# THREE ESSAYS ON RICE MARKETS AND POLICIES IN SOUTHEAST ASIA WITH A FOCUS ON RICE CONSUMPTION PATTERNS IN VIETNAM

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By

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THREE ESSAYS ON RICE MARKETS AND POLICIES IN SOUTHEAST ASIA WITH A FOCUS ON RICE CONSUMPTION PATTERNS IN VIETNAM

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# DEDICATION

*To my husband, Hien, for teaching me to stay faithful, in all circumstances…and to my daughter, Anna, for your cries and smiles that have spiced up my life.*

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Chapter 3: FOOD DEMAND IN VIETNAM: STRUCTURAL CHANGES AND PROJECTIONS TO 2030

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# ABSTRACT

The purpose of this dissertation is to analyze rice markets and policies in Southeast Asia with a focus on rice demand in Vietnam. The first essay explores the impacts of removing rice tariffs in the region's three largest importing countries, i.e. Indonesia, Malaysia and the Philippines, using a partial equilibrium approach. Results from the study indicate that the removal of AFTA tariffs has the largest impacts on Indonesia and the Philippines' net trade and modestly affects domestic prices as well as world prices. Relative to the baseline, the removal of AFTA tariffs leads to an 8% increase in the world price and an increase by 8%, 13% and 48% in Malaysia, Indonesia and the Philippines' imports, respectively. If all tariffs were eliminated, imports would increase significantly in Indonesia and the Philippines, by about 137% and 130% relative to the baseline. The world price is projected to increase by about 33% under this full liberalization scenario, leading to a modest rise in exports from Thailand and Vietnam but a significant decline in imports by African countries, by about 1 million tons. Results from this study suggest that the likely sizeable impacts of full trade liberalization would prevent governments of the importing countries from removing tariffs completely but some level of tariff removal would be viable.

The second essay examines dietary changes in the consumption of rice in Vietnam using recent household survey data. Two demand systems, AIDS and QUAIDS, are employed for

analysis. Robust test results suggest that QUAIDS outperforms AIDS in fitting data although both models yield similar outcomes. In addition, rice consumption patterns differ greatly by income class as well as between rural and urban areas. At the national level, the expenditure elasticity of rice is estimated to be positive but very small in magnitude, 0.05. Interestingly, rice appears to be a normal good for rural consumers but an inferior good for urban consumers with expenditure elasticities of 0.14 and -0.18, respectively. Rice is also found to be an inferior good for consumers at higher income quintiles in both rural and urban areas. Findings of this study imply that effective food, nutrition and poverty policies need to take into consideration the heterogeneity in demand responses with regard to price and income shocks across different demographic groups.

The third essay extends the results of the second essay by using the estimated QUAIDS model to project at-home food demand in Vietnam through the years 2020 and 2030 taking into account the effects of food expenditure, food prices and urbanization. Results indicate that budget shares of rice decline significantly while those for meat and fish, drinks and miscellaneous food group including out-of-home food increase at higher levels of food expenditures. On a per capita basis, rice demand shows a fall in 2020 from the 2010 level and continues to decline in 2030. Demand for pork on a per capita basis continues to increase at higher levels of food expenditures but its growth rate is slower than that of meat and fish, suggesting consumers' high preference for non-pork meats and seafood as their incomes rise. Interestingly, the effect of urbanization on the national average consumption is found to be remarkable for rice while modest for other food groups. Results of this study highlight the importance of considering the effects of income distribution and urbanization on food demand projections.

# IMPACTS OF ASEAN REGIONAL TRADE LIBERALIZATION: A PARTIAL EQUILIBRIUM APPROACH

## 1. Introduction

Rice is a critical commodity for Southeast Asian region as it is the major staple for nearly 600 million people, of which about one fifth are poor[1] (United Nations, 2011). In the global rice market, Southeast Asia plays an important role as it accounts for nearly 25% of total production and consumption and 50% of exports annually (USDA, 2013). The region is unique in the sense that it comprises some of the largest rice importers and exporters in the world. Indonesia, Malaysia and the Philippines are among the world's top rice importers while Thailand and Vietnam have been the world's leading rice exporters for nearly two decades. Rice has become a strategic and political commodity in these five countries, especially in three importing countries where maintaining adequate supply of rice has become a critical and sensitive issue for incumbent governments.

To protect the domestic rice markets from global price volatility, governments of Indonesia, Malaysia and the Philippines used interventionist policies and pursue price stabilization regimes. Tariffs and import quotas implemented through the operation of state-trading enterprises (STEs) are among the most commonly used tools for this purpose. While tariffs on a majority of products traded within the region have been reduced to 0-5%, rice tariffs in these three countries still remain at 30%, 20% and 40%, respectively.

[1] Poverty is defined as those living on less than PPP$1.25, in constant 2005 prices and on a daily basis.

Free trade vs. protectionism is a long-standing debate in economics. International trade theory based on the comparative advantage proposition states that any deviations from free trade would cause allocative inefficiencies and encourage rent-seeking behaviors (Samuelson, 1948). However, in the presence of market imperfections and distortions, it has been argued that trade policies such as tariffs or quotas would increase national welfare as the benefits of reducing the negative effects outweigh the efficiency losses caused by the protection (Bhagwati & Srinivasan, 1971; Krugman, 1987). This seems particularly true for the rice sector in major Southeast Asian countries where the market is formed by numerous small farmers and characterized by very inelastic supply and demand. This makes rent-seeking behavior unlikely and the costs, if they occur, trivial relative to the benefits (Dawe, 2001). Generally, it is argued that stable domestic rice prices benefit poor consumers, poor farmers and the macro-economy as a whole, especially in the absence of efficient insurance and credit markets and in the wake of global price volatility in recent years (Dawe, 2001; Dawe & Timmer, 2012; Gouel, 2013; C. P. Timmer, 1989).

In December 2015, the Association of Southeast Asian Nations (ASEAN) will become an Economic Community, which mainly implies stronger commitments on trade liberalization from its country members. In light of this, rice tariffs in Indonesia and the Philippines are scheduled to be reduced by 5% from the current levels while tariffs in Malaysia will remain at 20%. Given the critical role of rice in the economy and the high level of protection in these countries, little is known about whether rice tariffs will be further reduced in the near future. However, expectations are that in the long run, rice trade barriers will be removed gradually in congruence with the ASEAN Free Trade Agreement (AFTA) and WTO commitments.

Despite the fact that the adoption of price stabilization mechanisms is pervasive in the world's major rice importing countries such as the Philippines and Indonesia, there is a lack of studies that account for this important characteristic while modeling the global and regional rice market. The common practice is to assume that domestic rice prices move with world prices, either in a direct or indirect manner. There is no study that mimics the price stabilization mechanism, which requires some kind of modeling effort to fix domestic prices at a desired level.

In addition, it has been broadly accepted that rice consumption projections are important for governments and private sectors to make appropriate and timely investments in improving rice production and food security. At the global level, there is an unresolved debate over the long term outlook for rice consumption. One side of the debate projects that global rice consumption will increase to 450 million tons in 2020 and decline sharply after 2025. This declining trend is expected to continue to the year 2050 when global rice consumption is projected to fall to somewhere between 255 and 404 million tons (Timmer, Block, & Dawe, 2010). On the other hand, other studies project that global rice consumption will increase steadily to the year 2050. For example, using time series data aggregated at the global level, Rejesus, Mohanty, & Balagtas (2012) projected that global rice consumption would be as much as 490 million tons in 2020 and 650 million tons in 2050. The large divergence in the results underlines the difficulties in projecting rice consumption in the long term as well as the disparity in methods used among existing models. It also highlights the need of further research to bridge this gap.

This study goes beyond existing literature by capturing the unique characteristics of the rice markets in Indonesia, Malaysia, the Philippines, Thailand and Vietnam, hereafter called

ASEAN-5 countries, while maintaining a global rice modeling environment. The study aims to provide projections of regional and global rice production, consumption and trade through the year 2020 as well as to analyze the impacts of removing trade barriers in three major rice importing countries, i.e. Indonesia, Malaysia, and the Philippines. In doing so, the IRRI Global Rice Model (IGRM) developed by the International Rice Research Institute (IRRI) is modified and used as the fundamental modeling framework. IGRM is a partial equilibrium global rice model covering 31 major rice producing and consuming countries and regions in the world. Country models for ASEAN-5 are modified to reflect the price stabilization mechanisms, important trade policies such as Thailand's recent rice price pledging scheme as well as to measure the impacts of removing rice tariffs relative to the baseline.

This study is novel because it focuses on modeling the structural differences in the rice markets of the world's top rice trading countries - an issue that has been broadly discussed in the literature but received limited attention in modeling practice. The study is timely as it provides impact analyses of AFTA tariff reduction, which begins to be realized in 2015, in addition to the potential effects of abandoning price stabilization policies and gearing domestic markets toward free trade. The results of this study are useful for policy makers and analysts to understand the latent costs and benefits of pursuing different rice policies and the effects of those policies on domestic rice consumers, producers and the global market as a whole.

The next section of the essay presents an overview of the ASEAN rice market. Major rice trade policies in ASEAN-5 countries are discussed in the context of AFTA along with the roles of STEs in the international rice trade of selected countries.  These discussions are important for us to build assumptions and behavioral equations for the ASEAN-5 model. Section 3 reviews existing projection models and summarizes global rice projections to 2050 obtained from these models. Section 4 provides an overview of the original IGRM model, followed by detailed descriptions of the modifications and specifications used in the ASEAN-5 model. Section 5 presents the baseline projections and scenario impact analysis. The last section of this essay summarizes the projection results and discusses implications for policy.

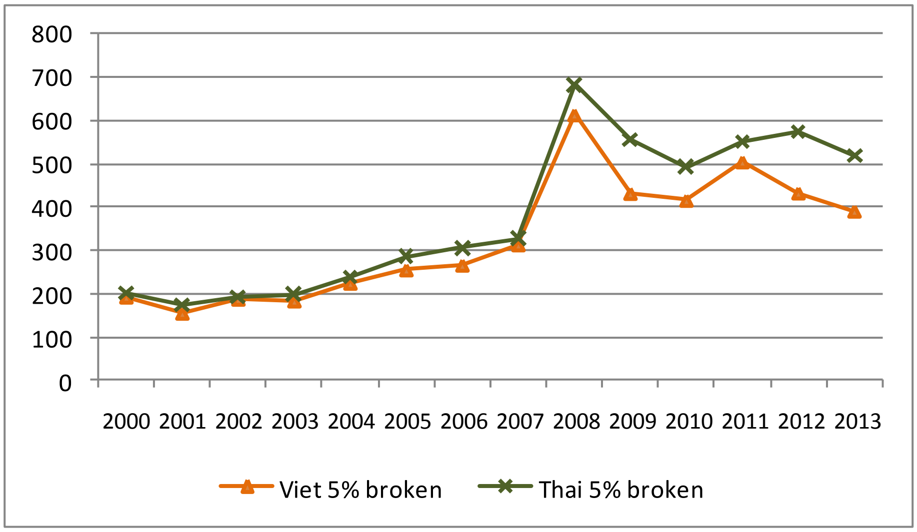
## 2. The ASEAN rice market and rice trade policy

### *2.1. Overview of ASEAN rice market*

Rice has a long history and is deeply rooted in Southeast Asian culture. The cultivation of rice was found to take place in 3500 BC at Ban Chiang, Thailand or sometime between 4000 BC to 2000 BC in the northern part of Vietnam (Kiple & Ornelas, 2000).

The Southeast Asian rice market embodies several interesting characteristics. First, Southeast Asian countries produce and consume mainly *indica* (long-grain) rice but the market is distinctively segmented by quality. Thailand has been known as the major supplier of high quality rice while Vietnam dominates the medium and low-quality rice segment. The price of Vietnamese rice is normally lower than the price of Thai rice even for the same quality. For example, the average price of Vietnamese 5% broken rice was about $20 below the price of Thai 5% broken rice during the 2000-2007 period (Figure 1). The price gap, however, has been getting wider since 2008 due to the effects of the 2007/08 food price crisis coupled with the Thai government's price support policy that drove up Thailand rice prices in the domestic and world market.

Figure 1: Viet and Thai 5% broken prices, 2000-2013 ($/MT)




Source: IGRM and (FAO, 2014a)

Second, ASEAN as a whole is a net rice exporter. The region exports about 15 million tons of rice each year, accounting for 47% of the world's total exports, while it imports about 5 million tons, accounting for 17% of the world's total on average (Table 1). Thailand and Vietnam together account for a dominant share of ASEAN rice exports, about 90% on average. Although India took over the top export position from Thailand in the past three years, both Thailand and Vietnam were consistently the world's top rice exporters for nearly two decades. In addition, the Philippines and Indonesia jointly account for nearly 70% of ASEAN imports on average. Indonesia accounts for the largest shares in harvested area and milled production in the region, about 26% and 34%, respectively. It is also the region's largest rice consumer with annual consumption of about 37 million tons. Average consumption often exceeds production by about 1.5 million tons, which is made up through imports. Among ASEAN-5 countries, the Philippines has the highest annual growth rates in both harvested area and milled production, 1.2% and 2.9%, respectively. However, its consumption also grows at an annual rate of 3.1%, faster than other countries in the region. To meet its increasing demand, the Philippines imports about 1.2 to 2 million tons of rice each year.

Table 1: ASEAN rice supply, utilization and trade, 2000-2013 averages

| | Harvested area | | Milled production | | Consumption | | Imports | Exports |
|---|---|---|---|---|---|---|---|---|
| | Average (1000HA) | *Average growth rate* | Average (1000MT) | *Average growth rate* | Average (1000MT) | *Average growth rate* | Average (1000MT) | Average (1000MT) |
| Indonesia | 11,900 | *0.3%* | 35,502 | *1.0%* | 36,908 | *0.6%* | 1,457 | - |
| Malaysia | 665 | *0.3%* | 1,521 | *1.8%* | 2,333 | *2.8%* | 832 | - |
| Philippines | 4,323 | *1.2%* | 9,899 | *2.9%* | 11,564 | *3.1%* | 1,685 | - |
| Thailand | 10,496 | *0.8%* | 18,922 | *1.5%* | 9,842 | *1.2%* | 188 | 8,400 |
| Vietnam | 7,503 | *0.3%* | 24,009 | *2.4%* | 18,953 | *1.9%* | 260 | 5,322 |
| ASEAN | 44,902 | *0.8%* | 105,676 | *1.7%* | 94,703 | *1.3%* | 4,886 | 14,909 |
| World | 154,722 | *0.4%* | 428,243 | *1.4%* | 428,227 | *1.4%* | 29,357 | 31,649 |

Source: USDA (2013)

Third, it has been observed that geography matters in rice production and trade, at least in the case of ASEAN-5 countries. One of the explanations for the chronic importation of rice in Indonesia and the Philippines is that they are island countries with less land suitable for rice cultivation than for other crops (Moya & Casiwan, 2006). In contrast, Thailand and Vietnam have led the global rice export market partly because they are endowed with big delta rivers. As the production of rice requires a large amount of water, rice production is well-suited in countries with high rainfall or big rivers. This characteristic of rice cultivation, however, leads to difficulties in land conversion as not many crops can be grown in rice land areas, which in turn makes rice supply highly inelastic (Wailes, 2005).

