close to cities and towns were transferred to flower, fruit and vegetable crops. The results were that the cultivated areas, in 2001, decreased by 2,3% of the total area or 174 thousand hectares and rice output decreased by 1,3%, or an equivalent of 421 thousand tonnes compared with the values in 2000 (Ngo, 2006). The largest decrease was in the Mekong River Delta with 154 thousand hectares less in crops.

However, the goals for this resolution are that by 2012 about 4 million hectares are allocated for rice farming, with a target of 40 million tonnes of grain this being about 33 million tonnes of rice. Rice production is therefore focused on quality improvement rather than yield growth as in the previous years. From this, there has been a growth in rice export quantities and an improvement in quality leading to the position of Vietnam being the world's second largest rice exporter.

4.1.3. Policy on export quotas and taxes

Tax and quota on rice export are always the controversial issues in Vietnam. Rice is the main food providing a large proportion of calorie intake for more than 80 million Vietnamese peoples. The main task of rice industry, thus, is to meet the domestic demand before to be exported. National food security is then always one of the top concerns. The quota on rice is based on such an opinion in order to control the export volume and stable the domestic rice price.

However, there is an increase in produced rice paddy over year. Domestic markets and government stock are on saturation point. This raises marketing problems and puts a

pressure Vietnamese Government. Rice householders and businesses have much expectation on international markets. In other words, globe market is now considered as an only exit door to Vietnamese rice industry. Then among a number of remaining constraints is quota on export rice. Critics believe that Vietnam exports rice is under its potential. Therefore, the quota policy has not been officially applied to rice export.

Although it is not clear to see, quota policy still appears and disappears alternatively as another version in some legal documents. An example is Dispatch No. 1746/BCT-XNK, at Article 1, dated March 2008 to Vietnam Food Association (VFA) and other departments. Ministry of Industry and Trade offered an expected number of rice export volume which was 4 or 4.5 million tonnes, simultaneously, steered the Association in plan of rice export progress for each single quarter. For example, it was allowed to export 0.7 to 0.8 million tonnes in the first quarter or 1.3 to 1.5 million tonnes in the second quarter…

Beside the quota policy, Vietnamese government has also used tax-tool. However, effects of taxes on the rice industry are pretty faint and unclear. Tax is always seen as a macro tool to re-distribute the income among stakeholders in the given industry. Government may take some benefit through taxing on export enterprise in order to subsidize rice farmers. In spite of that, a flip side of a tax is to cause distortion and increase in transaction in black markets. Both those sides can be clearly seen in rice export taxes in 2008, when the global rice prices were a lot of volatile.

Specifically, the starting point of taxation applied for shipments valued $US600/tonne. The highest tax rate applied for shipments valued exceed $US1300/tonne. Specific tariffs in Article 1 of Decision No. 104/2008/QĐ-TTg on July 21, 2008 are shown in Table 4.1.

Table 4.1: Taxes on export rice 2008

Level	FOB price range (USD/ton)	Taxes (Thousand VND)	Taxes ($US)
1	600-700	500	26.4
2	700-800	600	31.7
3	800-900	800	42.3
4	900-1,000	1,200	63.4
5	1,000-1,100	1,500	79.3
6	1,100-1,200	1,900	100.4
7	1,200-1,300	2,300	121.6
8	More than 1,300	2,900	153.3

Source: *Decision 104/2008/QĐ-TTg*

Once Decision 104 was issued, one of the negative impacts was that rice traders maintain lower price to avoid export taxes. They put such a pressure on rice farmers. Farmers had to sell at lower price than it would be and the Government did not earn through taxation. Furthermore, rice markets were, at that time, pretty quiet with few transactions. In such a circumstance, only a few months later, VFA had recommendated to abolish those taxes for encouraging rice export. Another option proposed by VFA is to raise the starting point to be taxed to $US800/tonnes. Thus, in december 19, 2008, Ministry of Industry and Trade has officially announced to stop applying taxes on export rice.

4.1.4. Decree on rice export business (Decree 109)[5]

Among several legal documents that affect on the export of rice, Decree 109 has also attracted multivariate analysis for a long time. The Decree has into effect on January 1st 2011. Rice industry has became a strict required industry. Trade companies were forced

[5] Decree 109/2010/NĐ-CP on rice export business dated 04 November 2010 and come into effect from 1st January 2011.

to go into intensive investment on developing material fields, processing technology and upgrading their storehouse systems.

Vietnam has officially joined the World Trade Organization since January 2007 and become its 150th member. Following the WTO[6] roadmap, Vietnam has to improve market access for rice from 2011 and Decree 109 is a good preparation for Vietnamese rice industry.

Many rice experts believe that, the Decree will cause major changes in the rice market. The first is the restructuring of rice bussinesses who involved in exporting. The following is a good preparation for rice industry for reacting with foreign companies landing into Vietnamese market when it is opened in early 2011. This is an interesting point and also absolutely challenge for management activities.

There is three main criteria for rice trade companies in this Decree, namely:

Firstly, they are established and have a business registration under the provisions of law. **Secondly**, they have to own 01 specialized storehouse with a minimum capacity of 5,000 tonnes matching the standard issued by Ministry of Agriculture and Rural Development. **Thirdly**, they have to own at least 01 rice husking facility with the minimum capacity of 10 tonne per hour matching the standard issued by Ministry of Agriculture and Rural Development. In addition, rice traders must always maintain a minimum reserve that equals to 10 percent of amount of export rice in the previous six months. Rice export contracts must be registered with the VFA within three working days from the date the contract was signed.

Satisfying those requirements, a certificate of eligibility on rice export will be issued.

[6] World Trade Organization

However, prior October 1st 2011, the traders have no this certificate is still allowed to continue exporting rice. However, after that date, they will not be allowed to export rice.

According to VFA, until December 2011, there was 145 traders who have rights for rice exports. There was an increase in numbers of eligible traders by 153 until the first quarter of the year 2012. In spite of that only 100 traders have a certificate of eligibility in January 2013. Decree also identifies that Vietnam will maintain the maximum number of 100 rice exporters until 2015.

Many rice experts in Vietnam hold as an opinion that the Decree has contributed to revise and stablize rice export markets what are inherently complicated. The Decree is alo encouraging the cooperation among businesses to create the greater advatange in capital or rice husking facility or in storehouse. Another contribution of the Decree is to strongly filter and reject the weak and negative factors who are considered to cause chaos within rice export environment over the years.

Some others go into every detail of the Decree and suppose that only large companies and rice-mill factories will get the benefit with their own current facilities. Condition on the minimum rice stockpile (10 percent of the amount of export rice in the previous six months) causes a stagnancy in capital. Another problem is in the paddy procurement programme when the paddy price falls down in the markets. Almost all of visible benefit come to local brokers. The rice farmers still have to deal with the market price. These experts assume that the Decree also give VFA too much power in setting the paddy price and export rice price. This mechanism on price will be presented in the section on controlling on prices of paddy and rice.

4.1.5. Price Controls Policy

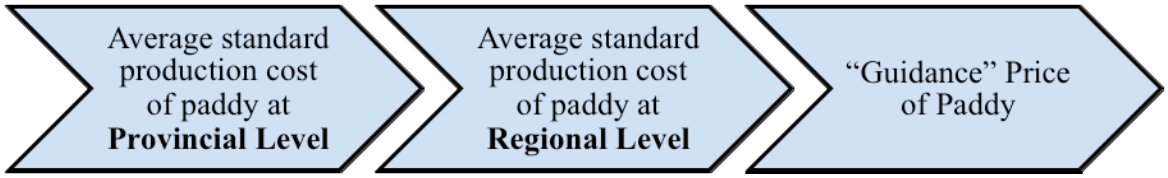
In addition to the above documents, a policy affecting the most frequent and direct to rice exports is Price Controls Policy. Based on the changes in the rice international markets, VFA may request to adjust the rice export prices known as Floor Prices of export rice or "Guidance" Prices of export rice. VFA will propose the method to determine prices following two guidelines. One is the correspondance to the changes in the rice domestic and worldwide markets. Another is the correspondance to "Guidance" Prices of paddy, the domestic prices of rice, the cost and benefit of rice traders.

In consequence of that, "Guidance" Prices of export rice are formed through two key basements. First is the production cost of paddy. Every single province will estimate the average standard production cost of paddy.

Second is the demand in the international markets. This is high competitive among rice suppliers. In the past few years, the return of India and Pakistan, the big rice exporters, results in a strong fluctuation in the rice markets due to their very low price. This cause a significant impacts on prices of Vietnam rice exports at the same categories of rice. VFA also put much attention on this factor to adjust the Vietnamese export price.

It should be added that, beside export "Guidance" Prices, the Government also set Floor Prices of paddy, also known as "Guidance" Prices. Methods of investigation and calculation of the production cost of commercial rice and paddy are detailed in [7]Circular 171. Three steps of determining paddy prices is shown in the Diagram 2.1.

[7] Circular 171/2010/TTLT-BTC-BNNPTNT dated November 11, 2010



Source: Compilation from Circular 171

Diagram 4.1: The process of determining "Guidance" Floor Price of paddy

The production cost is calculated for every single crop and at the beginning of the crops of rice. After ensuring a minimum profit of 30 percent production costs for rice farmers, the "Guidance" Prices of paddy are fixed. The Government will intervene in the rice supply chain when the market prices are lower than the "Guidance" Prices by proposing the paddy procurement program for temporary storage.

Theoretically, this programme aims to support the rice farmers when the prices of paddy are dropped. The demand will increase to push procurement prices. In reality, the rice farmers always complain that they can not access such a benefit in most cases. The most visible beneficiaries are local brokers. They are bridging the rice farmers, especially the small-scale rice farmers, and the export enterprises or husking units. The Floor Prices are applied at the factory's gate or the procurement points of the enterprises, where there is no appearance of rice farmers, but only transaction of export enterprises and local brokers. This issue will be continued analysing in the section of *production and business of rice exports*.

In terms of domestic consumer's side, one of the difficult Government's assignments is to

stabilize the prices of rice in the domestic markets. To cope with too high prices of rice, the Government issues a number of intervention policies such as asking the rice trades open their rice backlog, simultaneously, offering an offset to the costs caused.

4.1.6. Taskforce on Rice Export Management

Thanks to a huge influence of rice industry on national food security and international economics-political relationships, it has always been concerned from diffirent parties, especially Vietnamese Government. Ministry of Industry and Trade is directly monitoring the rice export activities and VFA and other Departments are responsible for supplementary supporting the Ministry. In addition, the Taskforce on Rice Export Management Task Force is formed to adjust the rice export management scheme.

In 2013, fifteen representatives of the Taskforce come from different related departments such as, Government's Office, Ministry of Agriculture and Rural Development, National Bank … and Vietnam Food Association as can be seen at Table 4.2

The Taskforce on rice export management has four main tasks which are (1) consulting and covering related issues of rice export; (2) closely watching changes in domestic and world rice markets in order to give measures on rice export management and make reports to the Prime Minister of Vietnam; (3) proposing the measures and policies relating to paddy rice production, marketing and export; (4) investigating, researching and exchanging the experience in the field of foodstuff and rice production, management and export

Table 4.2: List of members of the Taskforce on Rice Export Management

Representatives	Department	Assignment
Mr. Tran Tuan Anh	MOIT[8]	Team Leader
Mr. Phan Van Chinh	MOIT	Member
Ms. Duong Phuong Thao	MARD[9]	Permanent member
Mr. Le Hoang Tung	Government's Office	Member
Mr. Pham Dong Quang	MARD	Member
Ms Ho Phuong Chi	MPI[10]	Member
Mr. Ngo Minh Hai	MOF[11]	Member
Mr. Truong Thanh Phong	VFA	Member
Mr. Nguyen Loc An	MOIT	Member
Mr. Pham Trung Nghia	MOIT	Member
Mr. Tran Duy Dong	MOIT	Member
Ms. Dinh Thi Nuong	MOF	Member
Ms. Ha Thu Giang	State Bank of Vietnam	Member
Mr. Do Quoc Hung	MOIT	Member
Mr. Le Ba Luan	MOIT	Member

Source: Decision No. 6452/QĐ-BCT dated September 06, 2013

With above missions, the Taskforce has received great support from rice experts, who always expect adjustment in rice export management. Nevertheless, the Taskforce has not taken initiative in making decision and depend much on VFA.

4.2. Rice ecosystem

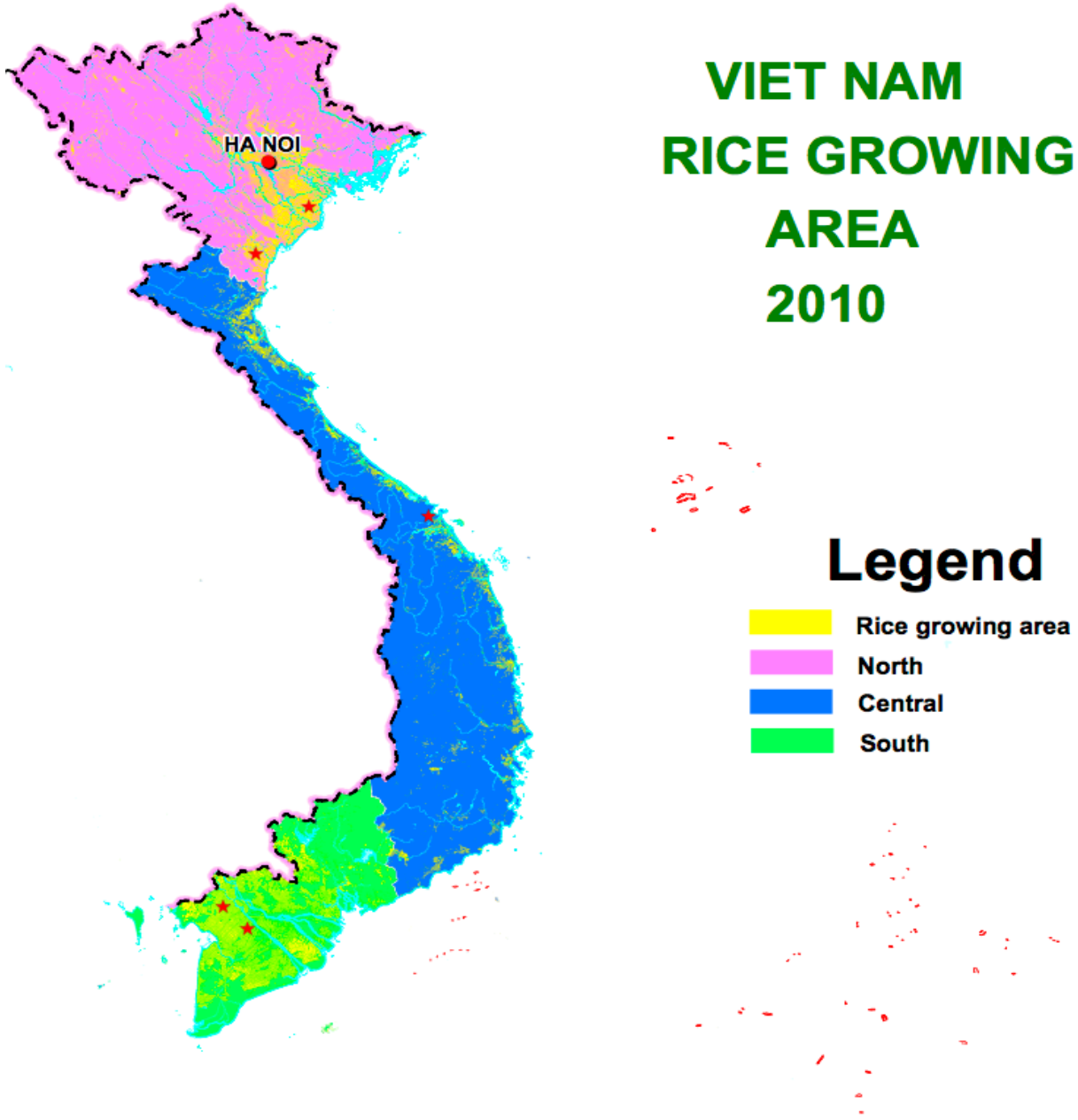
Of the total 33 million hectares of land in Vietnam, three quarters of this is made up of mountainous and hilly areas and the rest is the plain. Rice cultivation occurs in both

[8] Ministry of Industry and Trade of Vietnam
[9] Ministry of Agriculture and Rural Development
[10] Ministry of Planning and Investment
[11] Ministry of Finance

lowland and upland areas and in almost every ecological region across the country. However, the country can be divided into 3 major ecosystems. These are irrigated and intensive systems, rain fed and flood prone and upland areas. The irrigated ecosystem, that accounts for 80% of the cultivated area and is ideal for rice production, has the highest yields of 6 to 7 tonnes per hectare. Such regions lie mainly in the two deltas: the Mekong River delta in the south and Red River delta in the north. While the rain fed and flood prone ecosystem (9% of the total area) is mainly in the Mekong River Delta with floodwater depths of 30-100 cm, the upland ecosystem (11%) is in the Northern Upland and the Central Highlands with the total area of 0.45 million hectares (Bui, 2000). The annual statistics show that the total land allocation for rice is more than 4 million hectares in a total of 7 million hectares for agricultural land but due to multiple cropping, the rice-sown area reaches around 7.2 million hectares (GSO, 2010)

4.3. Weather and climate features

In terms of weather conditions, Vietnam is located in the tropical belt providing very good conditions for a diverse agriculture particularly rice production. In the North, there are four separate seasons including spring, summer, autumn and winter. This is also a cycle, which the Red river goes through providing the rich alluvial soils for crops. With a favourable climate and rich soils the conditions are excellent to develop two main rice crops and one other vegetable crop. In the South, there are only two main seasons, which are rainy and dry. The climate in the region is warm and humid all year round with ample sunshine. Another advantage of the area is the numerous river systems providing a great deal of water for agricultural plants. Particularly in this case, rice can be transplanted more than two times in one year.