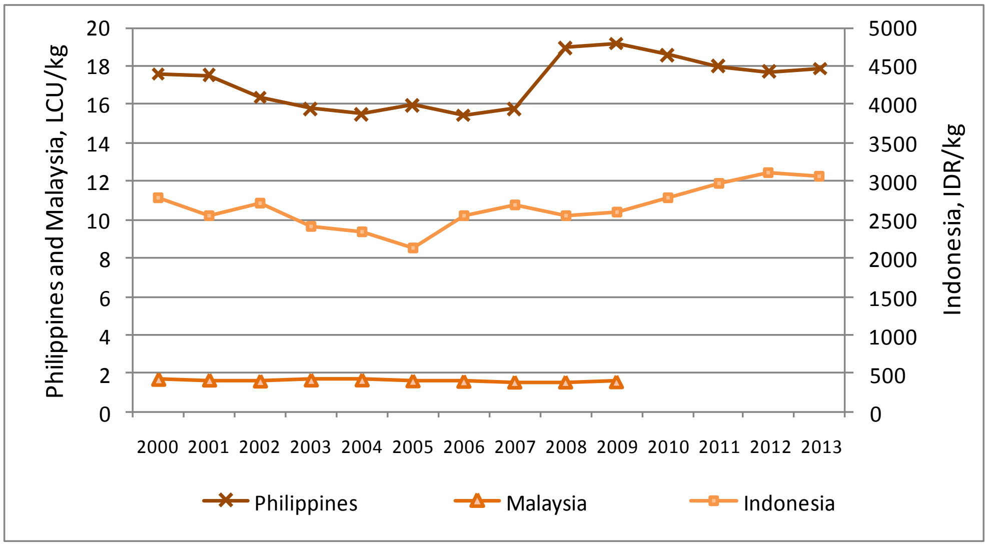
Fourth, the levels and trends of per capita rice consumption are diverse across ASEAN-5 countries. According to USDA consumption and residual data, the ASEAN average level is about 198 kg, almost three times higher than the world average, which was 68 kg in 2013 (USDA 2013). Thailand and Vietnam have the highest levels of rice consumption and residual, about 222 kg and 155 kg on a per capita basis, followed by Indonesia, the Philippines and Malaysia. Note that

USDA's consumption and residual data include not only human consumption but also other uses such as feed and seed use. Thus, the calculated per capita consumption using USDA data appears to be larger than results from other sources, such as household survey data, which often measure at-home rice consumption only. For example, per capita rice consumption imputed from the Vietnam Household Living Standard Survey is about 143 kg in 2010 compared to 220 kg according to USDA consumption and residual data. Using household survey data across countries, Mohanty (2013) found that per capita rice consumption has shown a declining trend in Thailand, Vietnam and Malaysia while it is on the rise in both rural and urban areas of the Philippines.

Fifth, most rice trade occurs within the region. Trade flow data from UN Comtrade database (United Nations, 2013a) showed that Thailand and Vietnam collectively account for a dominant share of total rice imports by all three importing countries, about 95% of Indonesia and the Philippines's annual imports and 90% of Malaysia's annual imports. The individual share of imports originated from Thailand and Vietnam also changed over time. Since 2000, Vietnam has been the major supplier of rice for the Philippines with a dominant share ranging from 80% to 99%. Similarly, about 70% of Malaysia's ASEAN-origin imports comes from Vietnam. As Thai rice became more expensive in the world market in the past few years, Indonesia has turned to Vietnam for cheaper rice as well. Their imports from Vietnam have been increasing, accounting for about 65% of total imports annually.

At the same time, it has been widely recognized that governments in Southeast Asian countries pursue price stabilization mechanisms. Figure 2 presents a graphic illustration of the real retail prices in the Philippines, Malaysia and Indonesia in local currencies from 2000 to 2013 (except for Malaysia whose price data are only available to 2009). Average prices and coefficients of variation were also calculated in addition to the world prices converted into Indonesian rupiahs and adjusted for inflation, as shown in Table 2.

Figure 2: Philippines, Malaysia, and Indonesia's real retail prices and world prices, 2000-2013




Source: Calculated.

Table 2: Average real retail prices and coefficients of variation, 2000-2013

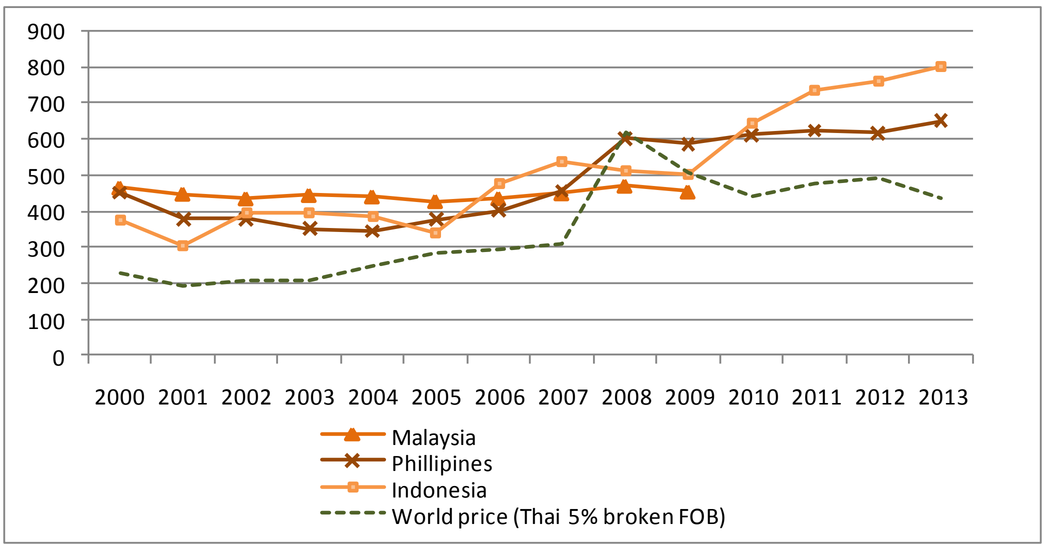
| | Unit | Average price | Coefficient of variation |
|---|---|---|---|
| Philippines | PHP/kg | 17.2 | 7.7 |
| Indonesia | IDR/kg | 2,661.4 | 10.3 |
| Malaysia | MYR/kg | 1.6 | 3.1 |
| World (Thai 5% broken) | IDR/kg | 1,832.8 | 26.6 |

Source: Calculated. World prices are converted into Indonesia's 2000 prices.

Apparently, Malaysia's real retail price of rice barely changed from its average of 1.6 MYR/kg. Although the Philippines and Indonesia' prices varied around their averages of 17 PHP/kg and 2,661 IDR/kg, their coefficients of variation are less than half of that for the world reference price. This implies that domestic retail prices were much less volatile than the world prices during this period. Converted into constant US dollars, domestic prices were consistently higher and more stable than the world prices before the 2008 food price crisis (Figure 3). Since this compares domestic retail to international wholesale prices, it is expected to be higher.

However, during the price spike in 2008, this price margin disappeared and retail prices in Malaysia and Indonesia did not even increase. In the Philippines, domestic prices increased in 2008 but the pre-2008 price margin disappeared. After 2008, in the Philippines and especially in Indonesia, retail prices started to rise well above the world prices, partly due to their governments' efforts to pursue self-sufficiency in the wake of the food crisis. They hoped that keeping domestic prices high will incentivize farmers and boost production, which in turn would help the country to be less dependent on imports.

Figure 3: Philippines, Malaysia, Indonesia's real retail prices and real world prices ($/MT)




Source: Calculated.

According to Timmer (1989), price stabilization policy has been subject to intense debate in the policy analysis arena since the 1950s. There are mainly two schools of thought which oppose price stabilization in favor of free trade and equity-oriented interventions. While the former was widely accepted among donors in the 1980s and the latter was highly welcome in Latin America, none of them were employed in Southeast Asian countries as a direction for food price policy.

Justifications for this widespread practice of price stabilization are, as Timmer (1989) and later Dawe (2001) and Dawe & Timmer (2012) argued, benefits for consumers, rice farmers and the economy. In Southeast Asian countries, rice is the basic food stuff for a majority of the population. Governments in these countries often face a “price dilemma”. On the one hand, rice prices need to be affordable for consumers. Low and stable rice prices keep wages low, which in turn induce investments and social stability (Timmer, 1989). Poor consumers benefit the most from stable rice prices as 40-60% of their calorie intake comes from rice. While their income is low and their food choice is limited, an increase in rice price may result in reducing consumption of high-protein foods and eventually cutting down on rice consumption if high prices continue to persist. A surge in rice price often causes hoarding and social unrest, which can endanger the political and social stability. In addition, farming is small and fragmented in most rice-based countries. Farmers often live a precarious life on rice farming and many of them are net rice buyers who benefit from low rice prices. At the same time, farm prices need to be high enough to farmers who are net rice sellers in order to sustain their incomes and give them incentives to keep investing in rice farming. At the macro level, maintaining an adequate supply of rice through domestic production is directly linked to the country’s food security. If farm prices remain too low, farmers would eventually have to abandon their rice fields and go to urban areas to find jobs. This trend has happened in some major rice producing areas of Vietnam in recent years (Kubo, 2013). Thus, maintaining stable rice prices is important for the country’s macroeconomic and political stability, which contributes to improve efficiency and welfare gains. In addition, Gouel (2013) argued that the problem with a market-based approach is that it advocates the use of safety net and market-based risk management practice. However, both instruments are difficult to implement in developing countries, especially in times of crisis. In addition, few countries can afford adequate social safety net programs and even if they exist, such programs are often out of reach for the poor, especially those in rural and remote areas.

However, stabilization mechanisms, if not used properly, can also distort the market and hinder development. In light of this, Dawe (2001) pointed out that a price stabilization policy that leads to limited differences between world prices and domestic prices is important for macroeconomic stability and food security. If price stabilization is backed by persistent protectionist instruments such as taxation or subsidization, it would violate WTO regulations and is not justifiable. Recent studies on Indonesia's rice market and policies also suggested that some level of liberalization, rather than pursuing a policy of self-sufficiency by raising the domestic prices, may help the government achieve food security targets (Dawe, 2008; Dodge & Gemessa, 2012; Warr, 2005).

Price stabilization policy intertwines a vast array of instruments, which include storage, subsidies, income supports, floor price and rice distribution programs (such as Indonesia's Rice for the Poor program - Raskin), and trade policies such as tariffs and quantitative restrictions. Among those, buffer stocks and trade policy have been the most commonly used tools to shield the domestic market from global price volatility. Interestingly, analyses of the food crisis 2007/08 have found that countries with interventionist policies that employed both trade and buffer stocks are those that coped with the crisis better (Gouel, 2013). As Timmer (1989) pointed out, trade and buffer stocks policy in achieving price stabilization are just like two sides of a coin. Governments in the adopting countries normally assign to an STE the monopoly control in buying rice or paddy for buffer stocks, which is often completed through two operations: domestic procurement and trade. Domestic procurement relates to seasonal buying in which the STE purchases rice or paddy from farmers at the peak of the harvest and releases the stock in low production seasons. The STE estimates and directs the level of imports or exports depending on the availability of supply and the level of world prices relative to domestic prices. This leads to the fact that net trade is subject to quantitative restrictions rather than allowed to change proportionally with world prices.

### *2.2. Rice trade policy and the role of STEs*

In Indonesia, rice stabilization policy has been associated with the national logistic agency, BULOG, since the 1970s. Before 1997, BULOG was given the monopoly power in importing rice and the authority to stabilize domestic prices. However, due to its mounting corruption and government's financial shortage during the 1997/98 financial crisis, BULOG's import monopoly was abolished. The domestic rice market was deregulated and opened to private trade with zero tariffs. As a result, rice imports increased dramatically, from 839,000 tons in 1996/97 to 5.7 mil tons in 1997/98 (USDA, 2013). To restrain the influx of cheap rice imports into the domestic market, in 2000, the Indonesian government imposed a specific tariff of 430 IDR/kg, which was equivalent to a 30% ad valorem tariff rate (Sidik, 2004). From 2004 to 2007, the government started to impose seasonal import bans, which allowed the importation of rice only one month before and two months after the country's harvest peak which runs from February to May (Sidik, 2004). During the implementation of this policy, rice prices started to increase substantially in the domestic market, around 40-50% above import prices (Warr, 2005). Later, rice import tariffs were reduced from 750 IDR/kg to 550 IDR/kg and further reduced to 450 IDR/kg in 2007 (equivalent to a tariff rate of about 30%). This specific tariff rate has remained unchanged except for a short period from December 2010 to March 2011 when tariffs were set to zero (Teguh, 2010).

It is noted that in 2003, BULOG was transformed in to a semi-profit organization, Perum BULOG, with its main purpose to support rice producers and maintain stable and affordable prices for consumers. Although Perum BULOG no longer has the monopoly in rice imports as before, it is still the only STE in Indonesia that directly engages in rice price stabilization policy by maintaining adequate buffer stocks and importing rice. Perum BULOG does not export rice and its imports are subject to custom duties (WTO, 2013). Private traders can import rice but under licensing requirements. In general, Perum BULOG uses imports, public procurement and a price subsidy through the Rice for the Poor program as instruments to stabilize prices and achieve food security. Public procurement, however, accounts for just about 6% of total production (McCulloch & Timmer, 2008).

In the Philippines, rice imports are strictly controlled by the National Food Authority (NFA), one of the country's largest STEs. The agency was established in 1973 as the National Grains Authority under President Marcos's regime, and then later renamed National Food Authority in 1981. Despite many attempts of the government to reform the agency, NFA still enjoys many privileges in rice trade as it continues to have the sole authority in importing rice, allocating import quotas to the private sector and issuing import licenses (Tolentino & Peña, 2011). Under their commitments with the WTO, the Philippines has employed the tariff-rate quota (TRQ) system for rice since 1995. Rice imports are subject to an in-quota tariff if imports lie within the minimum access volume (MAV) of the year, and subject to an out-of-quota tariff if the level of imports exceeds MAV. From 1995 to 2004, the applied in-quota and out-of-quota tariff rates were 50% and 100%, respectively. However, MAVs have increased due to the Philippine government's commitment to open their international rice trade. MAV was set at 59,000 tons in 1995, then increased to 119,460 tons in 1999 and to 239,940 tons in 2004 (Intal & Garcia, 2005). These restrictions should have been eliminated in 2005 under WTO commitments, but the Philippines successfully requested an extension until 2015 with an MAV of 350,000 tons at a 40% in-quota tariff rate. Import volumes beyond this MAV will receive a 50% tariff rate.

To maintain a stable price for consumers, NFA often imports rice and sells its imported rice to retailers at below market prices. From 2000 to 2013, NFA's imports averaged 1,6 mil tons, about 16 % of total milled production. In addition, NFA procures paddy from farmers at harvest time to sell later as a means to stabilize farm gate prices. The procurement, however, only accounts for about 1-3% of total production. The agency is also responsible for maintaining buffer stocks equivalent to 30 days of consumption in addition to 15 days of emergency storage (Jha & Mehta, 2008). In 2002, NFA started to open rice imports to private traders by allocating quotas. However, while NFA's import tariffs are waived by the government, private traders have to pay a tariff rate of 50% and are subject to a complex licensing process (Tolentino & Peña, 2011).

In Malaysia, rice imports are solely controlled by the Federal Paddy and Rice Authority**,** BERNAS. Unlike BULOG and NFA, BERNAS operates as a publicly held company but remains the only STE in Malaysia (WTO, 2014). The company was first incorporated with the National Paddy and Rice Board, subsequently privatized in 1996 and listed on the Kuala Lumpur Stock Exchange in 1997. In March 2011, its monopoly in the Malaysian rice market was extended for 10 years until January 2021 (Say, 2011). BERNAS is responsible for stabilizing rice prices through adequate imports and also engages in rice milling, wholesaling and retailing processes in the domestic market. Rice is the most heavily supported crop in Malaysia. For example, total government expenditures on rice subsidy programs which include a minimum support price, a price subsidy, and a fertilizer subsidy was nearly $150 million in 1998 (Athukorala & Loke, 2009).

As in Indonesia and the Philippines, the private sector in Malaysia is allowed to import rice but with limited access as it is subject to licensing approval and import tariffs.

In Vietnam, rice exportation is strictly controlled by the Vietnam Food Association (VFA). This state-owned agency comprises about 100 export companies in the country in which two colossal STEs, Vinafood 1 (alias Vietnam Northern Food Corporation) and Vinafood 2 (alias Vietnam Southern Food Corporation), together hold 47% of the export share while the remainder is taken over by other smaller STEs and private companies (Fulton & Reynolds, 2012). Before 1998, rice exportation was controlled exclusively by the government under a quota system. However, as an attempt to open international rice trade, private and foreign companies were allowed to export rice. In 2001, the export quota allocated for each company was removed and replaced by a target export policy in which a committee including the Ministry of Agriculture and Rural Development, the Ministry of Industry and Trade, and VFA set annual export targets as guidelines for exporting companies. The export targets are subject to revision based on market conditions. Export activities might be halted if there is low domestic supply. In spite of allocating quotas to every member as before, VFA now only controls the volume of total exports through an export approval system in which an export company has to submit its export-contract for VFA's approval. This application is subject to be denied at any time if VFA sees that the target export level is achieved (Tsukada, 2011). To regulate exports, VFA also sets the minimum export price (MEP) as the target export price. In fact, the MEP policy has been criticized as an ad-hoc policy to restrict export companies from selling rice at low prices in favor of Vinafood 1 and Vinafood 2.

In Thailand, international rice trade is less centralized compared to its counterparts. Rice exportation is not controlled by an STE but is shared among exporting companies. In addition, rice policy is set by the Department of Foreign Trade, Ministry of Commerce. However, the Thai Rice Exporters Association, TREA, which represents nearly 200 exporting companies, works closely with the government to advise on rice trade policies. Thailand is well-known for its "populist" paddy price support policy (alias price pledging scheme). The price pledging policy dates back to 1982. Like the US loan rate program, farmers who join the program are given a loan rate with low interest and use their paddy crop as collateral. With this policy, farmers can keep their mortgaged paddy to avoid selling when market price is low. The value of their pledged rice is based on the loan price, which is set at about 95% of the government's pledged price, and the corresponding quantity (Chulaphan, Chen, Jatuporn, & Jierwiriyapant, 2012). If farmers do not redeem their mortgaged paddy after 4-5 months, the government will take over their pledged paddy. After some interruptions, the pledging program was introduced again in 2000-2001 under Thaksin Sinawatra government. In between 2004 and 2005, the pledged price was set about 20-30% above the market price (farm price) and went up from 10,000 to 14,000 THB per tonne in 2008 (Chulaphan et al., 2012; Poapongsakorn, 2010). In 2011, when Yingluck Sinawatra took office, the support price was set at a record-breaking level, 15,000 THB for each tonne of white rice, equivalent to about $500/MT (The Economist, 2013). The government's stockpiles were estimated to be as much as 15.5 million tons and the total cost for government's budget in those years was estimated to be about $22 billion (Warr, 2014). As a result, Thailand's rice price became less competitive as it was about $50-60 higher than those of competitors for the same type of rice in the world market. Thailand's exports decreased significantly from 10 million tons in 2010 to 6.5 million tons in 2011, falling below India and Vietnam. This policy has received much criticism as it was abused for political gains and it distorted Thailand's rice market, which consequently drove up the world price due to supply shortages. In February

2014, the program was temporarily halted. Whether the government will resume or abandon the price pledging policy continues to be a controversial issue in Thai politics.

### *2.3. AFTA*

Since its inception in 1967, ASEAN has successively included all 10 countries in Southeast Asia including Thailand, Indonesia, Singapore, Malaysia, Brunei, the Philippines, Laos, Cambodia, Myanmar and Vietnam to become its member states and achieved numerous agreements to establish trust, security and economic cooperation in the region.

In 1992, the ASEAN Secretariat initiated the ASEAN Free Trade Agreement, which aimed to lower tariffs on a wide range of products and also eliminate non-tariff barriers, quantitative restrictions and other cross-border measures (Pasadilla, 2004). In 1995, the target date was accelerated to 2002, 6 years earlier, in conjunction with the agreement that import duties would be completely eliminated by January 2010 for the first 6 members, i.e. Thailand, Indonesia, Malaysia, the Philippines, Singapore, and Brunei, and by January 2015 for the other 4 members, i.e. Cambodia, Laos, Myanmar and Vietnam, with flexibility that tariffs on sensitive products would be eliminated no later than January 2018 (ASEAN, 2003). The product coverage of AFTA was believed to be very comprehensive and the liberalization targets were ambitious, making AFTA one of the “deepest” free trade agreements among developing countries, probably just second to MERCOSUR (Calvo-Pardo, Freund, & Ornelas, 2010).

Under AFTA, rice has been classified as “Sensitive Agriculture Product” and excluded from the normal tariff reduction phase. Rice was included into the Highly Sensitive List (HSL) for Indonesia, the Philippines and Malaysia and the Sensitive List (SL) for Myanmar. Products in the Highly Sensitive List are subject to a slower tariff reduction phase than those in the Sensitive

List. In 2010, rice from the Highly Sensitive List or Sensitive List was transferred to the Inclusion List and has been subject to gradual tariff reductions until 2015.

According to ASEAN Trade in Good Agreement (ATIGA), Thailand, Singapore and Brunei eliminated rice tariffs before 2010. Cambodia and Laos applied 0% tariff in 2013, followed by Vietnam in 2014. Myanmar will keep a current tariff rate of 5% until 2015. Indonesia and the Philippines will reduce their current tariff rates from 30% to 25% and from 40% to 35% in 2015, respectively, while Malaysia will maintain its tariffs of 20% for the entire 2010-2015 period (Table 3). As deeper trade liberalization is taking place in the region, it is expected that quantitative restrictions in rice trade will be eliminated eventually and tariffs will be reduced to zero for ASEAN members at some point. However, the magnitude and speed of reduction depends greatly on the readiness to open the rice markets in the three major importing countries, i.e. Indonesia, Malaysia and the Philippines.

Table 3: AFTA rice tariff schedule, 2000-2015 (%)

| Country | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Brunei | 0 | 0 | 0 | 0 | 0 | 0 |
| Cambodia | 5 | 5 | 5 | 0 | 0 | 0 |
| Indonesia | 30 | 30 | 30 | 30 | 30 | 25 |
| Laos | 5 | 5 | 5 | 0 | 0 | 0 |
| Malaysia | 20 | 20 | 20 | 20 | 20 | 20 |
| Myanmar | SL | SL | SL | 5 | 5 | 5 |
| Philippines | 40 | 40 | 40 | 40 | 40 | 35 |
| Singapore | 0 | 0 | 0 | 0 | 0 | 0 |
| Thailand | 0 | 0 | 0 | 0 | 0 | 0 |
| Vietnam | 5 | 5 | 5 | 5 | 0 | 0 |

Source: ATIGA, (ASEAN, 2009)

## 3. Rice models and consumption projections

This section focuses on reviewing models that can be used to provide projections for countries of the ASEAN-5 rice market. Those models mainly applied a partial equilibrium framework.

However, they are very different in terms of structure, purpose, rice type coverage, country coverage, the starting year of the baseline as well as the length of projections. Given the lack of studies that focused on the ASEAN rice market, results of global rice projections are discussed instead as this topic has captured increased attention of economists and policy analysts in response to the concern "How much rice do we need to feed the world in 2050?". This is relevant to the ASEAN-5 model as it is incorporated in a global rice model. The review is also useful for us to understand models' strengths and weaknesses as well as provide us with some empirical results to compare.

### *3.1. Review of existing rice models*

Quantitative models are commonly used in the literature to provide projections of commodity supply and demand as well as impacts of policy changes and exogenous shocks. Models are an important tool to provide impact analysis both in the short term and long term, which is useful for policy makers in their decision-making process. In this regard, simple and single commodity models are preferred in the short term to address specific questions while multi-commodity models are commonly used for medium and long term analyses as they are able to capture substitution effects among commodities (Wailes, 2005).

In the literature, the two most commonly used modeling frameworks are partial equilibrium (PE) and computable general equilibrium (CGE). These two types of modeling approaches often have variations in which a model can be spatial or non-spatial, linear or non-linear, single- or multi-commodity, country-level or global, static or dynamic, etc. PE models consider one or more commodity markets in isolation from the rest of the economy while CGE models include all key sectors in the economy. In a PE model framework, a system of equations representing supply and demand is specified and linked together through either domestic or international prices. Supply includes equations representing harvested area, yield, beginning stocks and imports. Demand includes equations representing domestic consumption, ending stocks and exports. As market equilibrators, prices are normally included in all equations in the form of domestic prices (farm, wholesale, or retail prices), import/export prices or world prices, depending on the economic relationship that the equation represents. In a standard PE framework, variables that are solved within the model are called “endogenous” while variables that are taken from outside of the model are called “exogenous”. Macroeconomic variables such as income, prices of other goods, exchange rates, population are normally exogenous. The model often assumes perfect competition, zero transportation costs, and product homogeneity for simplification. The equilibrium prices are solved by a market clearing condition that either equates total supply with total demand in a closed economy model or total imports with total exports in a global multi-country model. The strength of PE models is that they can represent the agricultural sector in great detail and the kind of data that they require are often more up-to-date than those used in CGE models. In the literature, PE commodity models have been widely used to provide projections and impacts of policy changes on trade, production, consumption and prices. However, PE models do not provide impacts of an agriculture shock on other sectors in the economy and they cannot directly measure welfare effects (IFPRI, 2010).

Unlike PE models, the CGE modeling approach represents the national economy as a whole. Thus, the agricultural sector is considered together with other sectors in the economy such as service, labor market and manufacturing. The strengths of CGE models are their ability to assess the impacts of a policy from one sector on another as well as measure the impact of macroeconomic policies, which often cannot be done by a PE model in fine detail. However, CGE modeling approach is often criticized to be oversimplified and that it fails to address the complexities and heterogeneity in a single sector (IFPRI, 2010).

In general, it is difficult to judge a model, as each model differs greatly from others in terms of structure, scope, country and product coverage, baseline, and the policy that is analyzed. However, there seems to be a consensus among modelers that a good model should provide consistent and stable results under shocks and over a period of time. It should also be able to reflect market reality in terms of magnitude and direction of market and policy effects (Wailes, 2004).

In the literature, there are several existing rice models that provide projections of production, consumption and trade for ASEAN-5 countries. Models on this list include the Arkansas Global Rice Model (AGRM) of the University of Arkansas, the Aglink-Cosimo model of the Organization for Economic Co-operation and Development (OECD) and Food and Agriculture Organization (FAO), the Country-Commodity Linked System (CCLS) of the US Department of Agriculture (USDA), the IMPACT model of the International Food Policy Research Institute (IFPRI) and the ASEAN Food Model, a joint project funded by FAO and was developed by modelers from Thailand and Japan in the early 2000s. All of these models build on a partial equilibrium framework. Except for AGRM which focuses its analysis exclusively on rice, other models cover a wide range of agricultural products. The ASEAN Food Model appears to be the only one that was specifically developed for ASEAN. A detailed review of the existing models that relate to the rice market is provided below. It is worth noting that policies are incorporated in these models at varying levels to reflect market behaviors, and a price transmission mechanism is often characterized by a linkage between world prices and domestic prices or trade. Nevertheless, none of these models incorporate the price stabilization policies that have been observed in ASEAN-5 rice importing countries.

The IMPACT model was developed by IFPRI in the mid-1990s. In a later version, the model was integrated with the WATER model to capture the effect of water availability and climate change. It has since then referred to as the IMPACT-WATER model to indicate this upgrade. Agricultural commodities, food security, poverty, malnutrition and water scarcity are the focuses of the IMPACT model. The model covers 44 major agricultural commodities including rice in 115 geopolitical regions and 126 hydrological basins in the world (M. W. Rosegrant, Meijer, & Cline, 2012). The IMPACT model uses estimated elasticities mainly from USDA for its structural equations and the baseline. Supply, demand and prices are generated endogenously within each region while the world market is cleared through trade. The model produces projections to 2020 and sometimes up to 2050 for production, yield, demand and net trade with some elasticity adjustments to take into account the impacts of urbanization and climate change in the projection period.

The Aglink-Cosimo model is a marriage between models AGLINK of OECD and COSIMO of FAO as a joint effort to expand the original AGLINK model and share outlook results between the two organizations. The Aglink-Cosimo model is a set of country models with commodity sub-models. The model covers 25 agricultural commodities in 41 countries and 12 regions (OECD-FAO, 2014). Agricultural commodities covered in the model include major agricultural commodities such as wheat, rice, eggs, milk, beef, pork and poultry. The world market price is solved for each commodity and linked with producer and consumer prices. The model provides year-on-year and longer-term projections of production, consumption, trade and prices (world and producer prices). In addition, the model includes a biofuel sector to estimate impacts of biofuels on agricultural markets. Several trade policies are also included in the model to capture the impact of trade agreements and domestic policies on a particular agricultural market. In the case of rice, the Thai 100% B long-grain price is used as the world price. The model covers the world's major rice importers and exporters which include ASEAN-5 countries.

The CCLS model is maintained by USDA to provide 10 year projections of global production and consumption of major agricultural commodities including rice, wheat, corn, barley, sorghum, soybean, cotton, beef, pork, and poultry. However, little is known about the model structures as documentation of the model is not publicly available. According to Wailes (2005), trade and international prices are linked in the country models through the LINKER module while the baseline is generated using a Delphi approach with USDA commodity experts. Some domestic and trade policies are also incorporated in the model to reflect market reality. The model covers about 43 countries and regions.

The AGRM model is a global rice model maintained at the University of Arkansas covering 46 major rice producing, consuming and trading countries and regions. Results from the model have been used for the international baseline projections of the Food and Agricultural Policy Research Institute at the University of Missouri and analyses of trade liberalization and food security at the regional and global level (Wailes & Chavez, 2011a). One strength of AGRM compared to other rice models is its disaggregation of rice into short/medium grain and long grain categories. The model uses Thai 100% B and California No.1 medium grain as international reference prices of long-grain and short/medium grain rice, respectively. The world market is cleared when the world's net exports equal the world's net imports. In the recent update, the model has incorporated a wide range of policy variables such as government purchase price, government procurement, tariffs (specific, ad valorem, in-quota) for major rice producing and consuming countries. Similar to CCLS, the model is used to provide 10 year projections of trade, production, consumption, stocks and prices.

The ASEAN Food Model (AFM) is a multi-country multi-commodity model focusing on the ASEAN agricultural market. The model covers 9 crops (rice, maize, wheat, other coarse grain, soybeans, palm and palm oil, other oil seeds, sugar and sugar canes, and cassava) and 6 livestock products (pork, beef, sheep, milk, chicken, and egg) in 17 countries including 10 ASEAN countries and other large economies such as Japan, US and EU. Due to the nature of data collected, rice is differentiated into two types for Thailand and Indonesia. In particular, rice in Thailand is divided into major type and secondary type due to double-and triple-cropping practice while in Indonesia, it is divided into dry-land and wet-land based on the season when rice is planted. Production and consumption equations in the model are specified in the log-log functional form. Elasticities of supply and demand in the country models of ASEAN-5 are estimated while those for other ASEAN countries are calibrated. The model provides projections of harvested area, yield, production, consumption (food, feed, other use) and net trade. Besides providing projections from 2003 to 2020, the model was used to assess the impact of the ASEAN Rice Reserve Scheme and the production of biofuel from palm oil (Ohga, Isvilanonda, Furuhashi, & Sirisupluxana, 2008).

### *3.2. Whither global rice demand*

How much rice do we need to feed the world in 2050? This question has received increased attention in the literature regarding the prospect for a growing world population, which is expected to reach 9.1 billion people in 2050 according to the United Nation's recent forecast (United Nations, 2013b). In light of this, FAO estimated that food production in between 2005/07 and 2050 needs to increase by 60% to meet the world's increased demand. In particular, cereal production would have to increase by 940 million tons from the base year 2005/07 and cereal imports from developing countries would grow to nearly 200 million tons, double their current level (FAO, 2012).

Demand projections are important for governments and private sectors to make appropriate and effective investments in rice production and improve food security in the future. Table 4 summarizes the projection results from existing rice models mentioned earlier along with those from other studies. Note that the existing partial equilibrium models normally focus on providing projections for 10 years beyond the baseline. Thus, global rice demand projections from these models are only available up to 2020 and few years beyond. Longer term projections, such as up to 2030 and 2050, are mainly provided by studies that were not built on a supply-demand equilibrium framework but rather focus mainly on rice consumption.

Table 4: World rice demand projections, 2020-2050 (million MT)

| Author | Method/Model | 2020 | 2030 | 2050 |
|---|---|---|---|---|
| OECD-FAO, 2013 | AGLINK-COSIMO model | 536 | - | - |
| Rosegrant et. al., 2010 | IMPACT model | 503 | - | - |
| Wailes and Chavez, 2014 | AGRM | 508 | - | - |
| USDA, 2013 | CCLS | 504 | - | - |
| FAO, 2006 | | - | 503 | 522 |
| FAO 2006 projection adjusted | | - | 520 | 556 |
| Abdullah et. al, 2005 | Scenario 1 | - | - | 527 |
| | Scenario 2* | - | - | 461 |
| | Scenario 3 | - | - | 383 |
| Timmer et. al., 2010 | Baseline | 466 | 466 | 404 |
| | Best judgment * | 450 | 430 | 360 |
| | Structural | 431 | 390 | 255 |
| Rejesus et.al., 2012 | Lower forecast interval | 437 | 457 | 504 |
| | Point forecast* | 491 | 544 | 651 |
| | Upper forecast interval | 545 | 630 | 797 |

Source: Adapted from Timmer, Block and Dawe (2010) with updates. * denotes “best guess” projections.

It has been widely accepted among modelers that projection results are often different for many reasons, including exogenous assumptions, model structures and behavioral parameters, for example. In this regard, rice is not an exception. As shown in Table 4, 2050 projections differ greatly across the literature as global demand is estimated to be from as low as 360 million tons in Timmer, Block, & Dawe (2010)’s study to as high as 651 million tons in a study conducted by Rejesus et al. (2012). It is noted that 2014/15 global rice consumption is estimated to be about 483 million tons according to USDA's recent WASDE report (USDA, 2014). Thus, such a wide range seems to be too different to be useful. It would prevent us from using the results without careful examination of the underlying assumptions and structure of each model.