Source: Compilation from GSOV

Figure 4.1**: Ecological map of Vietnam**

Temperature and climate condition have significantly affected the process of flowering, pollination of rice. If the temperature is too high or low, there will obstruct the opening of rice anthers. For that reason, crop timetable for rice is arranged in the different time for the different crops in respond to the appropriate temperature condition. This is mentioned in the provincial crop calendars which are completed by extension staff from

agricultural departments.

4.4. Cropping systems

Thanks to the favourable weather conditions combined with the farming practices, rice production can be cultivated in three forms of cropping. According to the Agricultural Census in 1994, there was 8.8% of triple crops, 55.2% of double crops and 36% of single crops out of the total paddy area (Minot and Goletti, 2000).

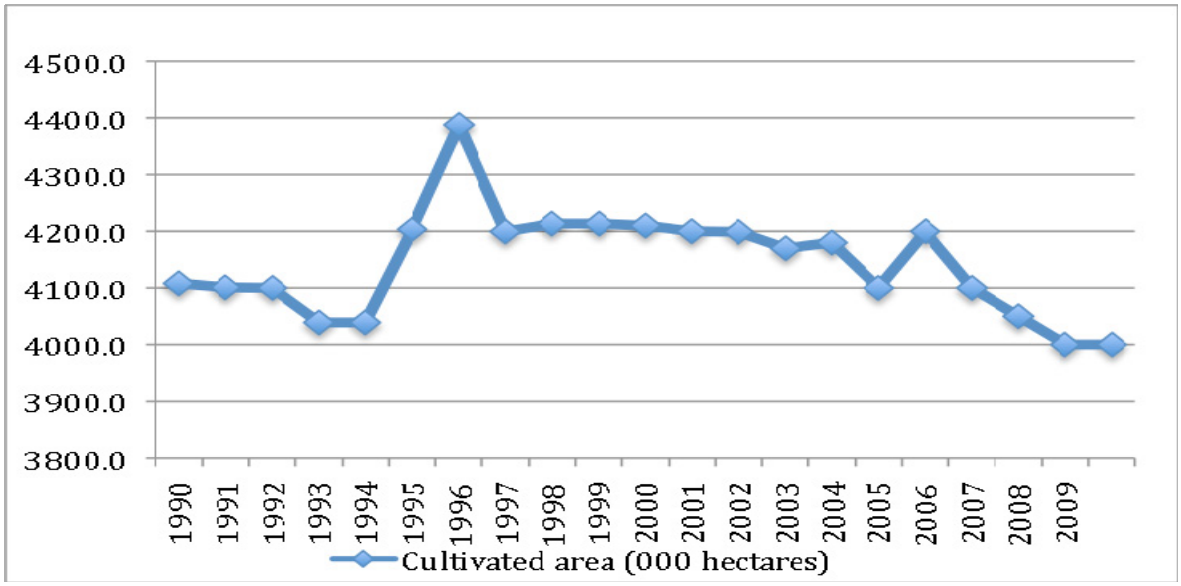
Double crops may involve one rainy season crop and one winter-spring crop in the river basins of the Red River Delta and the Mekong River Delta while single crops may be grown with a winter-spring harvest and usually in the upland areas in the Central Highlands and the Northern Uplands (largely populated by ethnic minority people).

Lowland rice is grown in the Mekong River Delta. Triple cropped rice is farmed in the rich soils of the irrigated and intensive ecosystem. The triple cropland is rotated at such a high level that there is no time for aerating the land so there is a resulting loss of fertility. In the long term, this contributes to more rapid soil erosion and the danger of insect disease development because of monoculture. As a result, the farmers try to use vegetables as rotational crops within rice crops to reduce these problems.

4.5. Rice production

Vietnamese rice production has the main characteristics of small-sized farms with non-contiguous cropland, labor-intensive farming practices, multiple cropping, widespread use of fertilizer and under-developed infrastructure such as the irrigation ditch and dike system. However, a numerous number of the impediments to development have been removed. In spite of the decreasing cultivated cropland (as seen in the Figure 4.2), there

is growing output and increased productivity. The annual average yield has been more than doubled with average yield in 1996 being 1.8 ton/ha and in 1980 has approached 3.9 ton/ha in 1997 (Kompas, 2004) with the result has been a 0.4% increase from 1976 to 1980, a 4.56% increase from 1981 to 1987, a 6.14% increase from 1988 to 1994 and a 5.72% increase from 1995 to 1999 (Kompas, 2004).



Source: General Statistics Office of Vietnam, 2010

Figure 4.2: Trend of rice cultivated area, 1990-2010

The long-term trend in rice production for the period of 1990-2010 is shown in Figure 4.2. This is no doubt that a dramatic fall in the cultivated area of rice is the consequence of new rural and urban development process. However, the Government has issued a lot of different policies to avoid the cropland reduce too quick. Maintaining 3.8 million hectares of rice cropland, of which 3.2 million hectares of double crops is the best measure to ensure the sustainability of national food security. This is what submitted to the Government by the Ministry of Agriculture and Rural Development.

For a developing country like Vietnam, these outstanding results of expansion in paddy production are mostly based on the adoption of new varieties, yield improvement and

crop intensity improvement rather than application of advanced machinery and technology into the production processes. In order to produce rice in Vietnam, a large amount of manual work is needed while in the other developed countries such as the United State, many kinds of machine are used to replace the labour-intensive practices. This can save time and labour units and also increases the labour productivity. What is more, it is not the same for different areas in Vietnam. In the South, particularly the Mekong River Delta there has been an opportunity to bring machinery into rice harvesting sooner than in the Red River Delta and in the mountainous areas where there is even less opportunity to use machinery than in the deltas.

Among the three main regions in Vietnam, including the South, Central and the North, only the South is a surplus area while the North and the Central regions are deficit regions although some parts of these areas are still surplus areas, such as the Red River Delta in the North. Therefore, the task in the South is to supply rice to other regions in the country.

Table 4.3: Area, yield and production of paddy in 2009

Region	Total area (1000 ha)	Agriculture land		Cultivated rice area		Rice production		Cropping intensity (time)	Sown paddy area (1000 ha)	Paddy yield (t/ha)
		Area (1000 ha)	% (of total area)	Area (1000 ha)	% (of agricultural land)	Volume (1000t)	Percent (of national output)			
North	11,555	2,453	21.2	1,156	47.1	6,877	27.5	1.60	1,850	3.72
Where RRD[12]	1,258	712	56.6	578	81.2	4,623	18.5	1.80	1,042	4.44
Central	15,254	1,844	12.1	818	44.4	4,320	17.3	1.68	1,373	3.15
South	6,295	3,610	57.3	2,229	61.7	13,767	55.1	1.59	3,543	3.89
Where MRD[13]	3,956	2,654	67.1	1,951	73.5	12,832	51.4	1.64	3,191	4.02
Total	33,104	7,907	23.9	4,203	53.2	24,964	100.0	1.61	6,766	3.69

[12] Red River Delta
[13] Mekong River Delta

Source: IFPRI, 2010

Table 4.3 represents the areas, yields and outputs in three regions in 2009. The cultivated areas of the Red River Delta accounted for 13.8% of the total areas for rice whereas that of the Mekong River Delta held 46.4% which was 3.38 times larger than that of the Red River Delta. However, the sown areas of the Mekong River Delta were 3.06 times larger than that of the Red River Delta. This is because cropping density and rice yield in the Red River Delta are higher than those in the Mekong River Delta. The rice production in the Mekong River Delta, finally, is just 2.78 times higher than those in Red river delta.

Table 4.4: Vietnamese paddy production from 1989-2009

Year	**Sown paddy area (1000 ha)**	**Yield (tonnes/ha)**	**Paddy (1000 tonnes)**
1989	5,895.8	3.22	18,996.3
1990	6,027.7	3.19	19,225.2
1991	6,302.7	3.11	19,621.9
1992	6,475.4	3.33	21,590.3
1993	6,559.4	3.48	22,386.6
1994	6,598.5	3.56	23,528.3
1995	6,765.6	3.69	24,963.7
1996	7,003.8	3.77	26,396.7
1997	7,099.7	3.88	27,523.9
1998	7,362.7	3.96	29,145.5
1999	7,653.6	4.10	31,393.8
2000	7,663.3	4.24	32,529.5
2001	7,484.6	4.27	31,970.5
2002	7,552.0	4.58	34,633.1
2003	7,452.2	4.64	34,568.4
2004	7,433.8	4.82	35,867.8
2005	7,458.0	4.80	35,600.0
2006	7,324.8	4.89	35,849.5
2007	7,207.4	4.99	35,942.7
2008	7,400.2	5.23	38,729.8

2009	7,440.1	5.23	38,895.5

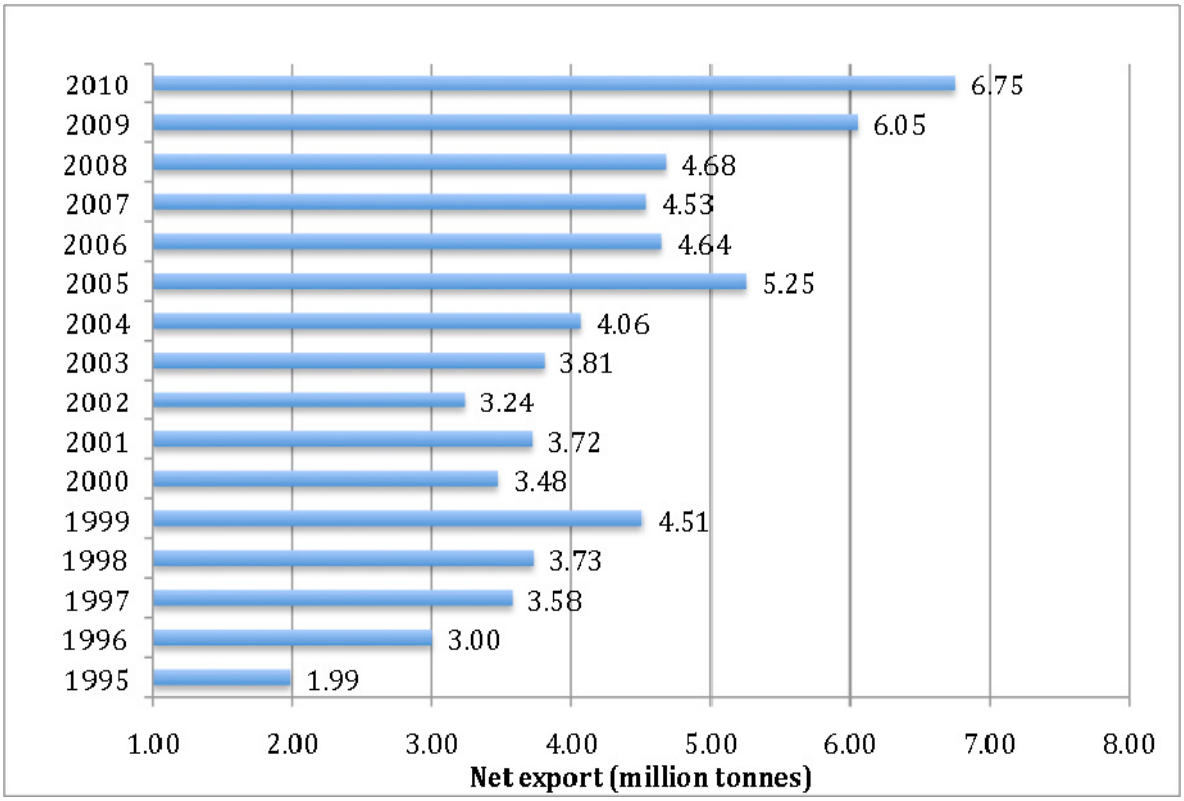
Source: General Statistical Office of Vietnam, 2010

In spite of a decrease in the cultivated area, the rice production has increased steadily over years as shown in Table 4.4. This is because of an increase in sown paddy area and paddy yield. According to GSOV (2010), the total rice production of Vietnam was approximately 40 million tonnes in 2009, doubled in the early years of decade 90.

Vietnam's rice production has been developing toward greater crop intensity, improvements in yield and in quality growth so as to ensure Vietnamese rice can compete in both internal and external markets. In 2005, while the cultivated areas decreased by 340 thousand hectares, equivalent to 4.4% less than in 2000, the rice production increased by 1.9% that year compared with 5.4% in the previous period (Ngo, 2006). Similarly, the speed of yield increase was 2.9%, not much higher than that in the period 1996 to 2000 (2.8%) but the remarkable outcome was an obvious rise in the quality of rice (Ngo, 2006).

4.6. Rice exports

At the present time, the average of Vietnamese rice export is about 4 million tonnes each year. The detailed annual volumes are indicated in Figure 4.3. The most significant results were in 2009 with the maximum volume of 5.95 million tonnes equivalent to value of $US 2.66 billion, followed by 2005 with 5.25 million tonnes and by 2006 with 4.69 million tonnes. There was an increasing trend in rice exports over the period of 1995-2000 and then considerable fall in 2000 because of a decrease in the overseas demands.



Source: General Statistical Office of Vietnam, 2010

Figure 4.3: The Vietnamese export rice volume from 1995-2010

The reforms allowing crop transfers occurred rapidly over the period 2001 and 2002 resulting in a large decrease in sown areas and in production. Since 2003, with adoption of new high productivity varieties, the production has continuously gone up providing good conditions for rice exports. However, the movement for "yield improvement at any cost" was replaced by a "quality improvement" from 2005 representing a large potential for increasing trade even further.

It can be seen in Table 4.5 that the exports fluctuated overall but remarkably increased from 2004 because of a rise in both export volumes and export prices. However, the highest export earnings is in 2010 with $3.2US billion, followed by nearly $2.9US billion in 2008. This is not a good sign because the price of export rice is increasingly going down. It

should be further noted that, in Vietnam, rice is well known as the top source of agricultural export earnings along with its value in providing for stable levels of food security.

Table 4.5: Export value and export prices in the period of 1995 – 2010

Year	Value (million $US)	Average export price ($US/tonne)
1995	530.0	267.0
1996	854.6	285.0
1997	875.6	245.0
1998	1024.0	273.0
1999	1025.1	227.0
2000	667.4	192.0
2001	625.0	167.6
2002	725.5	223.9
2003	720.5	188.9
2004	950.4	234.1
2005	1407.2	268.0
2006	1450.0	312.3
2007	1154.0	254.7
2008	**2894.0**	**618.5**
2009	2662.0	439.8
2010	**3212.0**	475.6

Source: General Statistical Office of Vietnam, 2010

Vietnamese rice markets are quite complicated with a large number of rice traders. While Thailand has over 20 rice export companies, Vietnam has had 262 companies prior 2009. After the introduction of the Decree 109, there is now 100 major rice exporter. They lie mainly in the Southern areas which is a rice surplus region, whereas some of them also import rice for animal and seed purposes and a small part for human consumption.

Table 4.6: Number of reliable rice export enterprises in 2012

Year	Number of enterprises
2008	19
2009	26
2010	32
2011	43
2012	45

Source: Ministry of Industry and Trade, accessed on 20.10.2013

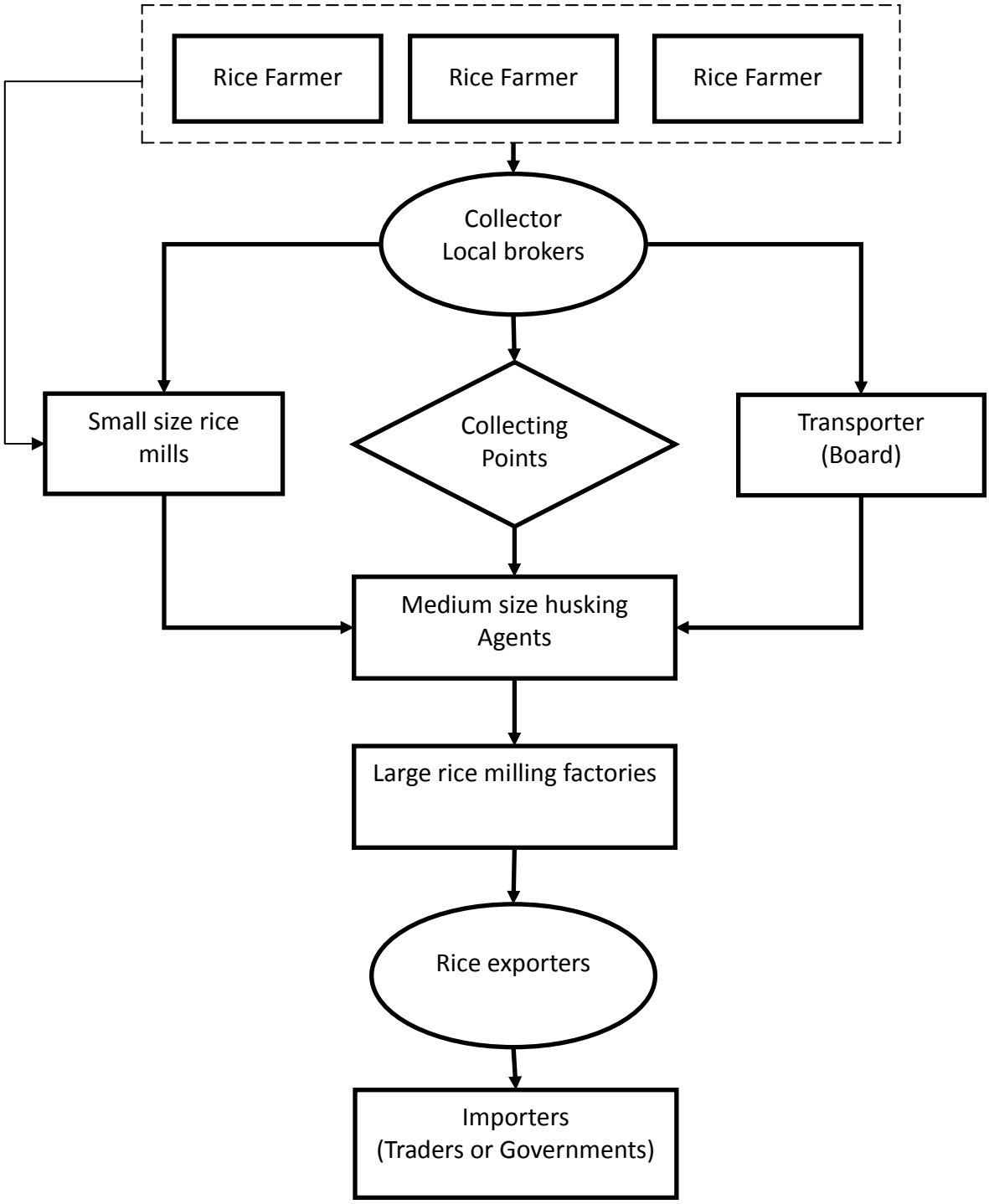
Based on the achievements and prestige of export enterprises, the Ministry of Industry and Trade annually suggests the list of reliable exporters for each industry. For the rice industry, there is an increase in the number of reliable rice traders over year as can be seen in Table 4.6. After two years the Decree 109 comes into effect, by 2012, the export companies have a focus on the investment in storehouse and husking milling. Thus the number of reliable enterprises reach 45 enterprises.

The names of such 45 export enterprises are presented in Table 1A in Appendix. There is only three of them from the Northern Vietnam and two of them from the Central Vietnam. Almost all of the suggested enterprises come from the Southern Vietnam where supplies more than 90 percent of total export.

While many people believe that the more export businesses the more competitive in the markets and the more effectively for the whole rice industry, the critics think that rice enterprises have pushed the prices of export down in order to scramble for export contracts.

They play two key roles at the same time. One is the rice seller when dealing with rice importer. The second role is the buyer when purchasing paddy from rice farmers. If they have to sell rice at the low prices, the they have to buy paddy at the low prices too. Ultimately, rice farmers is the last party surferring when the export prices of rice are. The following Diagram 4.2 will help us the better understand in export rice supply chain and the relationships among stakeholders in the industry.

As can be seen in Diagram 4.2, some of rice farmers can transport themselves to the small rice mills. They are also the transporters in the area or owning their small husking facilities. The remaining majority of rice farmers have to sell their paddy at the field or house to local brokers. The benefit of 30 percent of production cost from the Government's temporary storage scheme has always been shared to the local brokers. The behind reason is the week cooperation between enterprises and farmers. Historically, some companies have applied the "contract farming" for rice farmers but have been unsuccessful. When the market prices are higher than contract prices, farmers are willing to sell to others, or when oppositely, many enterprises incidently delay buying paddy in order to put pressure on lowing prices. Therefore, both of them can not build the long-term partnerships and the enterprises come back to the transporters and local broker for collecting paddy rice.

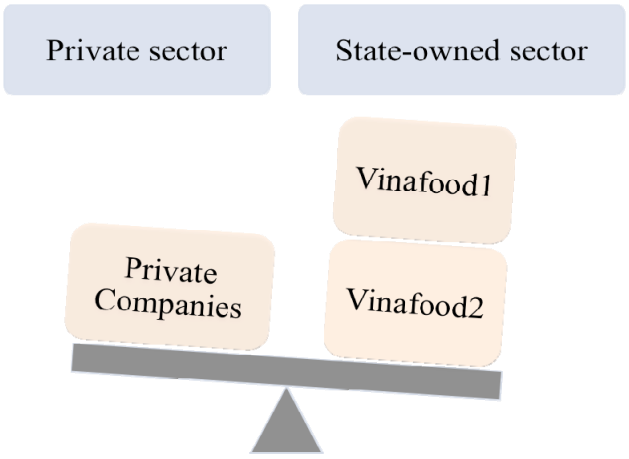


Source: Compilation from the fieldtrip, 2010

Diagram 4.2: Export Rice Supply Chain in MRD

In the past few years, the Government has intervened in the relationship in order to build the more professional business environment by offering the program named “large scale

field". The provincial agricultural department will be together with local businesses, farmers and input suppliers building a "*large scale field*" model. The farmer will buy input such as weeds and fertilizers from suppliers and sell their rice output to rice traders. This reflects the higher level of collaboration than that in "*contract farming*" model.



Source: Compilation from VFA database, 2010

Diagram 4.3: Relationship between private and state-owned sector in Vietnamese rice industry.

Another key point among rice exporters is that the important role of state-owned businesses. [14]Vinafood 1 and [15]Vinafood 2 are the two largest companies holding more than 50 percent of rice export value. Their rice contracts are almost between Vietnamese Government and another Government, namely G2G[16]. The private companies almost hold the commercial contracts with a small proportion. This relationship is outlined in Diagram 2.3.

In terms of rice categories and rice markets, Vietnamese rice exported is mainly as the broken rice 25% to the countries in Asia but there is a growing change to high-grade rice

[14] Vietnam Northern Food Corporation.
[15] Vietnam Sourthern Food Corporation.
[16] Government to Government Contract.

such as 5% of broken rice, glutinous rice and fragrant rice. Along with some traditional markets, such as, Japan, Indonesia and the Philippines, the new markets have extended to Korea, Iran, and some African nations. There has been a growing need for Vietnamese rice that is a good signal of market generating benefits for rice producers rather than rice importers. Given such a fact, the export price has been increasing and setting a new world record in 2011 which was more the doubled (153%) that of the corresponding period of the last year.

4.7. Advantages and disadvantages

4.7.1. Advantages

It is apparent that some of the advantages of producing rice in Vietnam are favourable weather, good quality land and the positive effects of the policy reforms. The significant reforms were the Resolution 10 in 1988, the Land Law in 2003 and the Decree 109 and some other guidelines and policies related to agriculture as well as the rice industry. There was an average rate of increase of 5.4% in rice output and an average of 14.78% in rice export volumes in the period 1996-2009 (GSO, 2010)

Furthermore, there are increasing demands for rice as a food in the world over years due to an increase in world population while the supply is always lower than the demand. Since 2011, Vietnam has a chance to penetrate into new potential markets and enjoy special privileges under WTO commitments. This is also an opportunity for Vietnam in conducting the further negotiation and seeking the potential export contracts.

The complicated changes of the weather patterns in some other major rice producing countries also leads to further opportunity for Vietnam spreading its markets. According to the FAO the current flood in October 2013 is damaging more than 13% of the rice area

in Thailand, 6% of that in the Philippines, 12% of that in Cambodian, 7.5% of that in Laos. This will reduce the numbers of rice supply, simultaneously, increase the demand of the rice import countries.

In addition, there is the pressure on grain prices from the use of corn and other grains, particularly in the United States for ethanol production. All of this suggests improved opportunities for other grain industries, such as rice, to take an increasing market share from wheat, particularly when consumers turn to use rice as a replacement.

Given the possibility of increasing rice consumption and also prices, Vietnam has been adopting new high-yielding varieties combined with implementing approaches for recovery of the native high quality varieties. The news from VietnamNet has reports of farmers having had good results for their winter-spring crops in the Mekong River Delta with traditional varieties, even in some areas where rice used to be planted, then land was then transferred to shrimp production and then returned to a rice crop in 2009. The rice outputs have nearly doubled with an average of 7.5 tonnes per hectare. Additionally, the program of "*large-scale field model*" has been promoted in the Mekong River Delta area and is contributing to an increased share of senior rice markets and also raising the level of rice's competition with that of Thailand who has a reputation for very high quality rice in the international markets.

4.7.2. Disadvantages

On the other hand, there are number of disadvantages reducing Vietnam's comparative advantage in rice production. There has been *a decline in both the cultivated area and the quality of cropland* used for rice production. In a few of the recent years, the reforms to agriculture have had cropping transfer to fruit and vegetable-crops and to aquaculture,

which has been more profitable. In addition to a considerable area of cropland transferred to other purposes (such as infrastructure transport and urbanization), the land for rice has also become comparatively less. Furthermore, the cropland is also nutrient exhausted due to over-cropping with crops grown and harvested more than two and three times per year. This problem is increasingly more serious in the Central Highlands and the Northern Uplands where it has become necessary to fallow again after a few harvests. This has caused a decrease in the rice cultivated area and then the rice supply. Currently, there is only around 4 million hectares of cultivated area and the Government plans to keep 3.8 million hectares until 2015.

With respect to rice trade policy, *export rice Price Controls* has been used as a strong regulatory tool to ensure the national food security and stabilize the domestic rice. But adjusting the export prices at many times in one year causes difficulties for the export companies. The policy has become a very restrictive tool that has strong effects in the development of the rice industry and the volume of rice export. The rice prices are kept artificial low, as a result, reducing motivation of rice farmers and then harming exports. Furthermore, the “guidance” prices of paddy can not really help farmers when the market prices are too low. Many critics believe that such policies has kept Vietnamese rice industry below its potential.

For the rice export companies*, there is a big risk in contract prices*. It is a requirement that the companies have to sign up rice contracts with the quantities and prices before harvesting. The performance of such contracts depends much on the weather and disease conditions so that it is uncertain if there will be a bumper or lean crop. In some cases, the enterprises have had to cancel contracts and suffer the cancellation fee while

others have complained that they had to suffer the export indemnification when the purchase price from individual farmers was 4,500 dong/kg, that is higher than the price in the signed contracts, and 4,300 dong/kg excluding the transportation cost.

Besides the policy issues, the *topography stretching from North to South Vietnam is a considerable obstacle* in shifting rice and this means there are high internal transportation costs from region to region, especially to the mountainous areas where there are usually rice deficit zones. Even the external transport costs are higher than for the same distance in Thailand.

Another difficulty is the high input prices for rice production. The inputs for rice production mainly fertilizer, fue and pesticide are derived from petroleum. These products must be imported from other countries. In other words, plants in general are dependent on imports and the input costs are pretty high due to adding the cost of distributareion and marketing. Especially, in many production areas in the North and Central income from rice production is almost enough to offset input costs. Thus the family labour cost is considered as the only benefit for rice farmers.

The weak brand reputation of Vietnamese rice and the poor marketing networks are also constraints which reduce the selling power and competitiveness of Vietnamese rice. The marketing of Thai rice provides a number of lessons for Vietnam and favours the building of a strong international brand for Hom Mali. This is not because Vietnam does not have good enough varieties of rice but that there is not sufficient investment of time and capital in the marketing activities. There are some major and famous Vietnamese rice brands, such as, Nang huong Cho Dao, Hong Hac, Chin Rong Vang, which are considered to be as high quality as Thai Jasmine, however, they would not be recognized by the

international rice consumers because of poor marketing activities. For the international markets, it is apparent that the Vietnamese rice is less competitive than Thai rice. Although Sohafarm is seen as the only international brand with an export purpose built by Song Hau state-farm, it is not really impressive and strong in the overseas markets. For the domestic markets, Vietnamese rice is also not presented in a sufficiently effective way. There is also evidence of "foreign name borrowing" in the Vietnamese markets. This is a quick method to promote and sell the Vietnamese high-grade rice with the Thai rice's name or Korean rice's name. Simultaneously, Vietnamese high quality rice is imported by Thai companies and then is polished and scented with the name of Thai rice, which is then exported to foreign countries.

Concluding remarks

Along with being endowed with a great number of favourable conditions, the policy changes that have been implemented in Vietnam are generally considered to have been a most significant factor having positive effects on the Vietnamese rice industry. Prior to 1988, this factor had held back the Vietnamese rice production with continuously lean harvests and severe famines. However, in response to market liberalization, the rice industry has rapidly recovered and significantly increased in production and value. Since then, rice production has been become the top source of export agro-products attracting considerable Government investment on infrastructure, the irrigation system, farming methods and research into cross-breeding and adoption of new high-yield rice varieties. There has also been private investment. Hence, the success of the reform is that Vietnam is now in the position of being the second largest rice exporter in terms of volume and in terms of export value is now ranked at third in the world.

While it is undisputable that the outcome gained is very impressive, many economists believe that Vietnam's rice industry should have been more successful if the Government controls less until removes the restriction of the rice export Price Controls Policy. Restriction of the rice price has caused a lower price for Vietnamese rice and this has been lower than Thai rice, or India rice and hence has partly reduced the competition of the Vietnamese rice in the international markets. Moreover, Vietnam has missed the chance to gain more foreign currency through exporting. In 2005, for instance, even though Vietnam exported the largest volume of 5.2 million tonnes, according to calculations of rice businesses there was a surplus of 1 million tonnes that could have been exported and this would still not harm the national food security.

Thus, in order to consider such a point of view as well as quantify the effect of Price Controls Policy, spatial equilibrium is applied. The expected result of the model will be presented in the chapter 5.

Chapter 5

APPLICATION OF SPATIAL EQUILIBRIUM MODEL ON RICE MARKETS

Spatial equilibrium model applied in this chapter was constructed so as to maximize the rice industry's revenue subject to the supply and demand balances, the supply and demand functions and the price arbitrage condition. Due to the objective function "net social revenue" contains quadratic terms leading to quadratic programming in basic solution algorithm. From the alternative values in the trade flows of the examined rice markets, we consider and analyze the trade competition of Vietnamese rice with Thai rice in the international rice markets.

Among the current policies directly and seriously impacting on rice export volume also the general benefit of Vietnamese rice industry, the Price Controls Policy from Vietnamese Government is the most controversial issue. Apart from a survey in rice businesses in 2010 as well as tracking on movement of graph of rice exports every month in the last few years, we are confident to build three assumptions about the link of level of the Government's intervention on rice price and export volume that are: (1) If the Government controlled on export rice price every week, then Vietnam would have exported 5 million tonnes; (2) If the Government controlled on export rice price every month, then Vietnam would have exported 6 million tonnes and; (3) If the Government controlled on export rice price every three months, then Vietnam would have exported 8.5 million tonnes or more. The third scenario shows that in such a situation, Vietnam can freely export as much as possible after meeting domestic consumption and preserving for the national food security.

There are five geographical regions added in the model that are the three main regions in Vietnam (North, South and Central) and two other regions (Thailand and Rest of the World)

The rice data used in the model is for the year 2010. A set of data for Vietnamese consumption, production and stocks is retrieved from various sources such as (1) the Ministry of Agriculture and Rural Development (MARD); (2) the General Statistical Office of Vietnam (GSOV); (3) Vietnam Food Association (VFA) and; (4) United State Department of Agriculture (USDA). The domestic Vietnamese rice price is calculated as an average of the daily price at seven local markets in the North, the Center and the South in 2010. Such data for Thailand and Rest of the World (R.O.W) were obtained from USDA and Food and Agricultural Organization (FAO). Transfer costs were assumed to be the difference among regional prices.

5.1. Input data

5.1.1. Rice production

Information on rice production in Vietnam is shown in Table 5.1. A conversion factor is used to convert rice from paddy and the total rice production is equal to the production plus stocks. Vietnam's rice production has rather a large share of the worldwide production. According to statistics of the General Statistic Office of Vietnam, the paddy production in 2010 was around 40 million tonnes, which is equivalent to 22 million tonnes of rice. After achieving self-sufficiency for its large population, Vietnam just exports a limited surplus that is just around 4.5 million tonnes per year during the period of 1990-2012 (VFA and GSOV, 2012)

Rice demand and supply of Vietnam in 2010 is firstly based on data from the General

Statistics Office of Vietnam. The rice production is converted from paddy production by the paddy-rice conversion rate of 55.5128%. Nevertheless, according to the United States Development of Agriculture, the Vietnamese rice supply, including the beginning stock was around 28 million tonnes. That number differs to the data from. Thus, in order to avoid the bias in building the model, the data of rice trade flows at the national level for Vietnam, Thailand and Rest of the World are collected from the same source that is USDA in 2010.

Table 5.1: Rice production by regions in Vietnam, 2010

Region	Paddy production (1000 t)	Conversion factor	Rice equivalent (1000t)	Proportion to USDA total	Adjusted production plus stocks (1000t)
North	9,884	0.5551	5,487	0.2472	6,882
Central	7,201	0.5551	3,998	0.1801	5,014
South	22,901	0.5551	12,713	0.5727	15,945
Vietnam in total	39,988	0.5551	22,198	1.0000	27,841

Source: GSOV and USDA, 2010

The data of rice trade flows in regional level in Vietnam are calculated based on the proportion to USDA total in Table 5.2.

Total supply of rice in each area consists of rice production, rice beginning stock and rice import. Similarly, total distribution is not only rice consumption for human and other purposes but also rice ending stock and rice export are included. South of Vietnam is the only one area that has nearly 8 million tonnes extra rice for exportation while in order to meet the regional consumption, North and Central of Vietnam have to import rice that is 503 thousand tonnes and 725 thousand tonnes, respectively

Table 5.2: Vietnamese regions balance sheet 2010[17]

Region	North	Central	South
Production plus stocks (1000t)	6,882	5,014	15,945
Import (1000t)	178	139	183
Total supply (1000t)	7,060	5,153	16,128
Export (1000t)	-325	-586	7,910
Total consumption (1000t)	6,905	5,390	7,106
Ending stock (1000t)	480	350	1,112
Consumption plus stocks (1000t)	7,385	5,739	8,217
Total distribution (1000t)	7,060	5,153	16,128
Adjusted net trade (1000t)	-503	-725	7,727
Population in 2010 (mil. people)	30.9	24.2	31.8

Source: Derived from USDA and GSOV, 2010

While table 5.2 shows the rice trade flows of three Vietnamese regions, table 5.3 shows that of Vietnam in total, Thailand, rest of the world and the world in total. Although, The rice production from Thailand and Vietnam is not large, only 10.4% of the total production in the world, they hold the a big role in the international markets. Nearly 54% of export volume is come from Vietnam and Thailand.

It is noticed that exports for the world do not equal imports because of the shipping. The amount of 2,129 thousand tonnes has been added to the ending stocks and exports were reduced by 2,129 thousand tonnes.