Based on assumptions regarding rural and urban migration and the rate of income growth, Timmer, Block, & Dawe (2010) projected that global rice demand will increase to 450 million tons in 2020, then remarkably decline after 2025. Global rice demand could vary between 255 and 404 million tons or reach 360 million tons in 2050 under the authors' best judgment. The authors argued that income elasticity, which is significantly influenced by income class and urbanization, will be the major determinant of global rice consumption in the long run. In light of this, time-series data can potentially lead to upwardly biased estimates due to aggregation problems, even at the country level. For example, income elasticity estimated for Indonesia during the 1967-2006 period was almost zero (-0.015), which would make little sense if used for demand projection purposes. Thus, the authors employed household data collected from 11 major rice producing and consuming countries across the world and disaggregated rice consumption by income quintile, age, and rural and urban areas to investigate the differences and trends in rice consumption patterns. Results showed that at the country-level, average rice consumption tends to increase at a decreasing rate as income rises over time. Per capita rice consumption was projected to decline in Indonesia, Bangladesh, India, China and many other countries. Annual global population growth was projected to decline from 1.02% in 2020 to 0.58% in 2050. Rural to urban migration, which was represented by the agricultural population share in the study, was projected to decrease from 34% in 2020 to 22% in 2050. In the baseline, net income elasticity, which accounted for both income and time trend effects at the global level, was projected to be -0.09 in 2020 and -0.5 in 2050. The study, however, did not provide details on the specification and underlying assumptions behind the projection results.

Rejesus et al. (2012) asserted that unit roots are common in time-series data, leading to biased estimates in demand projection studies that did not account for this problem. Thus, the authors employed several time-series techniques to correct for unit roots in USDA's global rice consumption data. The authors finally chose the double exponential method for forecasting purposes. Their results provided a different perspective compared to previous studies. Total consumption was forecasted to increase from 490 million tons in 2020 to approximately 650 million tons in 2050. If their projection were divided by a world population projection of 9.1 billion (United Nations, 2013b), the global per capita rice consumption would be approximately 71.4 kg in 2050, a modest increase from current consumption level. Although the authors claimed that most other studies' results fall into their projection intervals, ranging from as low as 504 million tons to as high as 797 million tons, such a wide projection band seems to be less helpful. One of the problems causing this upward bias is possibly that the authors failed to account for the impact of demographic and structural changes in global consumption over time. Instead of using disaggregated data, at least at the country-level, the study only employed consumption data at the global level, which is inherently not an ideal choice for demand projections over such a long period of time.

In another study, Abdullah, Ito, & Adhana (2005) projected global rice demand based on a simple growth formula and used past consumption trends as references for future growth. In particular, future rice consumption was specified as a function of the current level of consumption multiplied by a compound consumption growth rate. The study focused on India and China as the major drivers of global rice consumption with three scenarios laid out for each country. Per capita rice consumption was projected to decline steadily from the 2005 baseline to approximately 50.7 kg in 2050. In contrast, total rice consumption was projected to increase modestly from 442 million tons in 2025 to 460.7 million tons in 2050.

Additionally, in FAO's most recent outlook on world agriculture,  per capita rice consumption was projected to decline from 64 kg to 57 kg for developing countries and remain less than 20 kg for developed countries in 2050 (FAO, 2012). This report, however, did not provide projections for global rice consumption on a per capita basis as well as in total. However, in an older report published in 2006, FAO projected global rice consumption to be approximately 503 million tons in 2030 and 522 million tons in 2050 using population projections from the United Nations' 2002 revision (P. Timmer et al., 2010). Divided by population, the corresponding per capita rice consumption could be approximately 62 kg in 2030 and down to 59 kg in 2050. However, the United Nations has just increased its population projections from 8.9 billion in the 2002 revision to 9.1 billion in the 2012 revision. Thus, if the FAO 2006 projection were adjusted for this population change (9.1 instead of 8.9 billion people) assuming per capita rice consumption remains constant from 2006 to 2012, the adjusted global rice consumption would be approximately 520 million tons in 2030 and 556 million tons in 2050. This result is much higher than those of  Timmer, Block, & Dawe (2010) and Abdullah, Ito, & Adhana (2005) but still lower than that of Rejesus, Mohanty, & Balagtas (2012).

However, projections through the year 2020 are not too different among studies. In the four PE models reviewed, i.e. Aglink-Cosimo, IMPACT, AGRM and CCLS, global rice consumption in 2020 was projected to be around 500-540 million tons while "best guesses" from other studies were lower, ranging between 431 million tons (P. Timmer et al., 2010) to 491 million tons (Rejesus et al., 2012). In particular, using the current AGRM framework, Wailes & Chavez

(2014) projected global rice consumption to be 504 million tons in 2020. USDA and IFPRI's study (M. Rosegrant, Paisner, Meijer, & Witcover, 2001) provided similar projections while OECD's projection using Aglink-Cosimo model is slightly larger, 536 million tons.

## 4. Method and data

### *4.1. IGRM model description*

The ASEAN-5 rice model inherited the original framework, database and structural equations from IGRM, which was developed in 2008 and is currently being maintained at IRRI. IGRM has been used as an analytical framework for several studies presented at international conferences (Jamora, Valera, Matriz, Molina, & Mohanty, 2010; Jamora et al., 2010; Matriz, Molina, Valera, Mohanty, & Jamora, 2010; Mottaleb et al., 2012). The model baseline is currently being revised to incorporate policy variables that can capture recent and future policy changes as well as the dynamics of the rice market.

IGRM is a dynamic partial equilibrium framework covering the global rice market in 31 countries and regions. Countries included in the model are Bangladesh, Brazil, Cambodia, China, Cote d'Ivoire, Egypt, India, Indonesia, Italy, Japan, Kenya, Malaysia, Mozambique, Myanmar, Nepal, Nigeria, Pakistan, the Philippines, South Africa, South Korea, Spain, Sri Lanka, Sudan, Taiwan, Thailand, US, and Vietnam in addition to four regional aggregates, i.e. other Africa, other Latin America, other Asia, other European Union, and Rest of the World (IRRI, 2012). All ASEAN countries are included except for Laos, Brunei and Singapore. Countries in the model cover about 90% of the world's rice consumption and production and more than 90% of those for ASEAN. The model uses Thai FOB 5% broken rice price as the world reference price.

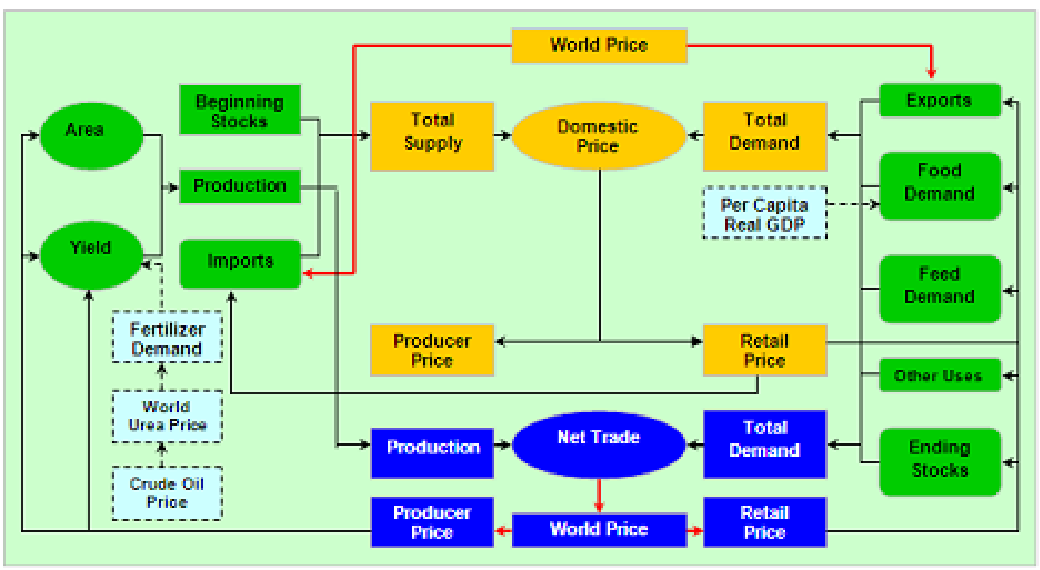
Data were mainly obtained from USDA-Production, Supply and Demand, FAO, country statistical yearbooks, and the World Bank. Historical data used for parameter estimations span a time frame from 1980 to 2013. Most countries have historical data available from 1990 to 2012.

Following a standard PE framework, each country model in IGRM includes equations representing supply, demand, trade and price relationships. Supply includes production, beginning stocks, and imports while demand includes domestic consumption, ending stock and exports. Endogenous variables include yield, area, production, per capita consumption, ending stocks, beginning stocks, net imports, net exports, paddy farm gate price, rice retail price, rice wholesale price, Thai 5% broken rice price, Vietnam rice export price, world urea price and fertilizer use. Exogenous variables cover world crude oil price, producer prices of competing crops (for example, corn or cassava), percentage of irrigated area, trend variables, policy variables and several macroeconomic indicators such as total population, consumer price index, gross domestic product (GDP), GDP deflator, and exchange rates.

One strength of IGRM compared to other existing rice models is that production is disaggregated at the regional level to account for geographical and climatic differences that affect water availability as well as other input factors, which are important in rice production. For example, rice supply in the Philippines is divided into 16 regions while Indonesia is divided into 5 regions. In light of this, farm prices are also estimated at the regional level. For example, an equation for national farm price is specified along with 6 other regional farm prices representing 6 major rice producing regions in the US: Arkansas, California, Louisiana, Mississippi, Missouri and Texas.

In addition, the model employs two different modes of solving for equilibrium prices to account for product and market differentiation. For countries where rice trade is assumed to be fairly insulated from the global market, domestic price (farm price) is initially solved within the country model by equating total supply equal with total demand. The country's net trade is linked to the world's total net trade to solve for the equilibrium world price. In doing so, the model avoids assuming a perfectly competitive market structure and captures some level of price transmission from the global to the domestic market through the trade equation. Countries under this specification include Bangladesh, Brazil, Cambodia, China, India, Indonesia, Japan, Myanmar, Pakistan, the Philippines, Taiwan, Thailand, US and Vietnam (gold background in Figure 4). Most of these countries are major players in the global rice market. For the remaining countries and regions, domestic price is directly linked to the world price (blue background in Figure 4). There is no market clearing condition within the country model and the country's net trade, which is the residual of supply and demand, is directly linked to the world's total net trade to solve for the equilibrium world price.

Figure 4: IGRM model structure




Source: IGRM Documentation, IRRI (2012).

At the global level, the world equilibrium price is solved by equating Thailand's net exports with the rest of the world's net imports. The model provides projections of and policy impacts on production, consumption, trade and prices. In addition, a limited number of policies have been captured in the model. In particular, Japan and Korea's minimum access quotas under WTO commitments are represented by fixing the level of net trade. The minimum support price in India is included in the regional price equation. For US, loan-deficiency payment and counter-cyclical payment policies are incorporated into regional farm prices which are directly linked to the national farm price. However, the US model has not yet been updated for the policy changes that occurred in 2014.

The model consistently applies a standard log-log functional form for per capita consumption and fertilizer use equations for all countries. The remaining equations are estimated in a linear form. An inverse of the retail price or world price is sometimes used as an explanatory variable for some countries' ending stock and trade equations. All equations are estimated by ordinary least squares through the year 2007. Details of the model specification are represented in Table 5.

Table 5: IGRM model specifications

| | |
|---|---|
| Supply | $YLD_{t-1}$: the previous year's paddy yield |
| PROD=HA*YLD*r | FU: fertilizer use |
| HA = f($P_{farm}$, $P_{others}$) | IRA: percentage of irrigated area |
| YLD=f(FU,IRA,T) | T: time trend |
| FU=f($P_{urea}$ /$P_{farm(t-1)}$ , $YLD_{t-1}$) | CONCAP: per capita rice consumption |
| $P_{urea}$ =f($P_{oil}$) | CON: total consumption |
| | INC: per capita real GDP |
| Demand | POP: total population |
| CON=f($P_{retail}$, INC) | ES: ending stocks |
| CONCAP=QDC*POP | $ES_{t-1}$: beginning stocks |
| ES=f($P_{retail}$, $ES_{t-1}$, PROD) | EX: exports |
| EX or IM=f($P_{world}$, $P_{retail}$,PROD, G) | IM: imports |
| | $P_{farm}$: farm gate price |
| Price transmission and linkages | $P_{retail}$ : retail prices of rice |
| $P_{farm}$=f($P_{world}$) | $P_{others}$ : price of competing crop |
| $P_{retail}$ = f($P_{farm}$) | $P_{urea}$ : the world price of urea |
| $P_{export}$ = f($P_{retail}$) | $P_{oil}$: the world price of crude oil |
| PROD + $ES_{t-1}$ + IM = CON + ES + EX | $P_{farm(t-1)}$ : the previous year's paddy farm price |
| | $P_{world}$ : the world reference price |
| Market clearing condition | $P_{export}$ : export price |
| $\sum_{i=1}^{n} IM_i = EX_{TH}$ (i ≠ TH) | $IM_i$: the world's total net imports |
| | $EX_{TH}$: Thailand's net exports |
| where | *r:* milling rate |
| PROD: total milled production | *i*: country *i* in the model except for Thailand |
| HA: harvested area | *n:* the number of countries i |
| YLD: paddy yield per hectare | |

Source: IGRM Documentation, IRRI (2012)

### *4.2. The ASEAN-5 model*

The major goal of the ASEAN-5 model is to capture the key structural characteristics of the rice market in Southeast Asia, which is represented by ASEAN-5 countries. In doing so, some changes in the assumptions as well as the country model specifications have been made to account for the price stabilization policies in importing countries as well as significant "game-changing" policies such as Thailand's recent rice pledging scheme. Other country models remain the same except for data updates and the inclusion of the Thailand and Vietnam price linkage. Ultimately, this modification is expected to provide a more relevant perspective on the Southeast Asian rice market and help improve the overall performance of IGRM. Justifications for changes from the original model are provided below.

*World reference price*

As discussed earlier, the resumption of Thai price support policy in 2008 drove up Thai rice prices, making Thai rice more expensive and less competitive in the world market. As shown in Figure 1, Vietnamese prices were about $20 lower than Thai prices of the same type, 5% broken, during the 2000-2007 period but the gap widened to as much as $123 per ton after 2008. Thai rice became more expensive and uncompetitive in the world market. The sizeable distortion in Thailand's domestic and export market leads us to believe that Thai 5% broken rice price has not been a good representative of the world reference prices since 2008.

In light of this, the world reference price in the ASEAN-5 model incorporates both Thai and Vietnamese prices, hereafter called "the world hybrid price", which is characterized by two distinct phases. Before 2008, Thai 5% broken FOB rice price was used to represent the world price. After 2007, Viet 5% broken FOB rice price was used to replace Thai price as the world reference price. Thus, from 2008 onward the model solves for the Vietnamese price rather than the Thai price. Country models for ASEAN-5 were estimated using this hybrid price. For the remaining countries where Thai price had been used as the world reference price, a price linkage between Thai and Vietnamese prices was added to link the "old" world price to the "new" world price to avoid re-estimating equations that had the world price in their specifications. The price linkage was estimated based on historical data spanning from 1990 to 2013 and has a form as follows.