[17] Notes:
1. The Vietnamese total consumption was distributed according to the population of the regions.
2. The total imports to Vietnam were distributed to the regions in proportion to the consumption since they were small, any errors will be small.
3. The exports for the Vietnamese regions were calculated from the total supply minus the total consumption minus the ending stock.

Table 5.3: Country balance sheet 2010

	Vietnam	Thailand	R.O.W	World total
Beginning stocks (1000t)	1,470	6,100	87,602	95,172
Production milled basis (1000t)	26,371	20,262	402,733	449,366
Production plus stocks (1000t)	27,841	26,362	490,335	544,538
Import (1000t)	500	200	32,012	32,712
Total supply (1000t)	28,341	26,562	522,347	577,250
Export (1000t)	7,000	10,647	15,065	32,712
Total consumption (1000t)	19,400	10,300	414,119	443,819
Ending stock (1000t)	1,941	5,615	93,163	100,719
Consumption plus stocks (1000t)	21,341	15,915	507,282	544,538
Total distribution (1000t)	28,341	26,562	522,347	577,250
Adjusted net trade (1000t)	6,500	10,447	-16,947	0
Population in 2010 (mil. persons)	87	-	-	-
Per capita consumption (kg/person)	223	-	-	-

Source: Derived USDA and GSOV, 2010

In the progressively more competitive rice market, Vietnam and Thailand are the two first rice exporters who could compete with each other in both the inferior and superior types of rice. Thailand had more advantages in the high-class markets in the past due to a better capacity in high quality rice production. However, Vietnam has recently redirected to produce high-quality rice towards to a long-term development strategy of Vietnam. Thus, Vietnam has been facing a strong competition from Thailand who already had a long business relationship in the traditional high-end rice markets.

5.1.2. Rice price

Table 5.4 shows the domestic price of rice in five different regions. Prices in three regions of Vietnam used in the model are the average retail prices from local markets daily

collected by the Ministry of Agriculture and Rural Development of Vietnam.

The price for Thai rice is the average price of 25 percent broken rice and A1 superior white rice.

The largest importers of Vietnamese rice in 2010 were Philippines, Singapore and Indonesia who have bought 2.3million tones. This is accounting for about 30.2% of the Vietnamese export rice (VFA, 2010), assuming that all of Vietnamese export rice were flowing to such markets. The price for the rest of the world is assumed to be the average of price for the three above mentioned importers.

The currency used in the paper were converted into Vietnam Dong (VND) and the foreign exchange rate at that time was assumed to be $1USD = 18,920.05 VND and 1 Thai Baht = 600.34 VND assessed to www.gocurrency.com for the average value.

Table 5.4: Rice balance Sheet and Prices, 2010

	Supply (1000t)	**Consumption (1000t)**	**Surplus/Deficit (1000t)**	**Prices (VND/kg)**
Northern Vietnam	6,882	7,385	-503	9,535.10
Central Vietnam	5,014	5,739	-725	8,964.10
Southern Vietnam	15,945	8,217	7,727	8,442.90
Thailand	26,362	15,915	10,447	8,395.10
Rest of the World	490,335	507,282	-16,947	8,813.00
Totals	544,538	544,538	0	

Source: Compilation from various sources (USDA, MARD, VFA, VGOS…)

The regional patterns of rice trade in 2010 are also presented in Table 5.4. The Central region in Vietnam was the most deficit region with a demand of 725 million tonnes, followed by a demand of 503 thousand tonnes in the North. This amount needed to be

moved from the South as it was the only surplus region in Vietnam. While nearly 8.22 million tonnes was saved for the own regional consumers, the South was able to supply about 7.7 million tonnes into other domestic markets and foreign markets. Due to high cost of production such as the input expenditure and labour cost, the domestic price in the North is always the highest price in Vietnam. In 2010, it reached 9,535.1 VND/kg that was much higher than in the South which was 8,442.9VND/kg. This also reflects transportation costs added into the price of rice in the North.

Thailand was able to trade more than 10 million tonnes of rice in 2010 with the price of (8,395VND/kg).

5.1.3. Elasticity and supply and demand functions

There were several comprehensive studies of food elasticities in general and the demand and supply elasticities of Vietnamese rice in particular by several different approaches. Haughton et al (2004) apply a double-log specification, whereas Benjamin and Brandt (2004) apply the Engel curve estimation. Linh Vu Hoang (2009) and Minot and Goletti (2000) apply the *Almost Ideal Demand System* functional form. Due to differences in specification, those estimates show are wide variation. In the study of Haughton et al (2004), Vietnamese rice has the mean expenditure elasticity of 0.09 and the own-price elasticity of -0.42. According to Linh Vu Hoang, the mean rice's expenditure elasticity is 0.36 and the rice's own-price elasticity is -0.8.

However, elasticities differ also in the regional areas in Vietnam. Minot and Goletti (2000) have calculated 0.48 and 0.11 for the rice's expenditure elasticity for the North and the South respectively while the rice's own-price elasticity are -0.2 for the North and -0.38 for the South. Moreover, Benjamin and Brandt pointed that there is a difference between

rural and urban areas in both North and South Vietnam. In Northern Vietnam, the rice's expenditure elasticities are 0.49 for the urban area and 0.64 for the rural area. In the South of Vietnam, it is similar by 0.41 and 0.63 for the urban and rural area, respectively.

In this paper, which is sown in Table 5.5, the elasticities of demand and supply in each Vietnamese region were derived from Linh Vu Hoang (2009). The elasticities for Thai rice were adopted from the work of Vanichjakvong (2002) whereas those for the Rest of the World were obtained from Luu (2007).

Table 5.5: Sources of elasticities

Region		Elasticity	Sources
Northern Vietnam	Supply	0.22	Linh Vu Hoang (2009)
	Demand	-0.80	Linh Vu Hoang (2009)
Central Vietnam	Supply	0.31	Linh Vu Hoang (2009)
	Demand	-0.90	Linh Vu Hoang (2009)
Southern Vietnam	Supply	0.39	Linh Vu Hoang (2009)
	Demand	-0.81	Linh Vu Hoang (2009)
Thailand	Supply	0.26	Vanichjiakvong (2002)
	Demand	-0.64	Vanichjiakvong (2002)
R.O.W	Supply	0.20	Luu (2007)
	Demand	-0.90	Luu (2007)

Source: Compilation from several sources

Intercepts and slopes of the supply and demand functions can be calculated if information on elasticities, rice prices and supplied and demanded quantities are known. Simultaneously, the supply and demand functions for rice for the three regions of Vietnam, Thailand and the rest of the world are built as can be seen in Table 5.6 and the following formulas.

Table 5.6: Intercepts and slopes of supply and demand equations

	Elasticity	Price (VND/tonnes)	Quantity	Intercept	Slope
Northern Vietnam					
Supply	0.22	9,535	6,881.85	-33,806.30	6.30
Demand	-0.80	9,535	7,384.63	21,454.00	-1.61
Central Vietnam					
Supply	0.31	8,964	5,013.86	-19,952.28	5.77
Demand	-0.90	8,964	5,739.14	18,924.15	-1.74
Southern Vietnam					
Supply	0.39	8,443	15,944.52	-13,205.56	1.36
Demand	-0.81	8,443	8,217.18	18,866.23	-1.27
Thailand					
Supply	0.26	8,395	26,362.00	-23,893.80	1.22
Demand	-0.64	8,395	15,915.00	21,512.50	-0.82
Rest of the world					
Supply	0.20	8,813	490,335.00	-35,251.88	0.09
Demand	-0.90	8,813	507,282.00	18,605.16	-0.02

Source: General Statistical Office of Vietnam, USDA, 2010

The intercepts for the indirect form of the supply and demand functions are derived from the equation:

(5.1) Intercept $= -\frac{a}{b} = \bar{p}\left(1 - \frac{1}{e}\right)$

where a is the intercept,

b is the slope,

e is the elasticity and

p is the price and y is the quantity.

The slopes for the indirect form of the supply and demand functions are derived from the equation:

(5.2) Slope = $\frac{1}{b} = \frac{\bar{p}}{e\bar{y}}$

The indirect form of the demand and supply functions is:

(5.3)P = - $\frac{a}{b} + \frac{1}{b}$ Y

The estimates in Table 5.5 can be interpreted for each region as showed below:

In the North: $P_{S1} = -33{,}806.30 + 6.30\ Y_{S1}$

$P_{D1} = 21{,}454 - 1.61\ Y_{D1}$

In the Central: $P_{S2} = -19{,}952.28 + 5.77\ Y_{S2}$

$P_{D2} = 18{,}924.15 - 1.74\ Y_{D2}$

In the South: $P_{S3} = -13{,}205.56 + 1.36\ Y_{S3}$

$P_{D3} = 18{,}866.23 - 1.27\ Y_{D3}$

In Thailand $P_{S4} = -23{,}893.80 + 1.22\ Y_{S4}$

$P_{D4} = 21{,}512.50 - 0.82\ Y_{D4}$

In the rest of the world: $P_{S5} = -35{,}251.88 + 0.09\ Y_{S5}$

$P_{D5} = 18{,}605.16 - 0.02\ Y_{D5}$

Where:

e: elasticities of demand and supply functions

Y_{S1}: the supplies responding to the prices in the North

Y_{S2}: the supplies responding to the prices in the Central

Y_{S3}: the supplies responding to the prices in the South

Y_{S4}: the supplies responding to the prices in Thailand

Y_{S5}: the supplies responding to the prices in the rest of the world

Y_{D1}: the demands responding to the prices in the North

Y_{D2}: the demands responding to the prices in the Central

Y_{S3}: the demands responding to the prices in the South

Y_{S4}: the demands responding to the prices in Thailand

Y_{S5}: the demands responding to the prices in the rest of the world

P_{S1}: the supply prices in the North

P_{S2}: the supply prices in the Central

P_{S3}: the supply prices in the South

P_{S4}: the supply prices in Thailand

P_{S5}: the supply prices in the rest of the world

P_{D1}: the demand prices in the North

P_{D2}: the demand prices in the Central

P_{D3}: the demand prices in the South

P_{D4}: the demand prices in Thailand

P_{D5}: the demand prices in the rest of the world

5.1.4. Transfer cost

In this study, the transfer costs from region to region are estimated as the differences among the regional prices for rice. Such data are implicitly considered as positive values because of the assumption that the cost of moving rice from market 1, e.g. the South, to market 2, e.g. the Central region, is equal to the cost to do so in either direction. Therefore, the transfer cost can be derived as the Table 5.7

Table 5.7: Transfer cost matrix among the regions - unit: VND/kg

Region	North	Central	South	Thailand	R.O.W
North	0	571	1,092	1,140	722
Central	571	0	521	569	151
South	1,092	521	0	48	370
Thailand	1,140	569	48	0	368
R.O.W	722	151	370	368	0

Source: GSOV and USDA, 2010.

In fact, due to stretching in topography from North to South, the transportation cost of rice shipments is very high in Vietnam, relatively to other Southeast Asian ports. "A shipment of 10,000 tonnes out of Saigon port could easily cost about $40,000 in various dues, while the same shipment would cost about $20,000 in Thailand. The premium that Bangkok rice prices have on Vietnam prices are partly a reflection of this higher transportation cost" (Goletti and Minot, 1997)

5.2. Model of Base Scenario in 2010

The objective function is to maximize the net social revenue and is subject to a set of constraints as given below.

Max $f(Y, X, DP, SP, Q_l) = Y P_y - X P_x - T'X$

Or Min $f(Y, X, DP, SP, Q_l) = - Y P_y - X P_x + T'X$

Or Min $f(Y, X, DP, SP, Q_l) =$

$$
\begin{aligned}
&- 21{,}454\, Y_1 \quad - 18{,}924\, Y_2 \quad - 18{,}866\, Y_3 \quad - 21{,}512\, Y_4 \quad - 18{,}605\, Y_5 \\
&- 33{,}806\, X_1 \quad - 19{,}952\, X_2 \quad - 13{,}206\, X_3 \quad - 23{,}894\, X_4 \quad - 35{,}252\, X_5 \\
&+ 571\, X_{12} \quad + 1{,}092\, X_{13} \quad + 1{,}140\, X_{14} \quad + 722\, X_{15} \\
&+ 571\, X_{21} \quad + 521\, X_{23} \quad + 569\, X_{24} \quad + 151\, X_{25} \\
&+ 1{,}092\, X_{31} \quad + 521\, X_{32} \quad + 48\, X_{34} \quad + 370\, X_{35} \\
&+ 1{,}140\, X_{41} \quad + 569\, X_{42} \quad + 48\, X_{43} \quad + 368\, X_{45} \\
&+ 722\, X_{51} \quad + 151\, X_{52} \quad + 370\, X_{53} \quad + 368\, X_{54} \quad + 5{,}000\, Q_l
\end{aligned}
$$

Subject to:

$-1.614\ Y_1 - DP_1 <= -21{,}454$(1)

$-1.735\ Y_2 - DP_2 <= -18{,}924$(2)

$-1.268\ Y_3 - DP_3 <= -18{,}866$(3)

$-0.8242\ Y_4 - DP_4 <= -21{,}512$(4)

$-0.019\ Y_5 - DP_5 <= -18{,}605$(5)

$-6.298\ X_1 + SP_1 <= -33{,}806$(6)

$-5.767\ X_2 + SP_2 <= -19{,}952$(7)

$-1.358\ X_3 + SP_3 <= -13{,}206$(8)

$-1.225\ X_4 + SP_4 <= -23{,}894$(9)

$-0.090\ X_5 + SP_5 <= -35{,}252$(10)

$DP1 - SP_1 <= 0$(11)

$DP2 - SP_1 <= 571$(12)

$DP3 - SP_1 <= 1{,}092$(13)

$DP4 - SP_1 <= 1{,}140$(14)

$DP5 - SP_1 - Q_l <= 722$ (15)

$DP1 - SP_2 <= 571$(16)

$DP2 - SP_2 <= 0$(17)

$DP3 - SP_2 <= 521$(18)

$DP4 - SP_2 <= 569$(19)

$DP5 - SP_2 - Q_l <= 151$ (20)

$DP1 - SP_3 <= 1{,}092$ (21)

$DP2 - SP_3 <= 521$ (22)

$DP3 - SP_3 <= 0$ (23)

$DP4 - SP_3 <= 48$ (24)

$DP5 - SP_3 - Q_l <= 370$ (25)

$DP1 - SP_4 <= 1{,}140$ (26)

$DP2 - SP_4 <= 569$ (27)

$DP3 - SP_4 <= 40$ (28)

$DP4 - SP_4 <= 0$ (29)

$DP5 - SP_4 <= 368$ (30)

$DP1 - SP_5 <= 722$ (31)

$DP2 - SP_5 <= 151$ (32)

$DP3 - SP_5 <= 370$ (33)

$DP4 - SP_5 <= 368$ (34)

$DP5 - SP_5 <= 0$ (35)

$Y_1 - X_{11} - X_{21} - X_{31} - X_{41} - X_{51} <= 0$ (36)

$Y_2 - X_{12} - X_{22} - X_{32} - X_{42} - X_{52} <= 0$ (37)

$Y_3 - X_{13} - X_{23} - X_{33} - X_{43} - X_{53} <= 0$ (38)

$Y_4 - X_{14} - X_{24} - X_{34} - X_{44} - X_{54} <= 0$ (39)

$Y_5 - X_{15} - X_{25} - X_{35} - X_{45} - X_{55} <= 0$ (40)

$-X_1 + X_{11} + X_{12} + X_{13} + X_{14} + X_{15} <= 0$ (41)

$-X_2 + X_{21} + X_{22} + X_{23} + X_{24} + X_{25} <= 0$ (42)

$-X_3 + X_{31} + X_{32} + X_{33} + X_{34} + X_{35} <= 0$ (43)

$-X_4 + X_{41} + X_{42} + X_{43} + X_{44} + X_{45} <= 0$ (44)

$-X_5 + X_{51} + X_{52} + X_{53} + X_{54} + X_{55} <= 0$ (45)

$X_{15} + X_{25} + X_{35} <= 5{,}000$ or $6{,}000$ or $8{,}500$ (46)

All variables >=0 (47)

Where

(1) Demand function in the North must hold (by its intercept)

(2) Demand function in the Central must hold

(3) Demand function in the South must hold

(4) Demand function in Thailand must hold

(5) Demand function in the rest of the world must hold

(6) Supply function in the North must hold

(7) Supply function in the Central must hold

(8) Supply function in the South must hold

(9) Supply function in Thailand must hold

(10) Supply function in the rest of the world must hold

(11) Transport equilibrium within the North (transfer cost = 0)

(12), (13), (14) Transport equilibrium to the North from the Central, the South and Thailand, respectively

(15) Transport equilibrium to the North from the rest of the world taking into account the shadow price of the policy

(16), (17), (18), (19) Transport equilibrium to the Central from the North, the Central, the South and Thailand respectively

(20) Transport equilibrium in the Central from the rest of the world taking into account the shadow price of the policy

(21), (22), (23), (24) Transport equilibrium to the South from the North, the Central, the South and Thailand respectively

(25) Transport equilibrium in the South from the rest of the world taking into account the shadow price of the policy

(26), (27), (28), (29), (30) Transport equilibrium to Thailand from the North, the Central, the South, Thailand and the rest of the world respectively

(31), (32), (33), (34), (35) Transport equilibrium to the rest of the world from the North, the Central, the South, Thailand and the rest of the world respectively

(36) The demand does not exceed the total of in-shipments in the North

(37) The demand does not exceed the total of in-shipments in the Central

(38) The demand does not exceed the total of in-shipments in the South

(39) The demand does not exceed the total of in-shipments in the Thailand

(40) The demand does not exceed the total of in-shipments in the rest of the world

(41) The total of out-shipments does not exceed the supply in the North

(42) The total of out-shipments does not exceed the supply in the Central

(43) The total of out-shipments does not exceed the supply in the South

(44) The total of out-shipments does not exceed the supply in the Thailand

(45) The total of out-shipments does not exceed the supply in the rest of the world

(46) The exports from the North, the Central and the South are subject to the export volume of Vietnam

5.3. Results

With known production, consumption, domestic price, transportation cost and elasticities of demand and supply function of the Vietnamese and the Thai rice industry, the model was solved by SOLVER in MS Excel.