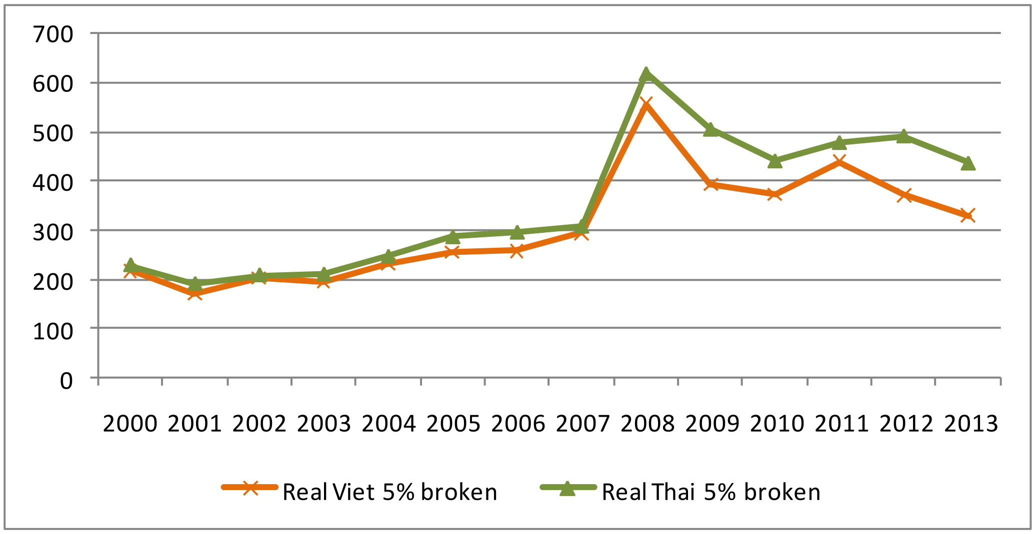
$$P_{thai} = 33.53 + 1.08P_{viet} \qquad (1)$$

*(t=1.0) (t=10.7) (R-squared: 0.82)*

where $P_{viet}$ is the price of Viet 5% broken rice, which is equal to the Viet rice price starting from 2008. $P_{thai}$ is the adjusted price of Thai 5% broken rice, which replaces the "old" Thai 5% broken price in the original model. Figure 5 presents a graphical illustration of the real Thai and Viet 5%

broken rice prices from 1990 to 2013 using FAO data. The world reference price, a combination of Thai and Viet prices, generally rose from 2001 to 2008 and fell back after 2008.

Figure 5: Thai and Viet 5% broken rice prices in constant US dollars (US$/MT)




Source: FAO (2014)

*Thailand's ending stock equation*

Given the substantial impacts of the Thai government's price pledging scheme, the stock equation for Thailand country model is divided into two phases. In the historical period (1990-2013), ending stocks are modeled as a function of the government's support price, $P_{support}$, production of the current year, production of the following year and beginning stocks.

$$ES_{Thai} = \alpha_0 + \alpha_1 P_{support} + \alpha_2 PROD + \alpha_3 PROD_{t+1} + \alpha_4 ES_{t-1} + e \quad (2)$$

The expected sign for parameter $\alpha_1$ is positive, meaning that the higher the support price, the larger the stock. This differs from a normal commercial stock equation where speculative demand and transaction demand are immensely related to market prices. The price support, $P_{support}$, is adjusted for different periods based on the existing policies at that time. Note that in most ASEAN countries, private stocks account for a very small proportion of the country's stockpiles. Thus, the level of stocks, used as a price stabilization instrument, largely depends on the government's stock policy.

For projection purposes, ending stocks are modeled as commercial inventory demand and directly linked to farm prices instead. This adjustment helps to make ending stocks move reasonably with the market prices given our limited knowledge of the future of the Thai government's price pledging scheme. Ending stock equation is specified as follows:

$$ES_{Thai} = \alpha_0 + \alpha'_1 P_{farm} + \alpha_2 PROD + \alpha_3 PROD_{t+1} + \alpha_4 ES_{t-1} \quad (3)$$

in which the intercept $\alpha_0$ and coefficients $\alpha_2$, $\alpha_3$, $\alpha_4$ remain as estimated in equation 2. The new coefficient $\alpha'_1$ is estimated by imposing an average farm price elasticity of -0.2 for 5 most recent years (2009-2013). From 2014 onward, ending stocks are linked directly to farm prices instead of government support prices.

*Trade and model closure*

In the existing models mentioned earlier, import tariffs, if they are incorporated as policy variables, are commonly modeled by multiplying the world price with a factor equivalent to 1 plus the tariff rate *t*:

$$P_{world} * (1+ t) \quad (4)$$

Values of tariff rates t are often taken from the official rates announced by governments. However, under a protectionist regime, it is believed that the official tariff rates do not fully reflect the true differences between border prices and domestic prices. Take Indonesia as an example. Using FAO's monthly data from January 2008 to December 2012, implicit tariffs are calculated as the difference between the real retail price and the real world price adjusted for transportation costs and a price mark-up representing handling fees from the border to end users. The specific formula has the form as follows:

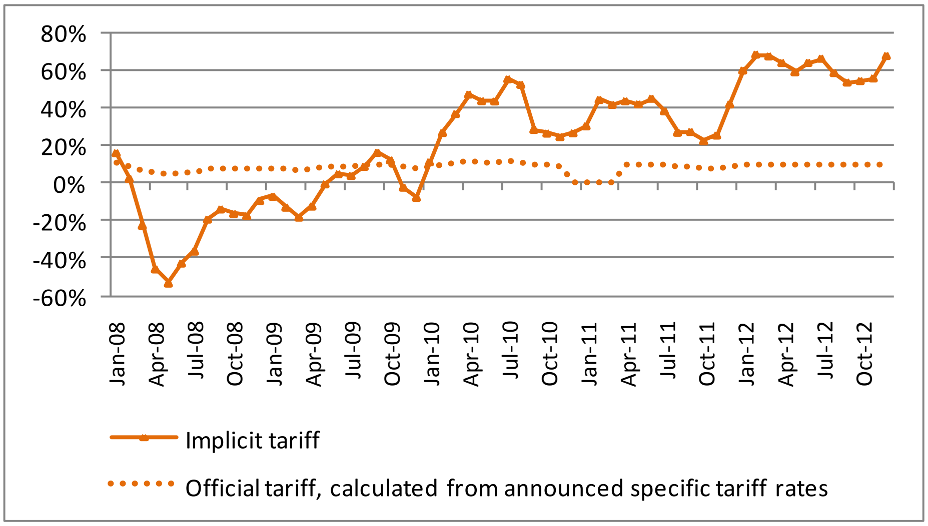
$$t_{implicit} = [P_{retail}/((P_{world} + c)*m)]-1 \quad (5)$$

where *c* denotes transportation costs, assumed to be fixed at $40 in real terms, and *m* represents the market mark-up, assumed to be fixed at 10% (i.e. *m* equals to a factor of 1.1). $P_{retail}$ and $P_{world}$ are converted into domestic currency in real terms. As mentioned in the earlier section of the essay, the Indonesian government applied a specific tariff of 450 IDR/kg during this period except for a short time when tariff was imposed to be zero from December 2010 to March 2011. These specific tariffs are converted into ad valorem tariffs using the following formula:

$$t_{ad\text{-}valorem} = t_{specific}/(P_{world} + c) \quad (6)$$

where $P_{world}$ and transportation cost *c* are in real terms. Figure 6 shows two distinct patterns between calculated (ad valorem equivalent) official tariffs and implicit tariffs. While the official tariffs were fairly stable around the average of 8%, implicit tariffs varied from being as low as -53% to as high as 69%. It is noted that implicit tariffs changed from being negative to positive after January 2010, which implies that rice trade in Indonesia was transformed from being subsidized to being taxed during this period.

Figure 6: Indonesia's implicit vs. official tariffs, January 2008 to December 2010



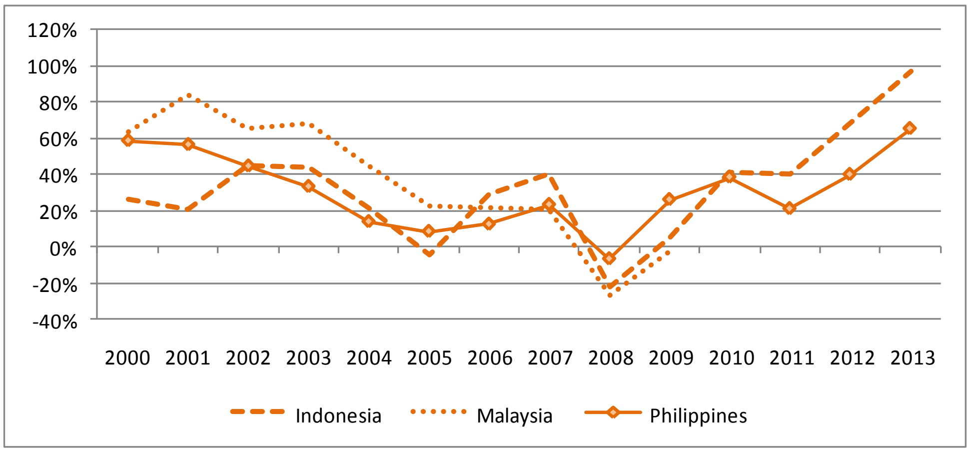

Source: Calculated. Monthly data are obtained from FAO-GIEWS database.

Similar patterns have been observed for Malaysia and the Philippines. It appears that the substantial variations in implicit tariffs are largely caused by the price stabilization mechanisms that aim to prevent domestic prices from changing proportionally with the world prices. In reality, these policies are hard to measure and only can be observed through price differences. Thus, the gap between the implicit and official tariff is hereafter denoted as "STE tariff" to indicate the impact of STE's interventions on domestic prices.

*Price stabilization policy*

To mimic the price stabilization policy in importing countries, it is assumed that in the baseline, governments in these countries will fix retail prices at the most current price level in real terms for the entire projection period spanning from 2014 to 2020. In particular, real retail prices are fixed at the 2013 level for Indonesia and the Philippines while it is fixed at the 2009 level for Malaysia due to data unavailability. After the equilibrium world price is solved, the overall implicit tariffs, $t_{implicit}$, in the projection period are calculated based on equation 5. It is noted that from 2000 to 2013, implicit tariffs calculated for the three importing countries varied greatly from as low as -27% to as high as 97% as shown in Figure 7, suggesting high levels of governments' intervention in the domestic rice markets of these countries. AFTA tariffs in 2014 and 2015 will follow the schedule as shown in Table 3 and are assumed to remain at the 2015 level for the remaining years (2016 to 2020). STE tariffs are then derived as the difference between the overall implicit tariffs and AFTA tariffs.

Figure 7: Implicit tariff rates of selected countries, 1991-2013




Source: Calculated.

Finally, three scenarios are proposed to analyze the impacts of removing some and all tariff barriers in the importing countries in 2020. One might argue that these hypothetical assumptions are far from reality, but the analysis is valid since it will serve as a measurement of the foregone benefits of placing trade restrictions relative to free trade. Knowing the benefits and costs of different tariff removal scenarios will be useful for policy makers in their decision making related to rice policies.

Based on the assumed tariff schedules and the equilibrium world prices solved within the model, the retail prices in each importing country are calculated by the following equation.

$$P_{retail} = (P_{world} + c)*(1+ t_{implicit})*m \quad \text{where } t_{implicit} = t_{official} + t_{STE} \qquad (7)$$

This equation is simply the inverse of equation 1.

*Model specification*

Detailed specifications of the model are provided in Table 6. To make the model simpler and easier to simulate, supply equations for ASEAN-5 countries are aggregated and re-estimated at the national level instead of regional level. While most equations are specified in linear forms, per capita consumption and stock equations are treated more carefully compared to other equations due to their complexities in fitting the data and their importance in the country model's structure. For example, ending stock equations in the importing countries include both imports and production to reflect the level of domestic supply. Another variation is Vietnam's per capita consumption equation, which takes a log-log-inverse functional form instead of a log-log relationship. Countries with exceptions are indented. As seen in the market clearing condition, the model is solved by equating Vietnam net exports to the sum of net imports of all other countries.

Table 6: ASEAN-5 model specifications

| | |
|---|---|
| **Price linkages**<br>Importing countries (Indonesia, Malaysia, the Philippines)<br>$P_{retail}$ = f($P_{world}$, c, m, t)<br>$P_{farm}$ = f($P_{retail}$)<br><br>Exporting countries (Thailand, Vietnam)<br>$P_{retail}$= f($P_{world}$)<br>$P_{farm}$ = f(Pretail)<br><br>**Production**<br>HA = f($HA_{t-1}$, $P_{farm\ (t-1)}$ *100/CPI)<br>    Indonesia<br>    HA=f($HA_{t-1}$, ($P_{farm\ (t-1)}$ *100/CPI)*$YLD_{t-1}$)<br>YLD=f(Trend90)<br>PROD=HA*YLD*r<br><br>**Ending stocks**<br>Importing countries<br>ES=f($P_{farm}$, PROD+IM, $PROD_{t+1}$, $ES_{t-1}$)<br><br>Exporting countries<br>ES=f($P_{farm}$, PROD, $PROD_{t+1}$, $ES_{t-1}$) | **Consumption**<br>Ln-CONCAP=f(Ln- $P_{retail}$ *100/CPI, Ln-GDP*100/CPI)<br>CON=CONCAP*POP<br>    Vietnam<br>    Ln-CONCAP=f(Ln- $P_{retail}$ *100/CPI, Ln-GDP*100/CPI, 1/(GDP*100/CPI))<br><br>**Trade**<br>Importing countries<br>IM=CON+ES – PROD – $ES_{t-1}$<br><br>Thailand<br>EX=PROD+$ES_{t-1}$ – CON – ES<br><br>**Global market clearing condition**:<br><br>$\sum_{j=1}^{n} IM_j = EX_{VN}$ (j ≠ VN)<br><br>where j denotes all countries in the model except for Vietnam, IMj represents the world's total net imports and $EX_{VN}$ denotes Vietnam's net exports. |

## 5. Projections and impact analysis

### *5.1. Results and baseline projections to 2020*

Equations in the model are estimated using ordinary least squares and historical data are updated to 2013. Supply and demand elasticities are calculated from the equation coefficients, which are estimated from historical data and sometimes calibrated when data failed to provide a sign consistent with economic theory. The final estimated elasticities in comparison with results from IGRM and AGRM are presented in Table 7.

Table 7: Estimated supply and demand elasticities compared with IGRM and AGRM

| Country | **ASEAN-5** | | | **IGRM** | | | **AGRM†** | |
|---|---|---|---|---|---|---|---|---|
| | Supply elasticity with respect to | Demand elasticity with respect to | | Regional supply elasticity with respect to | Demand elasticity with respect to | | Demand elasticity with respect to | |
| | Own price | Own price | Income | Own price | Own price | Income | Own price | Income |
| Indonesia | 0.04 | -0.05 | -0.08 | 0.11-0.28 | -0.07 | -0.10 | -0.13 | -0.09 |
| Malaysia | 0.03 | -0.09 | 0.08 | 0.25 | -0.01 | 0.08 | -0.30 | 0.09 |
| Philippines | 0.01 | -0.24 | 0.15 | 0.29-0.45 | -0.47 | 0.20 | -0.25 | 0.15 |
| Thailand | 0.02 | -0.01 | -0.11 | 0.11-0.28 | -0.04 | -0.15 | -0.05 | -0.16 |
| Vietnam | 0.02 | -0.08 | 0.02-(-0.02)* | 0.08-0.24 | -0.44 | -0.12 | -0.20 | -0.23 |

Source: IGRM and author's calculations.

Note: †AGRM's supply elasticities are not provided due to differences in the specifications of functional forms.*: Vietnam's income elasticities are reported for 2009 and 2013, respectively.

The presented elasticities use the averages of the last 5 years (2009-2013). Own price supply elasticities, which measure the percentage change of harvested area with respect to 1% change in lagged farm price, are positive and very inelastic, ranging from 0.01 to 0.04 across countries. Compared to IGRM's regional supply elasticities, which range from 0.08 to 0.45, ASEAN-5 estimates are much smaller on the national average. However, given the fact that rice production is very inelastic, these estimates are reasonable and can be plausibly used for the purpose of this study since the projection only covers a time span of 7 years (2014 to 2020). On the demand side, own price elasticities of demand are all negative and inelastic. With respect to per capita real GDP, rice is estimated to be an inferior good in Indonesia, Thailand and Vietnam and a normal good in the Philippines and Malaysia. These estimates are consistent with IGRM and AGRM's results. Estimated income elasticities are generally inelastic, ranging from 0.02 to 0.11 in absolute values. In the case of Vietnam, income elasticities are found to change from positive in 2010 to negative in 2011, which is consistent with the recent observation that Vietnam's rice consumption is on a declining trend (Mohanty, 2013). Consistent with previous studies, the estimated income elasticity for the Philippines is the most elastic (0.15) compared to its counterparts.

In the model's baseline projections, it is assumed that domestic prices in the importing countries that are insulating prices are fixed in real terms and the world equilibrium prices are solved accordingly. The overall implicit tariffs including AFTA and STE tariffs are then derived for each country, which are presented in Table 8. On average, Indonesia has the highest implicit tariff rate, 124%, compared to the Philippines and Malaysia, 86% and 50% respectively. STE tariffs are higher than AFTA tariffs in all three countries, which implies a larger impact of STEs' roles in the country's rice trade. Average STE tariffs are highest in Indonesia (99%) and lowest in Malaysia (30%).