Currently, Vietnamese government has no longer used quota and tariff policy in order to control its rice industry instead of Price Controls. This policy is necessary to strictly manage rice production, the key sector of Vietnam who heavily depends on agricultural

products. The export price will be offered at a given time in order to regulate the competition. The purpose is to protect the industry from price dumping or unfair competition that would harm the industry as a whole in a short term. Another purpose of this policy is to ensure the national food security for Vietnamese residents.

However, in our survey in 2010, when we asked about the effects of Price Controls Policy, 10 of the 14 enterprises strongly agreed that the policy with high intensity, 2 times per week at the time of March 2010, has led to many obstacles in export contracts seeking harming both businesses and farmers. This has given a rise in underground economy causing illegal cash-flows and market distortion and weakening the Vietnamese rice competition in the global market. The official export volume, in turn, was still under its potential. The remaining respondents who had a neutral idea about the policy are state companies while the former interviewees are state companies. Thus, a raising question is how often should the price of rice be controlled to get a maximization of net social revenue.

Based on (1) the search for achievements and shortcomings of the Vietnamese rice industry during the period of 10 years from 2000 to 2010; (2) the opinion of the rice export enterprises and our observations through the fieldtrip in the end of the year 2010, the authors have boldly given three hypotheses showing the relationship between the Vietnamese rice Price Controls Policy and the corresponding of export volume as follows:

(1) Export price changed every week; corresponding export volume is 5 million tonnes;

(2) Export price changed every month; corresponding export volume is 6 million tonnes;

(3) Export price changed every three months; corresponding export volume is 8.5 million

tonnes or more.

Three experiments were implemented by adjusting the Vietnamese rice export volume to 5 million tonnes, 6 million tonnes and 8.5 million tonnes to represent the alternative situations.

The expected results are the values of the endogenous variables reflecting the market equilibrium such as supplies, demands, trade flows, prices, optimal regional shipments and export volumes.

It is important to realize that these results are not predictions for rice production as a whole, but in order to predict there is a need to combine other factors such as policies of other countries, global economic context, the weather conditions, infrastructure and the other crops. The simulations are therefore designed to show the effects of a change in the export volume if all other factors were held constant and to examine consequences for the endogenous variables within the model.

5.3.1. Impact of Price Controls in every week and every month

(Corresponding to an export volume of 5 and 6 million tonnes)

The overall impacts of the policy on rice production are shown in Table 5.8. The revenue for Vietnamese producers is about 240 billion VND, 20.5 billion VND higher than the revenue for Thai producers. Since the rice production in the three regions of Vietnam (27.8 million tonnes) is greater than that in Thailand (26.4 million tonnes). There is not much change in both Vietnamese and Thai rice price. However, the rice surplus of Vietnam is just 6.4 million tonnes, which is much less than that of Thailand with 10.6 million tonnes. This reflects Thai rice's competitive power in terms of export quantity

even though the Thai rice price is still higher than the Vietnamese rice price.

Table 5.8: The overall results from the base scenario

(Corresponding to an export volume = 5 and 6 million tonnes)

Variable	Units	North	Central	South	Vietnam	Thailand	R.O.W
Rice price	VND/kg	9,490	8,919	8,398	-	8,446	8,814
Rice production	000 tonnes	6,875	5,006	15,911	27,792	26,403	490,341
Producer revenue	VND mill.	65,242	44,649	137,116	247,007	227,008	4,321,639
Exports	1000 tonnes	0	0	7,659	6,362	10,912	0
Imports	1000 tonnes	538	759	0	0	362	16,912
Net trade	1000 tonnes	-538	-759	7,659	6,362	10,550	-16,912
Rice consumption	1000 tonnes	7,413	5,765	8,253	21,430	15,854	507,253

Source: Results of the Spatial Equilibrium Model.

The detailed trade flows among the five regions are given in Table 5.9. The North and the Central are two deficit areas being able to produce about 6.9 million tonnes and 5 million tonnes respectively, whereas the South is a surplus region and ships around 0.5 million tonnes and 0.76 million tonnes to the North and the Central regions respectively along with exports of 5 million tonnes to the Rest of the World. Of the total supply of 26.4 million tonnes in Thailand, about more than half is for domestic consumption while the rest is reserved for export.

In the table it further can be seen that an amount of 1.36 million tonnes Vietnamese rice is shipped to Thailand in the scenario of exporting 5 million tonnes. This can be explained by the fact that *the impact of rice purchasing policy for storage of Thai government* at pre-election period is to push export price of Thai rice much higher compared to other rice exporters. Whereas export volume also become insufficient because of stockpile purpose so that supply sources were tightened. As a result, Thai rice exporters turn to

seek for supplies from surrounding nations including Vietnam and Cambodia in order to meet rice orders.

Table 5.9: Trade flows (unit in thousand tonnes)

From/To	North	Central	South	Thailand	R.O.W	Total supply
Scenario 1						
North	**6,875**	0	0	0	0	6,875
Central	0	**5,006**	0	0	0	5,006
South	538	759	**8,253**	1,362	5,000	15,911
Thailand	0	0	0	**14,492**	11,912	26,403
Rest of the world	0	0	0	0	**490,341**	490,341
Total demand	7,413	5,765	8,253	15,854	507,253	
Scenario 2						
North	**6,875**	0	0	0	0	6,875
Central	0	**5,006**	0	0	0	5,006
South	538	759	**8,253**	362	6,000	15,911
Thailand	0	0	0	**15,492**	10,912	26,403
Rest of the world	0	0	0	0	**490,341**	490,341
Total demand	7,413	5,765	8,253	15,854	507,253	

Source: Results of Spatial Equilibrium Model

Secondly, the *impact of Price Controls Policy of Vietnamese government* is a big barrier for Vietnamese enterprises to seek contracts from foreign partners. In other words, the intervention on export rice price is often more than necessary losing their initiative in negotiation. In many cases, the price of export rice may change even in two weeks during processing the export contract for official seal from Vietnamese Food Association. If the controlled price is higher than the contract price, the order will not be approved. If the contract price is higher than the controlled price, the buyer may decide a breach of

contract depending on the deposit and fine. The corollary is to lose the export contract to other competitors such as Thailand, India and Pakistan. Therefore, Vietnamese rice enterprises must choose the method that is to export under a Thai rice name. Almost all trades is via double auxiliary border gates and crossings which firstly happens between Vietnam and Cambodia and then Cambodia and Thailand. Cambodia becomes a rice intermediary market in this case. One more way to send Viet rice to Thailand is smuggling. Back to the aspect of economic management, these methods lead to a major hole then causing market distortion and revenue loss for the Vietnamese rice industry as a whole.

The above mentioned argument is confirmed again if looking at the result from the second scenario of the model assuming that the rice price is less often adjusted, such as 1 time per month. The amount of rice export via Thai names sharply falls down to 362 thousand tonnes compared to 1362 thousand tonnes in the first scenario. Thus, the Vietnamese Government has the ability to export much more than 5 or 6 million tonnes as the assumptions. The key point is that, by all means, small volume border crosses or official contract, legal or illegal, the rice will be distributed beyond Vietnamese borderlines until the export volume reaches 6.3 million tonnes.

In the two first scenarios, it is firm that the Price Controls Policy in one and more than one time per month will have a strong effect on export volume, 6.3 million tonnes, which is still under Vietnam's potential. If the mechanism is more favourable, the Vietnamese Government has less intervened on the price. The author strongly believes that Vietnam could provide a greater amount to the global market.

5.3.2. Impact of Price Control in every 3 months

(Corresponding to an export volume of 8500 thousand tonnes or more)

Overall, the model in Table 5.10 shows that general variables such as price, production, export and import for five regions, have not significantly changed. The exception is the Vietnamese rice export volume that has risen sharply. This was the new record in the history of rice exportation of Vietnam with more than 7.2 million tonnes. Subsequently, the increase in producer's revenue reached 248,350 billion VND, equivalent to $US 13.13 billion.

Table 5.10: The overall results from the base scenario

(Corresponding to an export volume = 8.5 million tonnes):

Variable	Units	North	Central	South	Total Vietnam	Thailand	R.O.W
Rice price	VND/kg	9,534	8,963	8,441	-	8,444	8,811
Rice production	1000 tonnes	6,882	5,014	15,943	27,839	26,402	490,319
Producer revenue	VND bill.	65,607	44,935	137,808	248,350	226,805	4,320,546
Exports	1000 tonnes	0	0	7,725	7,221	10,545	726
Imports	1000 tonnes	504	726	0	726	0	17,767
Net trade	1000 tonnes	-504	-726	7,725	6,495	10,545	-17,040
Rice consumption	1000 tonnes	7,386	5,740	8,218	21,344	15,856	50,7359

Source: Results of Spatial Equilibrium Model

Table 5.11 shows that rice production in the North of Vietnam is not sufficient for the local population but an import of 504 thousand tonnes from the South of Vietnam is necessary. Central Vietnam also must import 726 thousand tonnes from the Rest of the World to supply the domestic demand. In Southern Vietnam, after meeting the local demand of 8,218 thousand tonnes, almost all of the rest are shipped to rest of the world.

While Southern Vietnam exports more than 7.2 million tonnes, Thailand exports more than 10 million tonnes. The difference between total demand and total supply is exactly equal to the number of rice Vietnam can export after satisfying all domestic demands.

Table 5.11: Trade flow (1000 tonnes)

From/To	North	Central	South	Thailand	R.O.W	Total supply
North	**6,882**	0	0	0	0	6,882
Central	0	**5,014**	0	0	0	5,014
South	504	0	**8,218**	0	7,221	15,943
Thailand	0	0	0	**15,856**	10,545	26,402
R.O.W	0	726	0	0	**489,592**	490,319
Total demand	7,386	5,740	8,218	15,856	507,359	-

Source: Results of Spatial Equilibrium Model

It is also easy to conclude that in Vietnam the South is the only surplus area whereas the two remaining areas are deficit. The Central imports rice from the rest of the world. The best explanation is that the imported rice is from Cambodia, as recently happening, where rice production is currently thriving. Moreover, due to the borderline with Cambodia from Dak Lak province in the Central and stretching to the South, this is an advantage for the Central area to bargain a cheaper price of rice because of a lower transportation cost. Unlike the Central, the North does not have such favourable conditions, so rice is shipped from the South in order to avoid costs related to importation.

Recently Cambodia was seen as a potential area for rice production because of lower input cost, lower cropland fee, cheaper labour and more favourable weather conditions. Many Vietnamese farmers recognize and grasp the advantages to look for investment in land for rice cultivation in Cambodia. Cooperative programs and training on farming

techniques have been taking place within the framework of agricultural cooperation between the two countries since 2002. First of all, the most significance cooperation is between An Giang and Takeo, a border province of Cambodia, which spread to Kandal and Kompong Chnang. Nowadays, Cambodia is always regarded as a profitable investment and business environment for Vietnam. However, the trend is the same in Thailand and China.

From the results of the three above scenarios, the noticeable difference is revealed in the third scenario at all of the indicators of trade flows of both Vietnam and Thailand and Rest of the world. Between the first and the second scenario, there is almost no difference, except Thai rice export could fall by 1 million tonne. Therefore, based on the results from the model, only the differences between scenario 2 and 3 will be intensively analysed and compared.

Overall, Table 5.12 shows separately changes in some key indicators of global trade flows**.** If there are less controls on the export price, as in scenario 3, it is easy to see an increase in the Vietnamese rice price that becomes an encouraging factor for Vietnamese rice production which increases by 0.17 per cent or 47 thousand tonnes of rice. On the other hand, even though there is a decrease in Thai rice production, this figure is very small (0.01 per cent or 1 thousand tonnes).

The output of the model also shows that this policy leads to a significant rise in the Vietnamese rice export volume by 13.51 per cent, equivalent to 163 thousand tonnes, while the volume of rice export of Vietnam's competitor falls slightly by 3.35 per cent, equivalent to 367 thousand tonnes.

Moreover, with the shadow price equal to zero, less control or removal of the rice export price control policy contributes to clearing away the trade flow in any black markets. This

would occur in the case of controlling in rice price every month which is associated with a shadow price of 45.56 VND/tonne. This reflects the benefits to be obtained by less controlling the rice price.

Table 5.12: The overall effects of Price Controls Policy

	Unit	Scenario		Percentage change
		2	3	
Rice export of VN	1000 tonnes	6,362	7,221	13.51
Rice export of Thailand	1000 tonnes	10,912	10,545	-3.35
Vietnamese rice price	VND/kg	8,398	8,441	0.52
Thai rice price	VND/kg	8,446	8,444	-0.02
World rice price	VND/kg	8,814	8,811	-0.02
Shadow price	VND/kg	45.56	0	
Rice production in Vietnam	1000 tonnes	27,792	27,839	0.17
Rice production in Thailand	1000 tonnes	26,403	26,402	-0.01
Rice production in the world	1000 tonnes	544,537	544,559	0.004
Thai producer revenue	VND bill.	227,008	226,805	-0.09
Vietnam producer revenue	VND bill.	247,007	248,350	0.54
Vietnamese consumption	1000 tonnes	21,430	21,344	-0.40

Source: Compilation from results of the model

The policy has negligible effects on the world production resulting in a rise by 0.004 per cent (or 22 thousand tonnes). Nevertheless, the higher level of Vietnamese rice exports pushes the world rice price slightly down by 0.02 per cent.

For three different geographical regions in Vietnam, the effects of Price Controls Policy on them are summarized again in table 5.13 for a better view.

The model results thus demonstrate that less controlling the rice export price would cause a negligible rise in the domestic prices by an addition of 43.52 VND per kg in each

region. However it is not the same in the percentage changes with the highest increase in the South (0.52 per cent) and the smallest increase in the North (0.46 per cent). This reflects that rice farmers will be beneficiaries while non-rice farmers and others, especially in the North will not benefit from less controlling the rice export price.

Table 5.13: The regional effects of Price Controls Policy

	Scenario 2	Scenario 3	Change (+/-)	Change (%)
Rice price in the North (VND/kg)	9,490	9,534	43.52	0.46
Rice price in the Central (VND/kg)	8,919	8,963	43.52	0.49
Rice price in the South (VND/kg)	8,398	8,441	43.52	0.52

Source: Compilation from results of the model

On the Thai rice industry, the policy has effects through 4 main criteria: export volume, domestic price of rice and rice production and general revenue (see Table 5.14). A fall in quantity and price by 3.35% and 0.02% respectively drives a decrease in revenue by 0.09%. It is clear that Thailand would lose his competitiveness compared to Vietnam if the Vietnamese Government controls the rice export price in every 3 months or less.

Table 5.14: Effects on Thai rice

	Scenario 2	Scenario 3	Change (+/-)	Change (%)
Export volume (mill. tonnes)	10,912	10,545	-366.07	-3.35
Rice price (VND/kg)	8,446	8,444	-2.04	-0.02
Rice production (mill. tonnes)	26,403	26,402	-1.67	-0.01
Producer revenue (VND bill.)	227,008	226,805	-202.75	-0.09

Source: Compilation from results of the model

The significant differences between Vietnamese and Thai rice are compared in Table 5.15. The Vietnamese rice price is 47.8 VND/kg less than the Thai rice price in scenario 2 and still less than 2.2 VND/kg in scenario 3. However, the result suggests that the Vietnamese rice price increases to 43.52 VND/kg as a result of less controlling the price of export rice while Thai rice price decreases about 2 VND/kg. It is obvious to conclude again that the dual effects of increased output and price of Vietnamese rice and decreased output and price of Thai rice encourages a comparative advantage for Vietnamese rice. In other words, the fewer controls on the price of rice, the greater the comparative advantage of Vietnamese rice compared with Thai rice.

Table 5.15: Comparison of rice price between Thailand and Vietnam (VND/kg)

	Vietnam	**Thailand**	**Compare**
Scenario 2	8,398	8,446	47.8
Scenario 3	8,441	8,444	2.2
Change (+/-)	44	-2	-

Source: Compilation from results of the model

The correlation of turnover between the two largest rice exporters can be compared in table 5.16. The advantage of Vietnamese rice is not only reflected by indicators such as price and output as showed in the above tables but also by Vietnam's revenue, which is considerably increased by 0.54%. In scenario 2, the revenue of Vietnam's enterprises is with 20,000 VND billion greater but it is even larger in scenario 3 with more than 21,500 VND billion. Again it is clear that Vietnam will benefit if the Government intervenes less on rice export price.

Table 5.16: Effects on rice producer revenue (VND billion)

Regions	Revenue		Change	
	Scenario 2	Scenario 3	(+/-)	(%)
Vietnam	247,007	248,350	1,342	0.54
Thailand	227,008	226,805	-203	-0.09
Compare	-20,000	-21,545	-	-

Source: Compilation from results of the model

Conclusions

Although there are factors not included in the model, it does expose a relatively accurate picture of the effects of rice Price Controls Policy from the Vietnamese government on its rice production and a competitor's rice production, such as Thailand. Therefore, it is possible to see how Vietnamese rice competes with Thai rice. Altogether, a conclusion from 3 scenario could be that the less control on rice price, the more benefit on the Vietnamese economy. Further the competitiveness for Vietnamese rice compared with Thailand in the international markets would increase and there would not be negative effects on the national food security goal. Conclusion and recommendations are discussed in the next chapter.

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

The policies associated with the rice industry attract a lot of attention by many groups in Vietnam because rice is the main agricultural sector and it is grown by the majority of the Vietnamese rural population (nearly 90 per cent). Changes in the rice industry have effects not only on the rural economy but also the entire economy, particularly when Vietnam has joined the international rice market. In this instance, the rice policies such as price controls or tariff policies, become even more important. After carrying a research on Vietnamese rice industry, especially its operating mechanism, then applying the spatial equilibrium model in order to examine the effects of the Price Controls policy, we get back some important findings that lead to some logical conclusions as follow:

Firstly, in three rice production regions of Vietnam, the South is the only surplus region whereas in the Central and the North, rice production does not meet the domestic demand. This can be explained that the South has an absolute favourable for the large-scale production

Every year, most of the imported rice is shipped from the South of Vietnam and Cambodia and one part of premium rice is shipped from Thailand in order to fulfil the demand in Central and Northern Vietnam. There is a strong crop restructuring from rice to vegetables and other crops in such two regions due to higher economic effectiveness. This leads to a decrease in rice area and production is not enough supplying for the local

demand.

Secondly, Price Controls Policy will bring benefit to the rice farmers and the rice export enterprises while the losers could be the urban poor and rural householders who do not farm rice but who would be paying a higher rice price. However, the extra revenue of 1343 million VND could be a source of compensation to the losers.

Thirdly, the noticeable point is that within the Vietnamese rice industry, scenario 3 could raise the volume of rice exports to 7.221 million tonnes (that is, by 13.51 per cent). That reflects the Vietnamese rice competitive power in terms of export quantity.

Fourthly, prices of rice are always lower in the South Vietnam because of abundant supply. Moreover, more than 90% of export rice is coming from this area. Thus, the price of rice in the South Vietnam is often used for comparison to the export price of Thai rice. While both prices and volume of Viet rice increase that promotes exportation, the volume of Thai rice export significantly decrease and price of Thai rice also falls but only slightly.

However, the point is that the volume of Vietnamese rice exports is larger than it was and the Vietnamese rice prices would be raised and even obtain a higher level than Thai rice prices in the case of price of Viet rice is controlled in every 3 months. In other words, the Government has to often controlled on rice price with an expectation that is to protect farmers from income fall. However, the fact shows an opposite result. Farmer's income indirectly decreases and exportation activities are not effective.

Fifthly, less controlling in price will clear away the trade flow in any black markets, which could occur in scenario 1 and 2 (45.56 VND/tonne). If prices of rice are too often set at higher than market prices, small businesses and individuals will not be able to export, forced them to choose the black door in order to export to Thailand, then export to the

rest of the world.

Finally, on the whole, the effects of Price Controls Policy are quite small on its competitor, the Thai rice industry, and the consumption and production effects in the rest of the world are also small.

The important gain from the policy is that the competitiveness of Vietnamese rice is enhanced with respect to Thai rice. Also, Vietnamese rice producers gain. At the same time the Thai rice producers would get 202.75 billion VND less in their revenue due to decreased output and prices. With the increase in the Vietnamese rice prices by 0.46 per cent Vietnamese producers have a bit lower prices than Thai rice that is 2.2 VND/kg higher. Therefore, it can lead to a firm conclusion that the less control on export rice price until four times per year or less, the Vietnamese economy benefits more or the more competitiveness of Vietnamese rice industry is and the policy could further free up the potential of the Vietnamese rice industry as one of the world's leading exporters.

From the beginning, spatial equilibrium model are built for the purpose of independent analysis of Vietnamese Price Controls Policy. The conclusions are made from the very strict constraints mentioned in chapter 5. Like other methodologies, spatial equilibrium model also has its own strengths and limitations on page 26. Analysis in the paper shows that Vietnam rice has competiveness compared with Thailand in terms of quantity.

In the fact, along with advantage of scale, one product can compete by different tools, such as quality, brand, the product's unique. It can also compete by price, method of management, method of payment, bundled services, technology in production. Others can be new or creative point in products. Moreover, in the age that business ethics are the top concern, reputation and trust can be surely competitive advantages by. Thus, the

study only shows the competitiveness of Vietnamese rice in terms of quantitiy.

To find out a solution for the Vietnam's rice industry, which is always a controversial issue, a system of synchronous policies and actions is very essential. There is a need to combine the different policies from technology to production and marketing or towarding farmers and millers and exporters. Because this is a difficult task, it is necessary to have a other separate and serious studies. Our study only proposed recommendations based on learning from characteristics of business and production of Vietnamese rice industry and from the result of spatial equilibrium model.

6.2. Recommendations

From the model, it is clear that Vietnam has more competitiveness in terms of quantity but we recognize that the high level of intervention on prices of rice is a big barrier, leading unintended consequences on export agents. However, this does not mean that Price Controls Policy is unnecessary but the point is what level of intervention is rational. The Government has to much control on price of rice over these years. This can be explained by unsynchronous policies and actions and mismanagement level, then Government has quickly and directly intervened by imposing Price Controls Policy. Thus, in order to take the advantage of large-scale, we strongly believe that Vietnam should control less on price of rice until every 3 months or less. Simultaneously, implement of below policies and actions at the same time will help to reduce the negative impact of Price Controls Policy. These are also recommendations for exploiting the other competitive advantages, then raising the overall value of Vietnamese rice industry.

Firstly, ***building international brands for Viet rice***. This approach would help Vietnamese rice well-know in the global markets. Vietnam would not have to export rice under the

name of importers like the name “BULLOG” when exported to Philippines. Vietnam could now position its rice in the world. Thereby, consumption could be greater than before. The value of export could also increase due to elimination of intermediate’s roles or local broker’s role in the supply chain.

Secondly, ***switching the export strategy to high quality rice*****.** Vietnam mainly export inferior rice category. There is a high competition from India, Cambodia and Pakistan who are also big inferior rice producers. Vietnam’s rice exporters tend to compete by reducing the price of export rice while the Government tend to act to protect farmers by setting a system of floor- prices. However, the fact is that rice farmers were still vulnerable and rice industry was still under full potential. This results in much confusion for Vietnamese policy makers and rice becomes the controversial issue.

Farmers are already recommended to produce the high quality rice over years. Instead of being supported in selling rice, they have to fight theiselves under pressure of markets. The consequent is the lower economic efficiency compared with inferior rice. The Government can not impose a comprehensive policy system to control the problem. The situation becomes even more complicated than ever. Therefore, Vietnam should redefine its rice export strategy and propose drastic actions in order to shift one part of rice production from inferior type to high quality category, exploiting the current favourable weather conditions in almost areas of Vietnam.

Thirdly*,* ***improve the capacity of rice storage system*****.** One of natures of rice is that it can not be stored for a long time that is more than three months. After that the quality of rice will be greatly reduced. Farmers can only reserve their paddy in the hourse with a small capacity, thus, they have to sell most of paddy right after harvesting. Understanding this

weak point, local brokers usually put pressure on the farmer for lower prices. In addition, rice companies are also difficult to support farmers for temporary storage of all rice production due to the limited stockpile. The Government has recently made positive moves to solve above problem. In the Decree 109, storage capacity is mentioned as one of main three conditon for rice businesses. By maintaining this policy, Vietnam will certainly have stronger “baigaining power” in the international markets.

Fourthly, ***serious calculation for national reserve and then free trade for the surplus***. Vietnamese rice industry has two main tasks that are national food security and exportation activities. The reason that the Government intervenes in export prices and export volume is to ensure national food security for 90 million Vietnamese people. However, Price Controls Policies have the negative effect on exportation activity. In order to fulfill both objectives, the Government needs to a thorough calculation of the level of national reserve. After retaining this volume for national stockpile, the surplus of rice production should be controlled less until free trade in the markets.

Fifthly**,** ***active in seeking new contracts***. The current markets of Vietnamese rice are almost the traditional markets in Asia. The new markets are in a very small number. Most of the number of customers is provided through G2G contract. Individuals are not active in seeking new contracts. Especially, African countries are a huge potential but currently untapped by Vietnamese companies. So in this period of high competition, we highly recommend the Government plan more visits to the African countries and strengthen diplomatic activities to sign the rice export contracts. At the same time two largest companies of Vietnam are Vinafood 1 and Vinafood 2 also need to actively seek export contract, avoiding passive allocation of contracts from the Government

In addition to, other recommendations can go together to make a synchronic system are such as: the propagation of policies, to support and encourage for farmer joining the Vietnamese Food Association, to enhance the responsibility and business ethics of exporters; to reduce the power of middlemen in the supply chain of rice… and to restructure the agriculture sector towards more effective.

Open discussion

Vietnam is still a developing country where the farmers depend heavily on exportation. It is easy to see the large benefits for rice farmers in 2008 or 2012. The response of rice farmers to these good price signals for the rice industry could be a significant increase in the cultivated areas of rice. There could also be strong incentives to reduce other crops such as vegetables and aquaculture.

With high world prices and rising demand this could be a precious opportunity for Vietnamese rice growers to gain more benefit by expanding their crop areas. It is also an opportunistic time to bring about policy reform. However, it is a fact that the rice industry depends very much on the weather conditions and the change in the international markets which both are not easy to predict. Moreover, Vietnam has experienced many lessons of failure from the café and cocoa industries when the farmers were caught in a vicious circle of growing when prices were high and cutting off (harvesting) when prices were low.

Therefore, in order to avoid similar failures or inconsistent strategies for rice farmers, there is a need to carry out further research to analyse the impact of the policy of expansion of the cultivated areas of rice with the offset of other crops. There is also a need to compare the benefits of several crops to figure out a strategic commodity policy

for the Vietnamese agriculture. In such cases, spatial equilibrium models could be used to help in the development of these policies. It is recommended that further studies should be carried out to examine the impacts of such policy changes.

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APPENDIXES

Appendix A

Table 1A: The list of reliable rice export enterprises in Vietnam 2012

	Names	Region
1	An Giang Agriculture and Foods Import-Export Company (AFIEX)	Southern
2	Angiang Import - Export Company (ANGIMEX)	Southern
3	Angiang Tourimex Joint Stock Company	Southern
4	Ben Tre Food Company (Bentrefoodco)	Southern
5	Binh Dinh Food Joint Stock Company (BIDIFOOD)	**Central**
6	Dong Thap Foods Company (DARGRIMEX)	Southern
7	Dong Thap Trading Corporation (DOCIMEXCO)	Southern
8	Food Company of Hochiminh City Ltd	Southern
9	Gentraco Corporation (GENTRACO)	Southern
10	Ha noi Production Services Import - Export Joint - Stock Company	Southern
11	Hanoi Trade Corporation (HAPRO)	**Northern**
12	Hau Giang Food Joint Stock Company (Hau Giang Food)	Southern
13	Hiep Loi Joint Stock Company	Southern
14	Hong Trang Trading Joint Stock Company (Hong Trang JSCO)	Southern
15	Khiem Thanh Company Limited (Khiem Thanh Co., Ltd)	Southern
16	Kien An Phu Trading Company Limited (KIMEXCO)	Southern
17	Kien Giang Agriculture Product Trading Joint Stock Company	Southern
18	Kien Giang Agro-Forestry Product Joint Stock Company	Southern
19	Kien Giang Trade and Tourism Company Ltd (KTC)	Southern
20	Long An Food Company (Long An Food)	Southern
21	Long An Foodstuff Company Limited	Southern
22	Mechanics Contruction and Foodstuff Joint Stock Company	Southern
23	Mekong Joint Stock Company (MKC)	Southern
24	Nova Company Limited (Nova Co., Ltd)	**Northern**
25	Phu Vinh Food Corporation	Southern
26	Quang Nam Food and Service Joint Stock Company	**Central**
27	Quang Trung Trading Service Company Limited	Southern
28	Soc Trang Food Company (Soctrafood)	Southern
29	Song Hau Food Company (SOHAFOOD)	Southern
30	Tan Dong Tien Joint Stock Company (Tan Dong Tien Jsc)	Southern
31	Tan Long Chemical Industry Joint Stock Company	**Northern**
32	Techno-agricultural Supplying Joint Stock Company. (TSC)	Southern
33	Thanh Loi Cooperatives	Southern
34	Thinh Phat Company Limited	Southern
35	Thuan Phat Food Company Limited (TUPACO)	Southern
36	Tien Giang Food and Agricultural Products Company (Tigifaco)	Southern
37	Tien Giang Food Company (TIGIFOOD)	Southern
38	Trung An Company Limited (Trung An Co., Ltd)	Southern

39	Viet Hung Company Limited (Viet Hung Co., Ltd)	Southern
40	Viet Thanh Food Processing and Trading Joint Stock Company	Southern
41	Vilexim Import Export and Cooperation Joint Stock Company	**Northern**
42	Vinh Long Cereal and Food Import Export Joint Stock Company	Southern
43	Vinh Long Food Company (Vinh Long Food)	Southern
44	Vinh Long Import Export Joint Stock Company	Southern
45	Vinh Phat Investment Corporation	Southern

Source: Vietnam Food Association, 2013

Appendix B: SPATIAL EQUILIBRIUM MODEL RESULTS

The tables included in this Appendix provide and illustration of the detailed results obtained from MS Excel Solver. They are referred to in the main text.

Table 1B: Answer report for adjustable cell with export volume equals to 5000 tonnes

Cell	Name	Original Value	Final Value
$B$3	Solution Y1	7412.509659	7412.509659
$C$3	Solution Y2	5765.064977	5765.064977
$D$3	Solution Y3	8252.651369	8252.651369
$E$3	Solution Y4	15853.65274	15853.65274
$F$3	Solution Y5	507252.8179	507252.8179
$G$3	Solution X1	6874.709382	6874.709382
$H$3	Solution X2	5006.056536	5006.056536
$I$3	Solution X3	15911.38053	15911.38053
$J$3	Solution X4	26403.28196	26403.28196
$K$3	Solution X5	490341.2683	490341.2683
$L$3	Solution X11	6874.709382	6874.709382
$M$3	Solution X12	0	0
$N$3	Solution X13	0	0
$O$3	Solution X14	0	0
$P$3	Solution X15	0	0
$Q$3	Solution X21	0	0
$R$3	Solution X22	5006.056536	5006.056536
$S$3	Solution X23	0	0
$T$3	Solution X24	0	0
$U$3	Solution X25	0	0
$V$3	Solution X31	537.800277	537.800277
$W$3	Solution X32	759.0084409	759.0084409
$X$3	Solution X33	8252.651369	8252.651369
$Y$3	Solution X34	1361.920441	1361.920441
$Z$3	Solution X35	5000	5000
$AA$3	Solution X41	0	0
$AB$3	Solution X42	0	0
$AC$3	Solution X43	0	0
$AD$3	Solution X44	14491.7323	14491.7323
$AE$3	Solution X45	11911.54966	11911.54966
$AF$3	Solution X51	0	0
$AG$3	Solution X52	1.19209E-08	1.19209E-08
$AH$3	Solution X53	0	0
$AI$3	Solution X54	1.02696E-15	1.02696E-15
$AJ$3	Solution X55	490341.2683	490341.2683
$AK$3	Solution DP1	9490.113309	9490.113309
$AL$3	Solution DP2	8919.073309	8919.073309
$AM$3	Solution DP3	8397.903309	8397.903309
$AN$3	Solution DP4	8445.683309	8445.683309
$AO$3	Solution DP5	8813.533309	8813.533309
$AP$3	Solution SP1	9490.113309	9490.113309
$AQ$3	Solution SP2	8919.073309	8919.073309
$AR$3	Solution SP3	8397.903309	8397.903309
$AS$3	Solution SP4	8445.683309	8445.683309
$AT$3	Solution SP5	8813.533309	8813.533309
$AU$3	Solution LIMITATION	45.56	45.56

Table 2B: Answer report for constrains with export volume equals to 5000 tonnes

Cell	Name	Cell Value	Formula	Status	Slack
$AV$15	RY1 LHS	-21453.9975	$AV$15<=$AX$15	Binding	0
$AV$16	RY2 LHS	-18924.14778	$AV$16<=$AX$16	Binding	0
$AV$17	RY3 LHS	-18866.23333	$AV$17<=$AX$17	Binding	0
$AV$18	RY4 LHS	-21512.495	$AV$18<=$AX$18	Binding	0
$AV$19	RY5 LHS	-18605.15889	$AV$19<=$AX$19	Binding	0
$AV$20	RX1 LHS	-33806.29909	$AV$20<=$AX$20	Binding	0
$AV$21	RX2 LHS	-19952.28484	$AV$21<=$AX$21	Binding	0
$AV$22	RX3 LHS	-13205.56154	$AV$22<=$AX$22	Binding	0
$AV$23	RX4 LHS	-23893.80308	$AV$23<=$AX$23	Binding	0
$AV$24	RX5 LHS	-35251.88	$AV$24<=$AX$24	Binding	0
$AV$25	RX11 LHS	0	$AV$25<=$AX$25	Binding	0
$AV$26	RX12 LHS	-571.04	$AV$26<=$AX$26	Not Binding	1142.08
$AV$27	RX13 LHS	-1092.21	$AV$27<=$AX$27	Not Binding	2184.42
$AV$28	RX14 LHS	-1044.43	$AV$28<=$AX$28	Not Binding	2184.42
$AV$29	RX15 LHS	-722.14	$AV$29<=$AX$29	Not Binding	1444.28
$AV$30	RX21 LHS	571.04	$AV$30<=$AX$30	Binding	0
$AV$31	RX22 LHS	0	$AV$31<=$AX$31	Binding	0
$AV$32	RX23 LHS	-521.17	$AV$32<=$AX$32	Not Binding	1042.34
$AV$33	RX24 LHS	-473.39	$AV$33<=$AX$33	Not Binding	1042.34
$AV$34	RX25 LHS	-151.1	$AV$34<=$AX$34	Not Binding	302.2
$AV$35	RX31 LHS	1092.21	$AV$35<=$AX$35	Binding	0
$AV$36	RX32 LHS	521.17	$AV$36<=$AX$36	Binding	0
$AV$37	RX33 LHS	0	$AV$37<=$AX$37	Binding	0
$AV$38	RX34 LHS	47.78	$AV$38<=$AX$38	Binding	0
$AV$39	RX35 LHS	370.07	$AV$39<=$AX$39	Binding	0
$AV$40	RX41 LHS	1044.43	$AV$40<=$AX$40	Not Binding	95.56
$AV$41	RX42 LHS	473.39	$AV$41<=$AX$41	Not Binding	95.56
$AV$42	RX43 LHS	-47.78	$AV$42<=$AX$42	Not Binding	95.56
$AV$43	RX44 LHS	0	$AV$43<=$AX$43	Binding	0
$AV$44	RX45 LHS	367.85	$AV$44<=$AX$44	Binding	0
$AV$45	RX51 LHS	676.58	$AV$45<=$AX$45	Not Binding	45.56
$AV$46	RX52 LHS	105.54	$AV$46<=$AX$46	Not Binding	45.56
$AV$47	RX53 LHS	-415.63	$AV$47<=$AX$47	Not Binding	785.7
$AV$48	RX54 LHS	-367.85	$AV$48<=$AX$48	Not Binding	735.7
$AV$49	RX55 LHS	0	$AV$49<=$AX$49	Binding	0
$AV$50	RDP1 LHS	-4.54747E-13	$AV$50<=$AX$50	Binding	0
$AV$51	RDP2 LHS	-6.36646E-13	$AV$51<=$AX$51	Binding	0
$AV$52	RDP3 LHS	0	$AV$52<=$AX$52	Binding	0
$AV$53	RDP4 LHS	-1.45529E-11	$AV$53<=$AX$53	Binding	0
$AV$54	RDP5 LHS	1.16415E-10	$AV$54<=$AX$54	Binding	0
$AV$55	RSP1 LHS	0	$AV$55<=$AX$55	Binding	0
$AV$56	RSP2 LHS	0	$AV$56<=$AX$56	Binding	0
$AV$57	RSP3 LHS	9.09495E-13	$AV$57<=$AX$57	Binding	0
$AV$58	RSP4 LHS	1.81899E-12	$AV$58<=$AX$58	Binding	0
$AV$59	RSP5 LHS	-5.82077E-11	$AV$59<=$AX$59	Binding	0
$AV$60	RLIMITATION LHS	5000	$AV$60<=$AX$60	Binding	0