Table 8: Implicit, AFTA and STE tariffs under baseline assumptions, 2014-2020

| Country | Tariff | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Average |
|---|---|---|---|---|---|---|---|---|---|
| Indonesia | *Implicit tariff* | *129%* | *126%* | *123%* | *124%* | *124%* | *124%* | *121%* | *124%* |
| | AFTA tariff | 30% | 25% | 25% | 25% | 25% | 25% | 25% | 26% |
| | STE tariff | 99% | 101% | 98% | 99% | 99% | 99% | 96% | 99% |
| Malaysia | *Implicit tariff* | *54%* | *52%* | *49%* | *50%* | *50%* | *49%* | *46%* | *50%* |
| | AFTA tariff | 20% | 20% | 20% | 20% | 20% | 20% | 20% | 20% |
| | STE tariff | 34% | 32% | 29% | 30% | 30% | 29% | 26% | 30% |
| Philippines | *Implicit tariff* | *87%* | *85%* | *83%* | *85%* | *87%* | *88%* | *87%* | *86%* |
| | AFTA tariff | 40% | 35% | 35% | 35% | 35% | 35% | 35% | 36% |
| | STE tariff | 47% | 50% | 48% | 50% | 52% | 53% | 52% | 50% |

Source: Calculated.

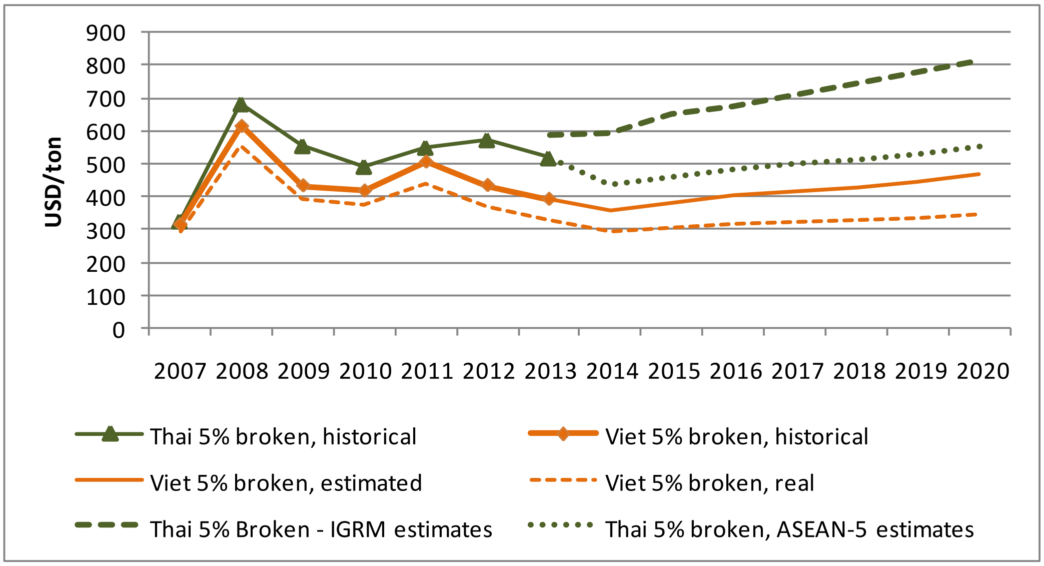
In addition, Table 9 and Figure 8 present the historical and projected world reference prices (Viet 5% broken FOB) in the ASEAN-5 model along with historical and projected Thai 5% broken FOB prices in IGRM. The results show a striking difference between ASEAN-5 and IGRM projections. According to IGRM estimates, the 2020 world reference price, Thai 5% broken FOB, is projected to be $815/MT in nominal terms, which is well above its 2008 record level of $682/MT.

Table 9: World reference price projections, 2014-2020 ($/MT)

| **Model** | **Price type** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **Growth rate** |
|---|---|---|---|---|---|---|---|---|---|---|
| ASEAN-5 | Viet 5% broken | 391 | 358 | 379 | 402 | 415 | 430 | 445 | 467 | 19% |
| ASEAN-5 | Thai 5% broken | 518 | 436 | 458 | 483 | 497 | 513 | 530 | 553 | 7% |
| IGRM | Thai 5% broken | 586 | 595 | 649 | 677 | 712 | 745 | 781 | 815 | 39% |
| AGRM | Thai 100% B | 393 | 401 | 402 | 403 | 403 | 404 | 404 | 406 | 3% |
| CCLS | Thai 100% B | 438 | 424 | 434 | 444 | 452 | 460 | 469 | 476 | 9% |
| Aglink-Cosimo | Thai 100% B | 391 | 382 | 357 | 395 | 400 | 408 | 410 | 412 | 5% |

Source: Calculated and compiled.

Figure 8: World reference prices, historical and projected to 2020




Source: IGRM and calculated.

On the other hand, ASEAN-5 model results show that nominal Viet 5% broken FOB prices are projected to increase slightly during the projection period, from $358/MT in 2014 to $467/MT in 2020, and are well below its 2008 record level. Moreover, the relative Thai 5% broken FOB estimated by ASEAN-5 model is projected to increase to $436/MT in 2014 and to $553/MT in 2020. From 2013 to 2020, the ASEAN-5 price projection increased by 19% for Viet 5% broken rice prices and by 7% for Thai 5% broken rice prices compared to a 3%, 9% and 5% increase of the Thai 100% B prices in AGRM (Wailes & Chavez, 2014), CCLS (USDA's unpublished projections) and Aglink-Cosimo (OECD, 2014), respectively.

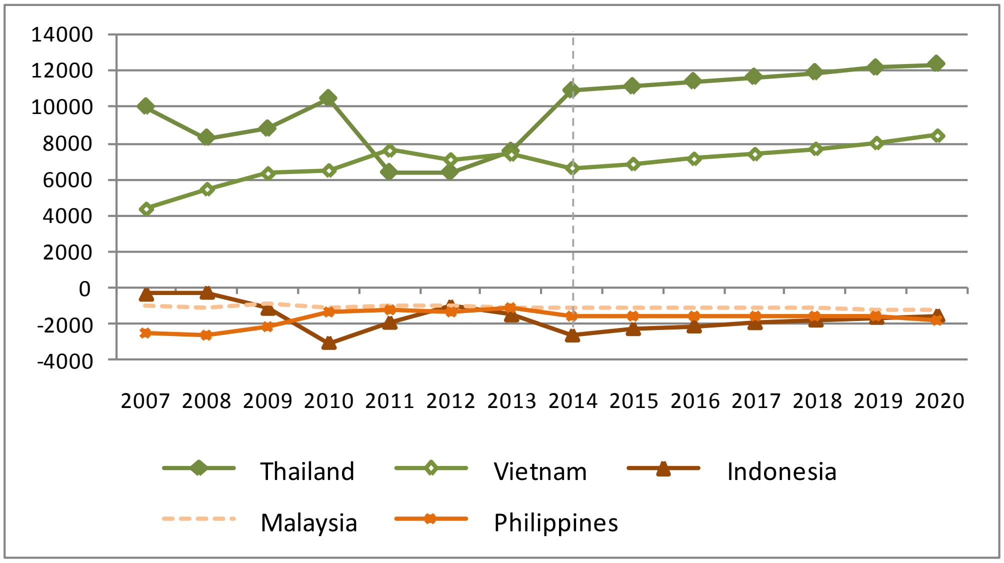
Table 10 summarizes the details of projections for harvested area, yield, milled production, consumption, net trade, stocks and prices for each country. A graphical illustration of net trade projections is also presented in Figure 9. While harvested area and yield together contribute to the increased production in Thailand as well as the remaining ASEAN-5 countries, harvested area in Vietnam is projected to decline. In particular, Thailand's harvested area is

Table 10: Baseline projections: ASEAN-5 supply, utilization and domestic prices, 2014-2020

| Item | Unit | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Growth rate |
|---|---|---|---|---|---|---|---|---|---|
| Malaysia | | | | | | | | | |
| Area | Million HA | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.0% |
| Yield | MT/HA | 4.0 | 4.0 | 4.1 | 4.1 | 4.2 | 4.2 | 4.3 | 1.1% |
| Milled production | Million MT | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.9 | 1.9 | 1.2% |
| Per cap consumption | KG/year | 96.5 | 97.5 | 98.5 | 99.5 | 100.5 | 101.5 | 102.5 | 0.3% |
| Consumption | Million MT | 2.9 | 2.9 | 3.0 | 3.0 | 3.0 | 3.1 | 3.1 | 1.6% |
| Ending stocks | Million MT | 0.8 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.5 | -6.2% |
| Net Imports | Million MT | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2% |
| Farm Price | LCU/KG | 0.9 | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 4.3% |
| Retail Price | LCU/KG | 2.0 | 2.1 | 2.2 | 2.3 | 2.3 | 2.4 | 2.5 | 3.4% |
| Philippines | | | | | | | | | |
| Area | Million HA | 4.8 | 4.8 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 0.4% |
| Yield | MT/HA | 3.9 | 4.0 | 4.0 | 4.1 | 4.2 | 4.2 | 4.3 | 1.4% |
| Milled Production | Million MT | 11.9 | 12.1 | 12.4 | 12.6 | 12.8 | 13.0 | 13.2 | 1.8% |
| Per cap consumption | KG/year | 125.9 | 126.5 | 127.0 | 127.6 | 128.1 | 128.7 | 129.3 | 0.4% |
| Consumption | Million MT | 13.4 | 13.7 | 14.0 | 14.2 | 14.5 | 14.8 | 15.1 | 2.0% |
| Ending Stocks | Million MT | 1.6 | 1.6 | 1.5 | 1.4 | 1.3 | 1.1 | 1.1 | -6.0% |
| Net Imports | Million MT | 1.6 | 1.6 | 1.5 | 1.5 | 1.6 | 1.6 | 1.8 | 2.0% |
| Farm Price | LCU/KG | 17.3 | 18.1 | 19.0 | 19.9 | 20.8 | 21.8 | 22.7 | 4.7% |
| Retail Price | LCU/KG | 35.3 | 37.0 | 38.9 | 40.9 | 42.9 | 44.8 | 46.9 | 4.8% |
| Indonesia | | | | | | | | | |
| Area | Million HA | 12.2 | 12.3 | 12.3 | 12.4 | 12.4 | 12.5 | 12.5 | 0.4% |
| Yield | MT/HA | 4.8 | 4.9 | 4.9 | 4.9 | 4.9 | 5.0 | 5.0 | 0.6% |
| Milled Production | Million MT | 37.5 | 37.9 | 38.3 | 38.7 | 39.0 | 39.4 | 39.7 | 0.9% |
| Per cap consumption | KG/year | 158.4 | 157.9 | 157.3 | 156.7 | 156.2 | 155.8 | 155.3 | -0.3% |
| Consumption | Million MT | 40.1 | 40.3 | 40.5 | 40.7 | 40.9 | 41.1 | 41.2 | 0.5% |
| Ending stocks | Million MT | 2.6 | 2.6 | 2.5 | 2.5 | 2.4 | 2.4 | 2.4 | -1.4% |
| Net Imports | Million MT | 2.7 | 2.3 | 2.1 | 2.0 | 1.8 | 1.7 | 1.5 | -8.8% |
| Farm Price | 1000 LCU/KG | 3.9 | 4.0 | 4.2 | 4.4 | 4.7 | 4.9 | 5.1 | 4.7% |
| Retail Price | 1000 LCU/KG | 8.9 | 9.3 | 9.8 | 10.2 | 10.7 | 11.2 | 11.7 | 4.6% |
| Thailand | | | | | | | | | |
| Area | Million HA | 11.2 | 11.2 | 11.2 | 11.2 | 11.3 | 11.3 | 11.3 | 0.1% |
| Yield | MT/HA | 2.9 | 2.9 | 3.0 | 3.0 | 3.1 | 3.1 | 3.1 | 1.2% |
| Milled Production | Million MT | 21.5 | 21.8 | 22.1 | 22.4 | 22.7 | 22.9 | 23.2 | 1.3% |
| Per cap consumption | KG/year | 159.1 | 158.8 | 158.5 | 158.2 | 157.9 | 157.7 | 157.4 | -0.2% |
| Consumption | Million MT | 10.6 | 10.7 | 10.7 | 10.7 | 10.7 | 10.8 | 10.8 | 0.3% |
| Ending Stocks | Million MT | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | 15.6 | 15.6 | 0.2% |
| Net Exports | Million MT | 10.9 | 11.1 | 11.4 | 11.6 | 11.9 | 12.2 | 12.4 | 2.1% |
| Farm Price | LCU/KG | 8.4 | 8.6 | 9.0 | 9.3 | 9.6 | 10.0 | 10.4 | 3.7% |
| Wholesale Price | LCU/KG | 12.3 | 12.7 | 13.6 | 14.1 | 14.7 | 15.4 | 16.2 | 4.7% |
| Vietnam | | | | | | | | | |
| Area | Million HA | 7.7 | 7.7 | 7.6 | 7.6 | 7.5 | 7.5 | 7.5 | -0.6% |
| Yield | MT/HA | 5.7 | 5.8 | 5.9 | 6.0 | 6.2 | 6.3 | 6.4 | 1.9% |
| Milled Production | Million MT | 27.6 | 27.9 | 28.2 | 28.6 | 29.0 | 29.4 | 29.8 | 1.3% |
| Per cap consumption | KG/year | 227.9 | 226.8 | 225.3 | 224.3 | 223.2 | 221.9 | 220.4 | -0.6% |
| Consumption | Million MT | 20.9 | 21.0 | 21.1 | 21.2 | 21.2 | 21.3 | 21.4 | 0.4% |
| Ending Stocks | Million MT | 2.2 | 2.2 | 2.2 | 2.3 | 2.3 | 2.3 | 2.3 | 0.9% |
| Net Exports | Million MT | 6.6 | 6.9 | 7.1 | 7.4 | 7.7 | 8.0 | 8.4 | 4.1% |
| Farm Price | 1000 LCU/KG | 5.5 | 5.9 | 6.4 | 6.7 | 7.1 | 7.5 | 8.1 | 6.7% |
| Retail Price | 1000 LCU/KG | 7.2 | 7.9 | 8.9 | 9.6 | 10.3 | 11.1 | 12.1 | 9.0% |

Source: Calculated.

Figure 9: Historical and projected net trade, 2007-2020 (1000MT)




Source: Calculated.

projected to increase by 0.1% on average while it declines by 0.6% for Vietnam. This downward trend, however, is consistent with recent projections conducted for the ASEAN rice market using AGRM (Wailes & Chavez, 2012). In their study, Thailand's harvested area was projected to increase by 0.31% during 2010-2021 period but harvested area in Vietnam decreases by 0.09%. In both countries, per capita consumption is projected to decline at average rates of 0.17% and 0.55%, respectively.

Consistent with historical trends, per capita consumption in Malaysia and the Philippines is projected to increase at average rates of 0.3% and 0.4% while for Indonesia it declines by 0.3%. However, total consumption is projected to increase in these three importing countries mainly due to continued population growth. The growth rate of projected total consumption is highest for the Philippines, 1.2%, and lowest for Indonesia, 0.5%. In addition, Thailand and Vietnam's net exports are projected to increase by 2.1% and 4.1% on average. Thailand's net export will increase from 10.9 million tons in 2014 to 12.4 million tons in 2020, while those for Vietnam will increase from 6.6 million tons to 8.4 million tons. The significant rise of Thailand's net exports in 2014 reflects the Thai government's move to release its huge stockpiles, which had accumulated to 15.5 million tons in 2013 according to USDA. Net imports in Malaysia and the Philippines are projected to continue to rise slightly at an average rate of 1.2% and 2.0%, respectively. In contrast, Indonesia's net imports are projected to decline significantly by 8.8% on average due to declining per capita consumption.

Note that in the baseline projection, prices increase in all five countries in nominal terms; however, the major drivers of price changes in these countries vary depending on different price relation assumptions. For importing countries, increases in nominal retail prices are driven solely by inflation as retail prices are fixed in real terms. For exporting countries, increases in retail prices are driven mainly by the increases in projected world reference prices.

In 2020, consumption is projected to be 498 million tons, an increase from the 2014 level of 476 million tons. The result is relatively close to CCLS and AGRM projections, which are 504 and 508 million tons respectively, and about 38 tons lower than Aglink-Cosimo (Table 11).