Table 3B: Sensitivity report for adjustable cells with export volume equals to 5000 tonnes

Cell	Name	Final Value	Reduced Gradient
$B$3	Solution Y1	7412.509659	0
$C$3	Solution Y2	5765.064977	0
$D$3	Solution Y3	8252.651369	0
$E$3	Solution Y4	15853.65274	0
$F$3	Solution Y5	507252.8179	0
$G$3	Solution X1	6874.709382	0
$H$3	Solution X2	5006.056536	0
$I$3	Solution X3	15911.38053	0
$J$3	Solution X4	26403.28196	0
$K$3	Solution X5	490341.2683	0
$L$3	Solution X11	6874.709382	0
$M$3	Solution X12	0	1143.257675
$N$3	Solution X13	0	2198.408219
$O$3	Solution X14	0	2188.775893
$P$3	Solution X15	0	1446.865368
$Q$3	Solution X21	0	1.154898394
$R$3	Solution X22	5006.056536	0
$S$3	Solution X23	0	1055.163834
$T$3	Solution X24	0	1045.531508
$U$3	Solution X25	0	151.033093
$V$3	Solution X31	537.800277	0
$W$3	Solution X32	759.0084409	0
$X$3	Solution X33	8252.651369	0
$Y$3	Solution X34	1361.920441	0
$Z$3	Solution X35	5000	0
$AA$3	Solution X41	0	100.0424666
$AB$3	Solution X42	0	98.87767169
$AC$3	Solution X43	0	47.84336993
$AD$3	Solution X44	14491.7323	0
$AE$3	Solution X45	11911.54966	0
$AF$3	Solution X51	0	48.278641
$AG$3	Solution X52	1.19209E-08	-105.4740445
$AH$3	Solution X53	0	797.1659701
$AI$3	Solution X54	0	749.3870356
$AJ$3	Solution X55	490341.2683	0
$AK$3	Solution DP1	9490.113309	0
$AL$3	Solution DP2	8919.073309	0
$AM$3	Solution DP3	8397.903309	0
$AN$3	Solution DP4	8445.683309	0
$AO$3	Solution DP5	8813.533309	0
$AP$3	Solution SP1	9490.113309	0
$AQ$3	Solution SP2	8919.073309	0
$AR$3	Solution SP3	8397.903309	0
$AS$3	Solution SP4	8445.683309	0
$AT$3	Solution SP5	8813.533309	0
$AU$3	Solution LIMITATION	45.56	0

Table 4B: Sensitivity report for constrains with export volume equals to 5000 tonnes

Cell	Name	Final Value	Lagrange Multiplier
$AV$15	RY1 LHS	-21453.9975	-7412.518179
$AV$16	RY2 LHS	-18924.14778	-5765.072204
$AV$17	RY3 LHS	-18866.23333	-8252.661079
$AV$18	RY4 LHS	-21512.495	-15853.66915
$AV$19	RY5 LHS	-18605.15889	-507253.3402
$AV$20	RX1 LHS	-33806.29909	-6874.715996
$AV$21	RX2 LHS	-19952.28484	-5006.061229
$AV$22	RX3 LHS	-13205.56154	-15911.39566
$AV$23	RX4 LHS	-23893.80308	-26403.30975
$AV$24	RX5 LHS	-35251.88	-490341.7782
$AV$25	RX11 LHS	0	-6874.715996
$AV$26	RX12 LHS	-571.04	0
$AV$27	RX13 LHS	-1092.21	0
$AV$28	RX14 LHS	-1044.43	0
$AV$29	RX15 LHS	-722.14	0
$AV$30	RX21 LHS	571.04	759.0109748
$AV$31	RX22 LHS	0	-5765.072204
$AV$32	RX23 LHS	-521.17	0
$AV$33	RX24 LHS	-473.39	0
$AV$34	RX25 LHS	-151.1	0
$AV$35	RX31 LHS	1092.21	-1296.813158
$AV$36	RX32 LHS	521.17	0
$AV$37	RX33 LHS	0	-8252.661079
$AV$38	RX34 LHS	47.78	-1361.95511
$AV$39	RX35 LHS	370.07	-4999.966309
$AV$40	RX41 LHS	1044.43	0
$AV$41	RX42 LHS	473.39	0
$AV$42	RX43 LHS	-47.78	0
$AV$43	RX44 LHS	0	-14491.71404
$AV$44	RX45 LHS	367.85	-11911.59571
$AV$45	RX51 LHS	676.58	0
$AV$46	RX52 LHS	105.54	0
$AV$47	RX53 LHS	-415.63	0
$AV$48	RX54 LHS	-367.85	0
$AV$49	RX55 LHS	0	-490341.7782
$AV$50	RDP1 LHS	-4.54747E-13	-9490.114772
$AV$51	RDP2 LHS	-6.36646E-13	-8919.074977
$AV$52	RDP3 LHS	0	-8397.904689
$AV$53	RDP4 LHS	-1.45529E-11	-8445.683623
$AV$54	RDP5 LHS	1.16415E-10	-8813.53369
$AV$55	RSP1 LHS	0	-9490.114772
$AV$56	RSP2 LHS	0	-8919.074977
$AV$57	RSP3 LHS	9.09495E-13	-8397.904689
$AV$58	RSP4 LHS	1.81899E-12	-8445.683623
$AV$59	RSP5 LHS	-5.82077E-11	-8813.53369
$AV$60	RLIMITATION LHS	5000	-45.55911636

Table 5B: Limits report with export volume equals to 5000 tonnes

Cell	Adjustable Name	Value	Lower Limit	Target Result	Upper Limit	Target Result
$B$3	Solution Y1	7412.509659	7412.509659	0	7412.509659	0
$C$3	Solution Y2	5765.064977	5765.064977	0	5765.064977	0
$D$3	Solution Y3	8252.651369	8252.651369	0	8252.651369	0
$E$3	Solution Y4	15853.65274	15853.65274	0	15853.65274	0
$F$3	Solution Y5	507252.8179	507252.8179	0	507252.8179	0
$G$3	Solution X1	6874.709382	6874.709382	0	#N/A	#N/A
$H$3	Solution X2	5006.056536	5006.056536	0	#N/A	#N/A
$I$3	Solution X3	15911.38053	15911.38053	0	#N/A	#N/A
$J$3	Solution X4	26403.28196	26403.28196	0	#N/A	#N/A
$K$3	Solution X5	490341.2683	490341.2683	0	#N/A	#N/A
$L$3	Solution X11	6874.709382	6874.709382	0	6874.709382	0
$M$3	Solution X12	0	0	0	0	0
$N$3	Solution X13	0	0	0	0	0
$O$3	Solution X14	0	0	0	0	0
$P$3	Solution X15	0	0	0	0	0
$Q$3	Solution X21	0	0	0	0	0
$R$3	Solution X22	5006.056536	5006.056536	0	5006.056536	0
$S$3	Solution X23	0	0	0	0	0
$T$3	Solution X24	0	0	0	0	0
$U$3	Solution X25	0	0	0	0	0
$V$3	Solution X31	537.800277	537.800277	0	537.800277	0
$W$3	Solution X32	759.0084409	759.0084409	0	759.0084409	0
$X$3	Solution X33	8252.651369	8252.651369	0	8252.651369	0
$Y$3	Solution X34	1361.920441	1361.920441	0	1361.920441	0
$Z$3	Solution X35	5000	5000	0	5000	0
$AA$3	Solution X41	0	0	0	0	0
$AB$3	Solution X42	0	0	0	0	0
$AC$3	Solution X43	0	0	0	0	0
$AD$3	Solution X44	14491.7323	14491.7323	0	14491.7323	0
$AE$3	Solution X45	11911.54966	11911.54966	0	11911.54966	0
$AF$3	Solution X51	0	0	0	0	0
$AG$3	Solution X52	1.19209E-08	1.19209E-08	0	1.19209E-08	0
$AH$3	Solution X53	0	0	0	0	0
$AI$3	Solution X54	1.02696E-15	1.02696E-15	0	1.02696E-15	0
$AJ$3	Solution X55	490341.2683	490341.2683	0	490341.2683	0
$AK$3	Solution DP1	9490.113309	9490.113309	0	9490.113309	0
$AL$3	Solution DP2	8919.073309	8919.073309	0	8919.073309	0
$AM$3	Solution DP3	8397.903309	8397.903309	0	8397.903309	0
$AN$3	Solution DP4	8445.683309	8445.683309	0	8445.683309	0
$AO$3	Solution DP5	8813.533309	8813.533309	0	8813.533309	0
$AP$3	Solution SP1	9490.113309	9490.113309	0	9490.113309	0
$AQ$3	Solution SP2	8919.073309	8919.073309	0	8919.073309	0
$AR$3	Solution SP3	8397.903309	8397.903309	0	8397.903309	0
$AS$3	Solution SP4	8445.683309	8445.683309	0	8445.683309	0
$AT$3	Solution SP5	8813.533309	8813.533309	0	8813.533309	0
$AU$3	Solution LIMITATION	45.56	45.56	0	#N/A	#N/A

Table 6B: Answer report for adjustable cells with export volume equals to 6000 tonnes

Cell	Name	Original Value	Final Value
$B$3	Solution Y1	7412.509659	7412.509659
$C$3	Solution Y2	5765.064977	5765.064977
$D$3	Solution Y3	8252.651369	8252.651369
$E$3	Solution Y4	15853.65274	15853.65274
$F$3	Solution Y5	507252.8179	507252.8179
$G$3	Solution X1	6874.709382	6874.709382
$H$3	Solution X2	5006.056536	5006.056536
$I$3	Solution X3	15911.38053	15911.38053
$J$3	Solution X4	26403.28196	26403.28196
$K$3	Solution X5	490341.2683	490341.2683
$L$3	Solution X11	6874.709382	6874.709382
$M$3	Solution X12	0	0
$N$3	Solution X13	0	0
$O$3	Solution X14	0	0
$P$3	Solution X15	0	0
$Q$3	Solution X21	0	0
$R$3	Solution X22	5006.056536	5006.056536
$S$3	Solution X23	0	0
$T$3	Solution X24	0	0
$U$3	Solution X25	0	0
$V$3	Solution X31	537.800277	537.800277
$W$3	Solution X32	759.0084409	759.0084409
$X$3	Solution X33	8252.651369	8252.651369
$Y$3	Solution X34	361.9204408	361.9204408
$Z$3	Solution X35	6000	6000
$AA$3	Solution X41	0	0
$AB$3	Solution X42	0	0
$AC$3	Solution X43	0	0
$AD$3	Solution X44	15491.7323	15491.7323
$AE$3	Solution X45	10911.54966	10911.54966
$AF$3	Solution X51	0	0
$AG$3	Solution X52	1.19209E-08	1.19209E-08
$AH$3	Solution X53	0	0
$AI$3	Solution X54	1.02696E-15	1.02696E-15
$AJ$3	Solution X55	490341.2683	490341.2683
$AK$3	Solution DP1	9490.113309	9490.113309
$AL$3	Solution DP2	8919.073309	8919.073309
$AM$3	Solution DP3	8397.903309	8397.903309
$AN$3	Solution DP4	8445.683309	8445.683309
$AO$3	Solution DP5	8813.533309	8813.533309
$AP$3	Solution SP1	9490.113309	9490.113309
$AQ$3	Solution SP2	8919.073309	8919.073309
$AR$3	Solution SP3	8397.903309	8397.903309
$AS$3	Solution SP4	8445.683309	8445.683309
$AT$3	Solution SP5	8813.533309	8813.533309
$AU$3	Solution LIMITATION	45.56	45.56

Table 7B: Answer report for constrains with export volume equals to 6000 tonnes

Cell	Name	Cell Value	Formula	Status	Slack
$AV$15	RY1 LHS	-21453.9975	$AV$15<=$AX$15	Binding	0
$AV$16	RY2 LHS	-18924.14778	$AV$16<=$AX$16	Binding	0
$AV$17	RY3 LHS	-18866.23333	$AV$17<=$AX$17	Binding	0
$AV$18	RY4 LHS	-21512.495	$AV$18<=$AX$18	Binding	0
$AV$19	RY5 LHS	-18605.15889	$AV$19<=$AX$19	Binding	0
$AV$20	RX1 LHS	-33806.29909	$AV$20<=$AX$20	Binding	0
$AV$21	RX2 LHS	-19952.28484	$AV$21<=$AX$21	Binding	0
$AV$22	RX3 LHS	-13205.56154	$AV$22<=$AX$22	Binding	0
$AV$23	RX4 LHS	-23893.80308	$AV$23<=$AX$23	Binding	0
$AV$24	RX5 LHS	-35251.88	$AV$24<=$AX$24	Binding	0
$AV$25	RX11 LHS	0	$AV$25<=$AX$25	Binding	0
$AV$26	RX12 LHS	-571.04	$AV$26<=$AX$26	Not Binding	1142.08
$AV$27	RX13 LHS	-1092.21	$AV$27<=$AX$27	Not Binding	2184.42
$AV$28	RX14 LHS	-1044.43	$AV$28<=$AX$28	Not Binding	2184.42
$AV$29	RX15 LHS	-722.14	$AV$29<=$AX$29	Not Binding	1444.28
$AV$30	RX21 LHS	571.04	$AV$30<=$AX$30	Binding	0
$AV$31	RX22 LHS	0	$AV$31<=$AX$31	Binding	0
$AV$32	RX23 LHS	-521.17	$AV$32<=$AX$32	Not Binding	1042.34
$AV$33	RX24 LHS	-473.39	$AV$33<=$AX$33	Not Binding	1042.34
$AV$34	RX25 LHS	-151.1	$AV$34<=$AX$34	Not Binding	302.2
$AV$35	RX31 LHS	1092.21	$AV$35<=$AX$35	Binding	0
$AV$36	RX32 LHS	521.17	$AV$36<=$AX$36	Binding	0
$AV$37	RX33 LHS	0	$AV$37<=$AX$37	Binding	0
$AV$38	RX34 LHS	47.78	$AV$38<=$AX$38	Binding	0
$AV$39	RX35 LHS	370.07	$AV$39<=$AX$39	Binding	0
$AV$40	RX41 LHS	1044.43	$AV$40<=$AX$40	Not Binding	95.56
$AV$41	RX42 LHS	473.39	$AV$41<=$AX$41	Not Binding	95.56
$AV$42	RX43 LHS	-47.78	$AV$42<=$AX$42	Not Binding	95.56
$AV$43	RX44 LHS	0	$AV$43<=$AX$43	Binding	0
$AV$44	RX45 LHS	367.85	$AV$44<=$AX$44	Binding	0
$AV$45	RX51 LHS	676.58	$AV$45<=$AX$45	Not Binding	45.56
$AV$46	RX52 LHS	105.54	$AV$46<=$AX$46	Not Binding	45.56
$AV$47	RX53 LHS	-415.63	$AV$47<=$AX$47	Not Binding	785.7
$AV$48	RX54 LHS	-367.85	$AV$48<=$AX$48	Not Binding	735.7
$AV$49	RX55 LHS	0	$AV$49<=$AX$49	Binding	0
$AV$50	RDP1 LHS	-4.54747E-13	$AV$50<=$AX$50	Binding	0
$AV$51	RDP2 LHS	-8.6402E-13	$AV$51<=$AX$51	Binding	0
$AV$52	RDP3 LHS	0	$AV$52<=$AX$52	Binding	0
$AV$53	RDP4 LHS	-1.81909E-11	$AV$53<=$AX$53	Binding	0
$AV$54	RDP5 LHS	2.32831E-10	$AV$54<=$AX$54	Binding	0
$AV$55	RSP1 LHS	0	$AV$55<=$AX$55	Binding	0
$AV$56	RSP2 LHS	0	$AV$56<=$AX$56	Binding	0
$AV$57	RSP3 LHS	9.09495E-13	$AV$57<=$AX$57	Binding	0
$AV$58	RSP4 LHS	1.81899E-12	$AV$58<=$AX$58	Binding	0
$AV$59	RSP5 LHS	-1.74623E-10	$AV$59<=$AX$59	Binding	0
$AV$60	RLIMITATION LHS	6000	$AV$60<=$AX$60	Binding	0

Table 8B: Sensitivity report for adjustable cells with export volume equals to 6000 tonnes

Cell	Name	Final Value	Reduced Gradient
$B$3	Solution Y1	7412.509659	0
$C$3	Solution Y2	5765.064977	0
$D$3	Solution Y3	8252.651369	0
$E$3	Solution Y4	15853.65274	0
$F$3	Solution Y5	507252.8179	0
$G$3	Solution X1	6874.709382	0
$H$3	Solution X2	5006.056536	0
$I$3	Solution X3	15911.38053	0
$J$3	Solution X4	26403.28196	0
$K$3	Solution X5	490341.2683	0
$L$3	Solution X11	6874.709382	0
$M$3	Solution X12	0	1143.257675
$N$3	Solution X13	0	2198.408219
$O$3	Solution X14	0	2188.776309
$P$3	Solution X15	0	1446.865124
$Q$3	Solution X21	0	1.154898393
$R$3	Solution X22	5006.056536	0
$S$3	Solution X23	0	1055.163834
$T$3	Solution X24	0	1045.531924
$U$3	Solution X25	0	151.0328489
$V$3	Solution X31	537.800277	0
$W$3	Solution X32	759.0084409	0
$X$3	Solution X33	8252.651369	0
$Y$3	Solution X34	361.9204408	0
$Z$3	Solution X35	6000	0
$AA$3	Solution X41	0	100.0420508
$AB$3	Solution X42	0	98.87725589
$AC$3	Solution X43	0	47.84295413
$AD$3	Solution X44	15491.7323	0
$AE$3	Solution X45	10911.54966	0
$AF$3	Solution X51	0	48.27810313
$AG$3	Solution X52	1.19209E-08	-105.4745824
$AH$3	Solution X53	0	797.1654322
$AI$3	Solution X54	1.02696E-15	749.3869136
$AJ$3	Solution X55	490341.2683	0
$AK$3	Solution DP1	9490.113309	0
$AL$3	Solution DP2	8919.073309	0
$AM$3	Solution DP3	8397.903309	0
$AN$3	Solution DP4	8445.683309	0
$AO$3	Solution DP5	8813.533309	0
$AP$3	Solution SP1	9490.113309	0
$AQ$3	Solution SP2	8919.073309	0
$AR$3	Solution SP3	8397.903309	0
$AS$3	Solution SP4	8445.683309	0
$AT$3	Solution SP5	8813.533309	0
$AU$3	Solution LIMITATION	45.56	0

Table 9B: Sensitivity report for constrains with export volume equals to 6000 tonnes

Cell	Name	Final Value	Lagrange Multiplier
$AV$15	RY1 LHS	-21453.9975	-7412.518495
$AV$16	RY2 LHS	-18924.14778	-5765.072498
$AV$17	RY3 LHS	-18866.23333	-8252.661481
$AV$18	RY4 LHS	-21512.495	-15853.66927
$AV$19	RY5 LHS	-18605.15889	-507253.3387
$AV$20	RX1 LHS	-33806.29909	-6874.715915
$AV$21	RX2 LHS	-19952.28484	-5006.061141
$AV$22	RX3 LHS	-13205.56154	-15911.39528
$AV$23	RX4 LHS	-23893.80308	-26403.30968
$AV$24	RX5 LHS	-35251.88	-490341.7785
$AV$25	RX11 LHS	0	-6874.715915
$AV$26	RX12 LHS	-571.04	0
$AV$27	RX13 LHS	-1092.21	0
$AV$28	RX14 LHS	-1044.43	0
$AV$29	RX15 LHS	-722.14	0
$AV$30	RX21 LHS	571.04	759.0113571
$AV$31	RX22 LHS	0	-5765.072498
$AV$32	RX23 LHS	-521.17	0
$AV$33	RX24 LHS	-473.39	0
$AV$34	RX25 LHS	-151.1	0
$AV$35	RX31 LHS	1092.21	-1296.813937
$AV$36	RX32 LHS	521.17	0
$AV$37	RX33 LHS	0	-8252.661481
$AV$38	RX34 LHS	47.78	-361.8934939
$AV$39	RX35 LHS	370.07	-6000.026367
$AV$40	RX41 LHS	1044.43	0
$AV$41	RX42 LHS	473.39	0
$AV$42	RX43 LHS	-47.78	0
$AV$43	RX44 LHS	0	-15491.77577
$AV$44	RX45 LHS	367.85	-10911.5339
$AV$45	RX51 LHS	676.58	0
$AV$46	RX52 LHS	105.54	0
$AV$47	RX53 LHS	-415.63	0
$AV$48	RX54 LHS	-367.85	0
$AV$49	RX55 LHS	0	-490341.7785
$AV$50	RDP1 LHS	-4.54747E-13	-9490.115282
$AV$51	RDP2 LHS	-8.6402E-13	-8919.075487
$AV$52	RDP3 LHS	0	-8397.905199
$AV$53	RDP4 LHS	-1.81909E-11	-8445.683717
$AV$54	RDP5 LHS	2.32831E-10	-8813.533662
$AV$55	RSP1 LHS	0	-9490.115282
$AV$56	RSP2 LHS	0	-8919.075487
$AV$57	RSP3 LHS	9.09495E-13	-8397.905199
$AV$58	RSP4 LHS	1.81899E-12	-8445.683717
$AV$59	RSP5 LHS	-1.74623E-10	-8813.533662
$AV$60	RLIMITATION LHS	6000	-45.55833435

Table 10B: Answer report for adjustable cells with export volume equals to 8500 tonnes

Cell	Name	Original Value	Final Value
$B$3	Solution Y1	7412.509659	7385.548871
$C$3	Solution Y2	5765.064977	5739.990989
$D$3	Solution Y3	8252.651369	8218.346512
$E$3	Solution Y4	15853.65274	15856.13382
$F$3	Solution Y5	507252.8179	507358.7559
$G$3	Solution X1	6874.709382	6881.618808
$H$3	Solution X2	5006.056536	5013.601689
$I$3	Solution X3	15911.38053	15943.43023
$J$3	Solution X4	26403.28196	26401.61238
$K$3	Solution X5	490341.2683	490318.513
$L$3	Solution X11	6874.709382	6881.618808
$M$3	Solution X12	0	0
$N$3	Solution X13	0	0
$O$3	Solution X14	0	0
$P$3	Solution X15	0	0
$Q$3	Solution X21	0	7.82688E-07
$R$3	Solution X22	5006.056536	5013.601688
$S$3	Solution X23	0	0
$T$3	Solution X24	0	0
$U$3	Solution X25	0	0
$V$3	Solution X31	537.800277	503.9300608
$W$3	Solution X32	759.0084409	5.19421E-07
$X$3	Solution X33	8252.651369	8218.346512
$Y$3	Solution X34	361.9204408	5.89697E-08
$Z$3	Solution X35	6000	7221.153655
$AA$3	Solution X41	0	0
$AB$3	Solution X42	0	6.62663E-09
$AC$3	Solution X43	0	0
$AD$3	Solution X44	15491.7323	15856.13382
$AE$3	Solution X45	10911.54966	10545.47856
$AF$3	Solution X51	0	7.30431E-07
$AG$3	Solution X52	1.19209E-08	726.3893005
$AH$3	Solution X53	0	0
$AI$3	Solution X54	1.02696E-15	1.02696E-15
$AJ$3	Solution X55	490341.2683	489592.1237
$AK$3	Solution DP1	9490.113309	9533.628362
$AL$3	Solution DP2	8919.073309	8962.588362
$AM$3	Solution DP3	8397.903309	8441.418362
$AN$3	Solution DP4	8445.683309	8443.638362
$AO$3	Solution DP5	8813.533309	8811.488362
$AP$3	Solution SP1	9490.113309	9533.628362
$AQ$3	Solution SP2	8919.073309	8962.588362
$AR$3	Solution SP3	8397.903309	8441.418362
$AS$3	Solution SP4	8445.683309	8443.638362
$AT$3	Solution SP5	8813.533309	8811.488362
$AU$3	Solution LIMITATION	45.56	0

Table 11B: Answer report for constrains with export volume equals to 8500 tonnes

Cell	Name	Cell Value	Formula	Status	Slack
$AV$15	RY1 LHS	-21453.9975	$AV$15<=$AX$15	Binding	0
$AV$16	RY2 LHS	-18924.14778	$AV$16<=$AX$16	Binding	0
$AV$17	RY3 LHS	-18866.23333	$AV$17<=$AX$17	Binding	0
$AV$18	RY4 LHS	-21512.495	$AV$18<=$AX$18	Binding	0
$AV$19	RY5 LHS	-18605.15889	$AV$19<=$AX$19	Binding	0
$AV$20	RX1 LHS	-33806.29909	$AV$20<=$AX$20	Binding	0
$AV$21	RX2 LHS	-19952.28484	$AV$21<=$AX$21	Binding	0
$AV$22	RX3 LHS	-13205.56154	$AV$22<=$AX$22	Binding	0
$AV$23	RX4 LHS	-23893.80308	$AV$23<=$AX$23	Binding	0
$AV$24	RX5 LHS	-35251.88	$AV$24<=$AX$24	Binding	0
$AV$25	RX11 LHS	0	$AV$25<=$AX$25	Binding	0
$AV$26	RX12 LHS	-571.04	$AV$26<=$AX$26	Not Binding	1142.08
$AV$27	RX13 LHS	-1092.21	$AV$27<=$AX$27	Not Binding	2184.42
$AV$28	RX14 LHS	-1089.99	$AV$28<=$AX$28	Not Binding	2229.98
$AV$29	RX15 LHS	-722.14	$AV$29<=$AX$29	Not Binding	1444.28
$AV$30	RX21 LHS	571.04	$AV$30<=$AX$30	Binding	0
$AV$31	RX22 LHS	0	$AV$31<=$AX$31	Binding	0
$AV$32	RX23 LHS	-521.17	$AV$32<=$AX$32	Not Binding	1042.34
$AV$33	RX24 LHS	-518.95	$AV$33<=$AX$33	Not Binding	1087.9
$AV$34	RX25 LHS	-151.1	$AV$34<=$AX$34	Not Binding	302.2
$AV$35	RX31 LHS	1092.21	$AV$35<=$AX$35	Binding	0
$AV$36	RX32 LHS	521.17	$AV$36<=$AX$36	Binding	0
$AV$37	RX33 LHS	0	$AV$37<=$AX$37	Binding	0
$AV$38	RX34 LHS	2.22	$AV$38<=$AX$38	Not Binding	45.56
$AV$39	RX35 LHS	370.07	$AV$39<=$AX$39	Binding	0
$AV$40	RX41 LHS	1089.99	$AV$40<=$AX$40	Not Binding	50
$AV$41	RX42 LHS	518.95	$AV$41<=$AX$41	Not Binding	50
$AV$42	RX43 LHS	-2.22	$AV$42<=$AX$42	Not Binding	50
$AV$43	RX44 LHS	0	$AV$43<=$AX$43	Binding	0
$AV$44	RX45 LHS	367.85	$AV$44<=$AX$44	Binding	0
$AV$45	RX51 LHS	722.14	$AV$45<=$AX$45	Binding	0
$AV$46	RX52 LHS	151.1	$AV$46<=$AX$46	Binding	0
$AV$47	RX53 LHS	-370.07	$AV$47<=$AX$47	Not Binding	740.14
$AV$48	RX54 LHS	-367.85	$AV$48<=$AX$48	Not Binding	735.7
$AV$49	RX55 LHS	0	$AV$49<=$AX$49	Binding	0
$AV$50	RDP1 LHS	6.96178E-13	$AV$50<=$AX$50	Binding	0
$AV$51	RDP2 LHS	6.82121E-13	$AV$51<=$AX$51	Binding	0
$AV$52	RDP3 LHS	0	$AV$52<=$AX$52	Binding	0
$AV$53	RDP4 LHS	-1.02696E-15	$AV$53<=$AX$53	Binding	0
$AV$54	RDP5 LHS	1.16415E-10	$AV$54<=$AX$54	Binding	0
$AV$55	RSP1 LHS	0	$AV$55<=$AX$55	Binding	0
$AV$56	RSP2 LHS	3.63798E-12	$AV$56<=$AX$56	Binding	0
$AV$57	RSP3 LHS	-9.09495E-13	$AV$57<=$AX$57	Binding	0
$AV$58	RSP4 LHS	3.63798E-12	$AV$58<=$AX$58	Binding	0
$AV$59	RSP5 LHS	-5.82077E-11	$AV$59<=$AX$59	Binding	0
	RLIMITATION				2778.84634
$AV$60	LHS	7221.153655	$AV$60<=$AX$60	Not Binding	5

Table 12B: Sensitivity report for adjustable cells with export volume equals to 8500 tonnes

Cell	Name	Final Value	Reduced Gradient
$B$3	Solution Y1	7385.548871	0
$C$3	Solution Y2	5739.990989	0
$D$3	Solution Y3	8218.346512	0
$E$3	Solution Y4	15856.13382	0
$F$3	Solution Y5	507358.7559	0
$G$3	Solution X1	6881.618808	0
$H$3	Solution X2	5013.601689	0
$I$3	Solution X3	15943.43023	0
$J$3	Solution X4	26401.61238	0
$K$3	Solution X5	490318.513	0
$L$3	Solution X11	6881.618808	0
$M$3	Solution X12	0	1105.115055
$N$3	Solution X13	0	2160.257863
$O$3	Solution X14	0	2196.184939
$P$3	Solution X15	0	1408.715794
$Q$3	Solution X21	7.82688E-07	0
$R$3	Solution X22	5013.601688	0
$S$3	Solution X23	0	1017.00919
$T$3	Solution X24	0	1052.936267
$U$3	Solution X25	0	151.0262032
$V$3	Solution X31	503.9300608	0
$W$3	Solution X32	5.19421E-07	0
$X$3	Solution X33	8218.346512	0
$Y$3	Solution X34	5.89697E-08	-2.2968777
$Z$3	Solution X35	7221.153655	0
$AA$3	Solution X41	0	16.33947479
$AB$3	Solution X42	6.62663E-09	14.86398447
$AC$3	Solution X43	0	2.284299005
$AD$3	Solution X44	15856.13382	0
$AE$3	Solution X45	10545.47856	0
$AF$3	Solution X51	7.30431E-07	0
$AG$3	Solution X52	726.3893005	0
$AH$3	Solution X53	0	713.4594993
$AI$3	Solution X54	1.02696E-15	711.2396201
$AJ$3	Solution X55	489592.1237	0
$AK$3	Solution DP1	9533.628362	0
$AL$3	Solution DP2	8962.588362	0
$AM$3	Solution DP3	8441.418362	0
$AN$3	Solution DP4	8443.638362	0
$AO$3	Solution DP5	8811.488362	0
$AP$3	Solution SP1	9533.628362	0
$AQ$3	Solution SP2	8962.588362	0
$AR$3	Solution SP3	8441.418362	0
$AS$3	Solution SP4	8443.638362	0
$AT$3	Solution SP5	8811.488362	0
$AU$3	Solution LIMITATION	0	0

Table 13B: Sensitivity report for constrains with export volume equals to 8500 tonnes

Cell	Name	Final Value	Lagrange Multiplier
$AV$15	RY1 LHS	-21453.9975	-7385.55485
$AV$16	RY2 LHS	-18924.14778	-5739.993384
$AV$17	RY3 LHS	-18866.23333	-8218.355877
$AV$18	RY4 LHS	-21512.495	-15856.15025
$AV$19	RY5 LHS	-18605.15889	-507359.2852
$AV$20	RX1 LHS	-33806.29909	-6881.625529
$AV$21	RX2 LHS	-19952.28484	-5013.607244
$AV$22	RX3 LHS	-13205.56154	-15943.44505
$AV$23	RX4 LHS	-23893.80308	-26401.63976
$AV$24	RX5 LHS	-35251.88	-490319.022
$AV$25	RX11 LHS	0	-6881.625529
$AV$26	RX12 LHS	-571.04	0
$AV$27	RX13 LHS	-1092.21	0
$AV$28	RX14 LHS	-1089.99	0
$AV$29	RX15 LHS	-722.14	0
$AV$30	RX21 LHS	571.04	726.3861401
$AV$31	RX22 LHS	0	-5739.993384
$AV$32	RX23 LHS	-521.17	0
$AV$33	RX24 LHS	-518.95	0
$AV$34	RX25 LHS	-151.1	0
$AV$35	RX31 LHS	1092.21	2231.268807
$AV$36	RX32 LHS	521.17	0
$AV$37	RX33 LHS	0	-8218.355877
$AV$38	RX34 LHS	2.22	0
$AV$39	RX35 LHS	370.07	-9956.357978
$AV$40	RX41 LHS	1089.99	0
$AV$41	RX42 LHS	518.95	0
$AV$42	RX43 LHS	-2.22	0
$AV$43	RX44 LHS	0	-15856.15025
$AV$44	RX45 LHS	367.85	-10545.48951
$AV$45	RX51 LHS	722.14	-3461.584268
$AV$46	RX52 LHS	151.1	0
$AV$47	RX53 LHS	-370.07	0
$AV$48	RX54 LHS	-367.85	0
$AV$49	RX55 LHS	0	-486857.4377
$AV$50	RDP1 LHS	6.96178E-13	-9533.626381
$AV$51	RDP2 LHS	6.82121E-13	-8962.582298
$AV$52	RDP3 LHS	0	-8441.41935
$AV$53	RDP4 LHS	-1.02696E-15	-8443.639229
$AV$54	RDP5 LHS	1.16415E-10	-8811.488869
$AV$55	RSP1 LHS	0	-9533.626381
$AV$56	RSP2 LHS	3.63798E-12	-8962.582298
$AV$57	RSP3 LHS	-9.09495E-13	-8441.41935
$AV$58	RSP4 LHS	3.63798E-12	-8443.639229
$AV$59	RSP5 LHS	-5.82077E-11	-8811.488869
$AV$60	RLIMITATION LHS	7221.153655	0