Table 11: Global consumption projections, 2014-2020 (million MT)

| Model | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|
| ASEAN-5 | 471 | 476 | 479 | 483 | 487 | 491 | 494 | 498 |
| AGRM | 474 | 478 | 483 | 489 | 494 | 499 | 504 | 508 |
| Aglink-Cosimo | 491 | 499 | 507 | 514 | 519 | 525 | 531 | 536 |
| CCLS-USDA | 473 | 481 | 487 | 490 | 493 | 497 | 500 | 504 |

Source: Calculated and compiled.

### *5.2. Scenarios and impact analysis*

To measure the impact of trade openness in the importing countries, three tariff removal scenarios are simulated in the model. Descriptions of each scenario are provided below.

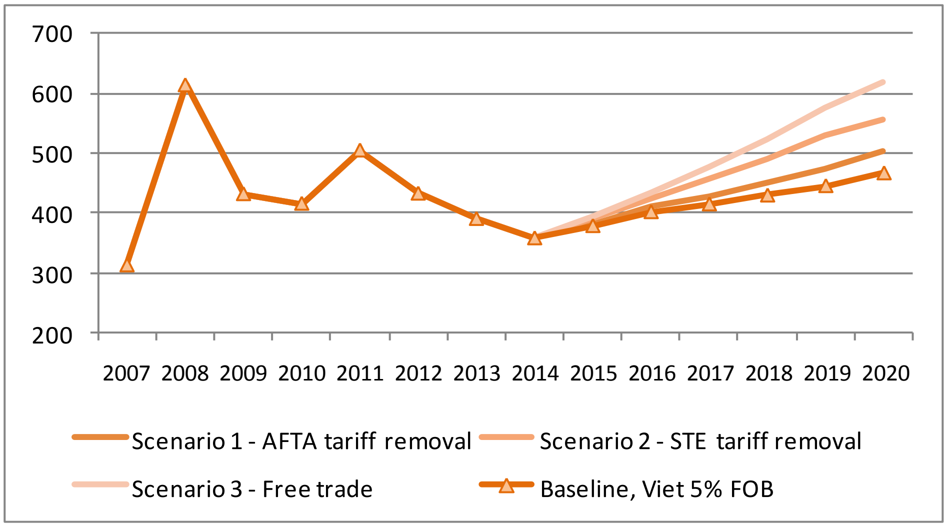
In scenario 1, the official AFTA tariff schedule shown in Table 6 is gradually removed starting from 2015 while the STE tariffs remain at the baseline level. The overall implicit tariff is re-calculated as the sum of the STE implicit tariff and reduced AFTA tariff, which becomes zero in 2020. This new tariff level is then linked to the retail price linkage as shown in equation 7 in each importing country to solve for equilibrium world prices.

Similarly in scenario 2, the STE tariffs are gradually removed starting from 2015 while the AFTA tariffs remain at the baseline level. The overall implicit tariff is re-calculated as the sum of the official AFTA tariff and reduced STE tariff, which becomes zero in 2020. This new tariff level is then linked to the retail price equation in each importing country to solve for equilibrium world prices.

Finally in scenario 3, both the official AFTA tariffs and STE tariffs are gradually removed starting from 2015. The overall implicit tariff is the sum of the gradually reduced AFTA and STE tariffs, which are together phased out in 2020. This new tariff level is then linked to the retail price equation in each importing country to solve for equilibrium world prices. As a consequence, free trade is assumed in the three importing countries as all implicit tariffs are eliminated in 2020.

Changes in world prices from the three scenarios are presented in Figure 10. As expected, the world reference price, Viet 5% broken rice, increases as tariffs are gradually reduced in the importing countries. The impact on world prices is lowest in scenario 1 and highest in scenario 3. In particular, if the official AFTA tariffs are removed while STE tariffs remain at the baseline level under scenario 1, the world reference price is expected to increase to $503/MT in 2020, which is equivalent to a 7.8% increase relative to the baseline price. If STE tariffs are removed and AFTA tariffs remain at the baseline level under scenario 2, the world reference price is expected to increase to $555/MT or a 19.0% increase relative to the baseline price. Finally, in the case of free trade when implicit tariffs become zero in 2020, the world reference price is expected to increase to $620/MT, which is modestly higher than its 2008 record level and about 32.7% above the baseline level.

Figure 10: Impacts of tariff reduction on world reference prices ($/MT)




Source: Calculated.

For the sake of brevity, the impacts of removing AFTA tariffs (scenario 1) and free trade (scenario 3) on supply and demand will be discussed in the following section. Results of removing STE tariffs (scenario 2) are provided in Appendix. Table 12 presents the quantity and percentage change in supply, utilization and prices under scenario 1 relative to the baseline.

Table 12: Utilization, supply and price differences under AFTA tariff reduction relative to the baseline

| Variable | Unit | 2013 | 2015 | | 2017 | | 2020 | |
|---|---|---|---|---|---|---|---|---|
| | | | Level | Percent | Level | Percent | Level | Percent |
| **Malaysia** | | | | | | | | |
| Milled Production | 1000MT | 1,750.6 | 0.0 | *0.0%* | -2.3 | *-0.1%* | -5.6 | *-0.3%* |
| Consumption | 1000MT | 2,825.0 | 2.8 | *0.1%* | 9.2 | *0.3%* | 20.0 | *0.6%* |
| Ending stocks | 1000MT | 744.0 | 20.8 | *2.7%* | 110.8 | *16.2%* | 298.3 | *56.8%* |
| Net Imports | 1000MT | 1,099.4 | 23.6 | *2.1%* | 60.7 | *5.4%* | 97.7 | *8.0%* |
| Farm Price | LCU/KG | 0.9 | 0.0 | *-1.5%* | -0.1 | *-4.7%* | -0.1 | *-9.2%* |
| Retail Price | LCU/KG | 2.0 | 0.0 | *-1.2%* | -0.1 | *-3.7%* | -0.2 | *-7.5%* |
| **Philippines** | | | | | | | | |
| Milled Production | 1000MT | 11,700.6 | 0.0 | *0.0%* | -6.7 | *-0.1%* | -31.4 | *-0.2%* |
| Consumption | 1000MT | 12,850.0 | 80.8 | *0.6%* | 169.3 | *1.2%* | 466.9 | *3.1%* |
| Ending Stocks | 1000MT | 1,487.0 | 99.8 | *6.3%* | 357.6 | *24.9%* | 1277.5 | *117.8%* |
| Net Imports | 1000MT | 1,149.4 | 180.6 | *11.6%* | 348.3 | *22.5%* | 866.1 | *47.9%* |
| Farm Price | LCU/KG | 16.5 | -0.5 | *-2.5%* | -1.0 | *-5.0%* | -2.8 | *-12.5%* |
| Retail Price | LCU/KG | 33.7 | -1.0 | *-2.6%* | -2.1 | *-5.2%* | -6.0 | *-12.8%* |
| **Indonesia** | | | | | | | | |
| Milled Production | 1000MT | 37,681.5 | 0.0 | *0.0%* | 7.8 | *0.0%* | -121.9 | *-0.3%* |
| Consumption | 1000MT | 39,800.0 | -20.0 | *0.0%* | 30.9 | *0.1%* | 107.3 | *0.3%* |
| Ending stocks | 1000MT | 2,485.0 | -43.4 | *-1.7%* | 60.5 | *2.4%* | 150.1 | *6.2%* |
| Net Imports | 1000MT | 1,518.5 | -63.4 | *-2.8%* | 65.5 | *3.3%* | 202.7 | *13.3%* |
| Farm Price | LCU/KG | 3,637.7 | 41.0 | *1.0%* | -68.0 | *-1.5%* | -260.3 | *-5.1%* |
| Retail Price | LCU/KG | 8,408.4 | 93.2 | *1.0%* | -154.5 | *-1.5%* | -591.5 | *-5.1%* |
| **Thailand** | | | | | | | | |
| Milled Production | 1000MT | 21,136.9 | 0.0 | *0.0%* | 7.7 | *0.0%* | 40.8 | *0.2%* |
| Consumption | 1000MT | 10,600.0 | -0.5 | *0.00%* | -1.4 | *-0.01%* | -3.1 | *-0.03%* |
| Ending Stocks | 1000MT | 15,530.0 | -14.3 | *-0.1%* | -68.4 | *-0.4%* | -199.4 | *-1.3%* |
| Net Exports | 1000MT | 7,536.9 | 14.7 | *0.1%* | 41.4 | *0.4%* | 83.2 | *0.7%* |
| Farm Price | LCU/KG | 9.7 | 0.1 | *0.9%* | 0.3 | *2.7%* | 0.7 | *6.3%* |
| Wholesale Price | LCU/KG | 14.9 | 0.1 | *1.1%* | 0.5 | *3.4%* | 1.2 | *7.7%* |
| **Vietnam** | | | | | | | | |
| Milled Production | 1000MT | 27,690.0 | 0.0 | *0.0%* | 8.6 | *0.0%* | 45.7 | *0.2%* |
| Consumption | 1000MT | 20,500.0 | -23.9 | *-0.1%* | -71.1 | *-0.3%* | -153.0 | *-0.7%* |
| Ending Stocks | 1000MT | 2,126.0 | -1.1 | *0.0%* | -5.9 | *-0.3%* | -18.8 | *-0.8%* |
| Net Exports | 1000MT | 7,390.0 | 24.9 | *0.4%* | 82.6 | *1.1%* | 202.3 | *2.4%* |
| Farm Price | LCU/KG | 5,517.1 | 57.7 | *1.0%* | 208.4 | *3.1%* | 573.3 | *7.1%* |
| Retail Price | LCU/KG | 7,316.5 | 107.6 | *1.4%* | 388.8 | *4.1%* | 1069.6 | *8.9%* |
| Vietnam Export Price | US$/MT | 390.6 | 4.3 | *1.1%* | 14.5 | *3.5%* | 36.6 | *7.8%* |

Source: Calculated.

Overall, domestic prices decrease in the importing countries when AFTA tariffs are removed by 2020. Compared to the baseline, retail prices are projected to decline by 7.5%, 12.5% and 5.1% in 2020 for Malaysia, the Philippines and Indonesia, respectively. Production in these countries is slightly affected as it declines by only 0.2% to 0.3%. Consumption increases by less than 1% for Malaysian and Indonesia and 3.1% for the Philippines. Increased demand is the major driver of the rise in the Philippines' net imports, which increase by 47.9% or 866,000 tons in 2020 compared to the baseline. The Philippines also has the highest percentage change in ending stocks, 117% or 1.3 million tons, mainly due to increases in its imports.

In the exporting countries, increased world prices drive up domestic prices, which in turn decrease consumption and boost production. However, the magnitude of the change is very small. In 2020, retail (or wholesale in the case of Thailand) and farm prices increase by less than 10% while production increases by 0.2% in both countries. Vietnam gains more in exports with an increase of 2.4% while Thailand's exports increase by 0.7%. In contrast, consumption in Thailand decreases by 0.03% while it decreases by 0.7% in Vietnam.

As expected, larger changes in production, consumption and prices occur when tariffs are further reduced. When all tariffs are removed and free trade is realized, Malaysia's imports increase modestly by 13.4% (163,000 tons) in 2020 but the Philippines and Indonesia's imports more than double their baseline levels. Imports go up by 130.1% or 2.3 million tons in the Philippines and by 137.3% or 2.1 million tons in Indonesia, respectively (Table 13).

Table 13: Utilization, supply and price differences under free trade scenario relative to the baseline

| Variable | Unit | 2013 | 2015 | | 2017 | | 2020 | |
|---|---|---|---|---|---|---|---|---|
| | | | Level | Percent | Level | Percent | Level | Percent |
| **Malaysia** | | | | | | | | |
| Milled Production | 1000MT | 1,750.6 | 0.0 | *0.0%* | -1.6 | *-0.1%* | -6.7 | *-0.4%* |
| Consumption | 1000MT | 2,825.0 | 1.5 | *0.1%* | 9.5 | *0.3%* | 29.2 | *0.9%* |
| Ending stocks | 1000MT | 744.0 | 11.1 | *1.4%* | 97.5 | *14.2%* | 381.2 | *72.6%* |
| Net Imports | 1000MT | 1,099.4 | 12.6 | *1.1%* | 69.2 | *6.1%* | 163.3 | *13.4%* |
| Farm Price | LCU/KG | 0.9 | 0.0 | *-0.8%* | -0.1 | *-4.8%* | -0.2 | *-13.2%* |
| Retail Price | LCU/KG | 2.0 | 0.0 | *-0.6%* | -0.1 | *-3.8%* | -0.3 | *-10.7%* |
| **Philippines** | | | | | | | | |
| Milled Production | 1000MT | 11,700.6 | 0.0 | *0.0%* | -13.2 | *-0.1%* | -71.5 | *-0.5%* |
| Consumption | 1000MT | 12,850.0 | 95.7 | *0.7%* | 416.6 | *2.9%* | 1289.5 | *8.6%* |
| Ending Stocks | 1000MT | 1,487.0 | 118.2 | *7.4%* | 802.2 | *55.9%* | 3141.0 | *289.8%* |
| Net Imports | 1000MT | 1,149.4 | 213.9 | *13.8%* | 859.0 | *55.6%* | 2351.9 | *130.1%* |
| Farm Price | LCU/KG | 16.5 | -0.5 | *-3.0%* | -2.4 | *-11.8%* | -6.8 | *-30.1%* |
| Retail Price | LCU/KG | 33.7 | -1.1 | *-3.1%* | -5.0 | *-12.2%* | -14.5 | *-30.8%* |
| **Indonesia** | | | | | | | | |
| Milled Production | 1000MT | 37,681.5 | 0.0 | *0.0%* | -262.6 | *-0.7%* | -1368.1 | *-3.4%* |
| Consumption | 1000MT | 39,800.0 | 101.6 | *0.3%* | 378.7 | *0.9%* | 1124.9 | *2.7%* |
| Ending stocks | 1000MT | 2,485.0 | 217.1 | *8.5%* | 840.6 | *33.9%* | 1430.0 | *59.5%* |
| Net Imports | 1000MT | 1,518.5 | 318.6 | *13.9%* | 1011.2 | *51.6%* | 2097.6 | *137.3%* |
| Farm Price | LCU/KG | 3,637.7 | -201.8 | *-5.0%* | -763.4 | *-17.2%* | -2138.0 | *-42.2%* |
| Retail Price | LCU/KG | 8,408.4 | -458.7 | *-4.9%* | -1735.1 | *-16.9%* | -4859.0 | *-41.7%* |
| **Thailand** | | | | | | | | |
| Milled Production | 1000MT | 21,136.9 | 0.0 | *0.0%* | 30.7 | *0.1%* | 175.4 | *0.8%* |
| Consumption | 1000MT | 10,600.0 | -1.8 | *-0.02%* | -5.7 | *-0.05%* | -11.8 | *-0.11%* |
| Ending Stocks | 1000MT | 15,530.0 | -55.7 | *-0.4%* | -284.2 | *-1.8%* | -847.3 | *-5.4%* |
| Net Exports | 1000MT | 7,536.9 | 57.5 | *0.5%* | 176.5 | *1.5%* | 336.4 | *2.7%* |
| Farm Price | LCU/KG | 9.7 | 0.3 | *3.3%* | 1.1 | *11.4%* | 2.7 | *26.1%* |
| Wholesale Price | LCU/KG | 14.9 | 0.5 | *4.3%* | 2.0 | *14.4%* | 5.2 | *32.0%* |
| **Vietnam** | | | | | | | | |
| Milled Production | 1000MT | 27,690.0 | 0.0 | *0.0%* | 34.0 | *0.1%* | 196.4 | *0.7%* |
| Consumption | 1000MT | 20,500.0 | -91.3 | *-0.4%* | -281.0 | *-1.3%* | -560.9 | *-2.6%* |
| Ending Stocks | 1000MT | 2,126.0 | -4.2 | *-0.2%* | -24.5 | *-1.1%* | -79.9 | *-3.5%* |
| Net Exports | 1000MT | 7,390.0 | 95.6 | *1.4%* | 327.7 | *4.4%* | 771.4 | *9.1%* |
| Farm Price | LCU/KG | 5,517.1 | 225.3 | *3.8%* | 879.5 | *13.1%* | 2390.4 | *29.7%* |
| Retail Price | LCU/KG | 7,316.5 | 420.3 | *5.3%* | 1640.8 | *17.1%* | 4459.6 | *37.0%* |
| Vietnam Export Price | US$/MT | 390.6 | 16.7 | *4.4%* | 61.0 | *14.7%* | 152.7 | *32.7%* |

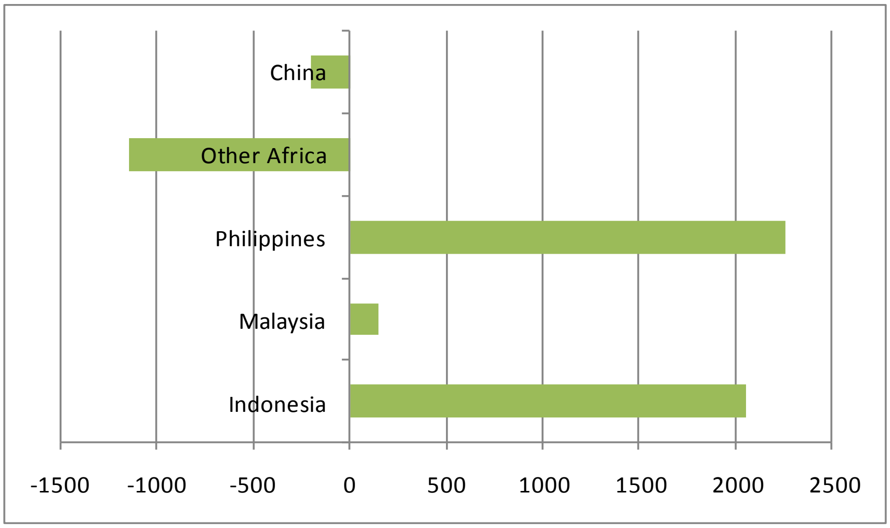
Source: Calculated.

A significant rise in imports in the Philippines and Indonesia is reasonable as both countries have been the major consumers of exported rice in the world market. The rise in imports is also the major cause of large increases in ending stocks (for 3 importing countries, imports and production are specified as a variable in ending stock equations, see Table 6 for details), which are projected to increase by nearly 3 times in the Philippines and about 60% in Indonesia. Consumers in these countries, i.e. Malaysia, the Philippines, Indonesia, however, benefit from lower prices as retail prices decrease by 10.7%, 30.8%, and 41.7%, respectively. As a result, the Philippines experiences the highest growth rate in consumption, by 8.6% compared to the baseline, followed by Indonesia (2.7%) and Malaysia (0.9%). Production is affected negatively but only slightly. Milled production in Indonesia decreases by 3.4% while it is just 0.4% and 0.5% for Malaysia and the Philippines, respectively.

In contrast, domestic prices in Thailand and Vietnam go up by as much as 37% while exports increase by 2.7% and 9.1%, respectively, as world prices increase. Milled production in both countries increases modestly by about 0.8 % compared to the baseline. As prices go up, consumption in Vietnam goes down by 2.6% while it decreases by 0.1% in Thailand. Ending stocks in both countries just decrease slightly by 5.4% for Thailand and 3.5% for Vietnam.

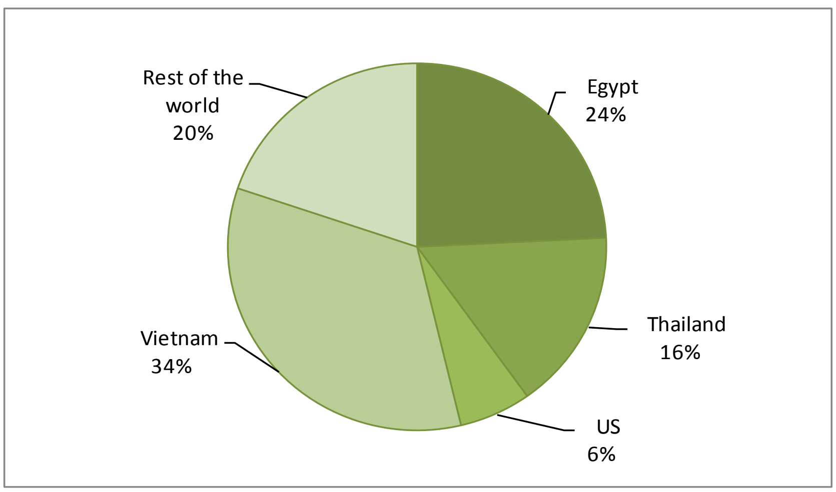
At the global level, the removal of rice tariffs in three ASEAN-5 countries has the largest impacts on the importation of the Philippines, Indonesia and African countries compared to their counterparts. While imports by the Philippines and Indonesia increase, due to tariff removal, imports by African countries is projected to fall by more than 1 million tons relative to the baseline (Figure 11). On the export side, Vietnam enjoys the largest share in the total growth of the world's net exports relative to the baseline, 34%, followed by Egypt (24%), Thailand (16%) and US (6%) (Figure 12).

Figure 11: Change in net imports under free trade scenario relative to the baseline




Source: Calculated.

Figure 12: Shares of the increase in net exports under free trade scenario relative to the baseline




Source: Calculated.

In general, when all tariffs on rice were removed, it is projected that domestic prices in the importing countries will decrease as much as 42%. The Philippines and Indonesia's imports will be more than doubled compared to the baseline. Ending stocks are directly affected by both an increase in imports and a decrease in farm prices. Ending stocks go up the most in the Philippines (nearly three times compared to the baseline), followed by Indonesia and Malaysia

(60-70%). Impacts on consumption and production are projected to be small. For exporting countries, a free trade scenario mostly affects domestic prices as retail prices increase by as much as 37.0% compared to the baseline. Exports are projected to increase by 9.1% in Vietnam and 2.7% in Thailand. The effects on production and consumption are modest.

## 6. Conclusion

The ASEAN-5 model was constructed under a partial equilibrium framework with a focus on five major rice trading countries in Southeast Asia. Functional forms in the country models and price linkages were specified to account for the unique characteristics of the Southeast Asian rice market. Among those are the price stabilization policy, trade restrictions in the importing countries and Thailand's recent price pledging scheme. Results from the model baseline and impact analyses of tariff removal are highly encouraging.

The original IGRM was improved significantly as there is a richer policy content that can be used to analyze current policies. In addition, the world reference price projections appeared to be more realistic than in the original model. The Viet 5% broken FOB was projected to increase from $358/MT in 2014 to $467/MT while the corresponding Thai 5% broken FOB was projected to increase from $436/MT to $553/MT in 2020. For the three importing countries, i.e. Malaysia, the Philippines and Indonesia, milled production was projected to increase to 1.9, 13.2, and 39.7 million tons in 2020 or at an average annual rate of 1.2%, 1.8%, and 0.9%, respectively. In the same manner, total consumption also increases to 3.1, 15.1 and 41.2 million tons or at an annual rate of 1.6%, 2.0% and 0.5%, respectively. These three countries continue to be net rice importers as rice imports in 2020 were projected to be about 1.2, 1.8, and 1.5 million tons, respectively. For Thailand and Vietnam, both countries continue to be major exporters as their rice exports were projected to be approximately 12.4 and 8.4 million tons in

2020, respectively. Milled production was projected to increase to 23.2 and 29.8 million tons, respectively, or at an annual rate of 1.3% for both countries. Total consumption is projected to grow to 10.8 million tons in Vietnam and 21.4 million tons in Thailand despite declining per capita consumption in both countries.

The main contribution of this paper is to disassemble two parts of protection, STE and AFTA tariffs, and estimate different impacts of each. Results from the study indicate that the removal of AFTA tariffs has the largest impacts on Indonesia and the Philippines' net trade and modestly affected domestic prices as well as world prices. Relative to the baseline, the removal of AFTA tariffs led to an 8% increase in the world price and a reduction of 5% to 13% in the retail prices in these countries. Imports from Malaysia, Indonesia and the Philippines were estimated to increase by 8%, 13% and 48%, respectively. However, if the monopoly of STEs in the importing countries were eliminated together with AFTA tariffs, rice imports would rise significantly in response to increases in consumption at lower prices. In the importing countries, retail prices were estimated to fall by about 11% to 42% and imports were projected to increase, notably by 137% and 130% in Indonesia and the Philippines, respectively. The world price was projected to increase by about 33%, leading to a modest rise in exports from Thailand and Vietnam (2.7% and 9.1%) but imports by African countries were projected to decline by about 1 million tons in response to higher world prices.

It appears that under full trade liberalization, low prices faced by domestic rice farmers, especially in Indonesia and the Philippines, seem to be sizeable and may create strong pressures on governments and prevent these countries from removing tariffs completely. Nevertheless, some level of tariff removal would be viable as the impacts of removing AFTA tariffs on the domestic and world market analyzed in this study have been shown to be more modest.

There are, however, some limitations in this study. Due to time constraints, many other existing policies in ASEAN-5 countries were not incorporated in the model. Most of the modeling effort was spent improving the models of three major importing countries. Thus, an improved version of this study would consider the inclusion of other important rice policies such as farm price support and government procurement. The country models of Thailand and Vietnam also need to be enhanced so as they can account for the export restriction regime in Vietnam and future changes in Thailand's price pledging scheme. Despite these drawbacks, results from this study are useful for policy makers and stakeholders who are interested in the possible benefits and costs of trade liberalization in the Southeast Asian rice market.

# APPENDIX

*Utilization, supply and price differences under STE tariff reduction relative to the baseline*

| Variable | Unit | 2013 | 2015 | | 2017 | | 2020 | |
|---|---|---|---|---|---|---|---|---|
| | | | Level | Percent | Level | Percent | Level | Percent |
| **Malaysia** | | | | | | | | |
| Milled Production | 1000MT | 1,750.6 | 0.0 | *0.0%* | 0.8 | *0.0%* | -0.9 | *0.0%* |
| Consumption | 1000MT | 2,825.0 | -1.4 | *0.0%* | 0.0 | *0.0%* | 8.6 | *0.3%* |
| Ending stocks | 1000MT | 744.0 | -10.2 | *-1.3%* | -16.0 | *-2.3%* | 78.8 | *15.0%* |
| Net Imports | 1000MT | 1,099.4 | -11.5 | *-1.0%* | 6.7 | *0.6%* | 67.3 | *5.5%* |
| Farm Price | LCU/KG | 0.9 | 0.0 | *0.8%* | 0.0 | *0.0%* | 0.0 | *-4.1%* |
| Retail Price | LCU/KG | 2.0 | 0.0 | *0.6%* | 0.0 | *0.0%* | -0.1 | *-3.3%* |
| **Philippines** | | | | | | | | |
| Milled Production | 1000MT | 11,700.6 | 0.0 | *0.0%* | -6.2 | *0.0%* | -35.6 | *-0.3%* |
| Consumption | 1000MT | 12,850.0 | 12.1 | *0.1%* | 213.8 | *1.5%* | 579.5 | *3.8%* |
| Ending Stocks | 1000MT | 1,487.0 | 15.0 | *0.9%* | 405.0 | *28.2%* | 1510.1 | *139.3%* |
| Net Imports | 1000MT | 1,149.4 | 27.1 | *1.7%* | 449.3 | *29.1%* | 1085.6 | *60.1%* |
| Farm Price | LCU/KG | 16.5 | -0.1 | *-0.4%* | -1.3 | *-6.3%* | -3.5 | *-15.2%* |
| Retail Price | LCU/KG | 33.7 | -0.1 | *-0.4%* | -2.7 | *-6.5%* | -7.3 | *-15.6%* |
| **Indonesia** | | | | | | | | |
| Milled Production | 1000MT | 37,681.5 | 0.0 | *0.0%* | -267.5 | *-0.7%* | -1191.2 | *-3.0%* |
| Consumption | 1000MT | 39,800.0 | 122.3 | *0.3%* | 331.6 | *0.8%* | 864.1 | *2.1%* |
| Ending stocks | 1000MT | 2,485.0 | 260.6 | *10.2%* | 752.5 | *30.4%* | 1100.9 | *45.8%* |
| Net Imports | 1000MT | 1,518.5 | 382.9 | *16.7%* | 906.9 | *46.3%* | 1639.0 | *107.3%* |
| Farm Price | LCU/KG | 3,637.7 | -241.6 | *-6.0%* | -676.4 | *-15.2%* | -1743.9 | *-34.4%* |
| Retail Price | LCU/KG | 8,408.4 | -549.2 | *-5.9%* | -1537.2 | *-15.0%* | -3963.5 | *-34.0%* |
| **Thailand** | | | | | | | | |
| Milled Production | 1000MT | 21,136.9 | 0.0 | *0.0%* | 21.9 | *0.1%* | 116.2 | *0.5%* |
| Consumption | 1000MT | 10,600.0 | -1.3 | *-0.01%* | -4.0 | *-0.04%* | -7.2 | *-0.07%* |
| Ending Stocks | 1000MT | 15,530.0 | -40.6 | *-0.3%* | -198.7 | *-1.3%* | -514.6 | *-3.3%* |
| Net Exports | 1000MT | 7,536.9 | 41.9 | *0.4%* | 121.8 | *1.0%* | 183.8 | *1.5%* |
| Farm Price | LCU/KG | 9.7 | 0.2 | *2.4%* | 0.7 | *7.9%* | 1.6 | *15.1%* |
| Wholesale Price | LCU/KG | 14.9 | 0.4 | *3.1%* | 1.4 | *10.0%* | 3.0 | *18.6%* |
| **Vietnam** | | | | | | | | |
| Milled Production | 1000MT | 27,690.0 | 0.0 | *0.0%* | 24.3 | *0.1%* | 130.1 | *0.4%* |
| Consumption | 1000MT | 20,500.0 | -67.0 | *-0.3%* | -199.9 | *-0.9%* | -348.3 | *-1.6%* |
| Ending Stocks | 1000MT | 2,126.0 | -3.1 | *-0.1%* | -17.1 | *-0.8%* | -49.2 | *-2.2%* |
| Net Exports | 1000MT | 7,390.0 | 70.1 | *1.0%* | 233.0 | *3.1%* | 484.5 | *5.7%* |
| Farm Price | LCU/KG | 5,517.1 | 164.1 | *2.8%* | 610.0 | *9.1%* | 1386.9 | *17.2%* |
| Retail Price | LCU/KG | 7,316.5 | 306.1 | *3.9%* | 1138.1 | *11.9%* | 2587.4 | *21.5%* |
| Vietnam export price | US$/MT | 390.6 | 12.2 | *3.2%* | 42.3 | *10.2%* | 88.6 | *19.0%* |

Source: Calculated

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# RICE DEMAND IN VIETNAM: DIETARY CHANGES AND IMPLICATIONS FOR POLICY

## 1. Introduction

Rice is the most important staple and one of the major agricultural commodities in Vietnam. Rice has such deep roots in Vietnamese culture that it is often equated with a meal that one eats[2]. Analyses of rice demand are important as rice consumption is directly related to food security, poverty and malnutrition policies. In a recent study, Nguyen & Winters (2011) found that cereals remain the food group that provides the majority of calories in the diets of the Vietnamese. Cereals, in which rice makes up the largest share, account for about 30% of expenditure but contribute more than 65% of calorie per capita on a daily basis.

After more than 20 years of economic reform and openness, Vietnam reached its $1,000 GDP per capita threshold in 2008 and joined the group of lower-middle income countries for the first time (Ohno, 2009). Rapid economic growth has led to dramatic changes in the economic and socio-demographic structures of the population. According to the General Statistics Office of Vietnam (GSO), real income almost doubled from $561 (4,273,200 VND) to $894 (16,645,200 VND) between 2002 and 2010[3]. The proportion of food expenditure in total income, however, fluctuated around 40% during this period (GSO, 2011b), indicating that food remains important in the consumption basket of Vietnamese consumers.

In food policy analysis, income and price elasticities of food demand are two important indices to measure the sensitiveness of a consumer' consumption of a particular food in

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[2] In Vietnamese parlance, asking "Did you have your rice yet?" means "Did you have your lunch/dinner yet?"

[3] Adjusted for inflation using CPI (2010=100). Exchange rate is 15,297VND/$ in 2002 and 18,162VND/$ in 2010 according to the World Bank's World Development Indicators.

response to a change in income and food price. Knowing these possible responses helps policy makers and analysts design appropriate and timely programs to reduce hunger and maintain the country's food security. In the literature, a few studies have examined Vietnam's food demand patterns using household data. However, results from these studies fail to reflect recent changes in food demand patterns induced by economic growth and the changing structure of the population during the past 10 years. In addition, literature on demand analysis applied for developing countries has shown the popularity of the Quadratic Ideal Demand System (QUAIDS) over the Almost Ideal Demand System (AIDS), Linear-Approximated Almost Ideal Demand System (LA/AIDS) and other demand models. One key strength of QUAIDS is that it can capture a non-linear Engel relationship. Thus, a good estimated in QUAIDS can switch from being a luxury to a necessity at higher expenditure levels. However, it appears that there has been no study that applied QUAIDS to fit food consumption data in Vietnam.

To bridge that gap in the literature, this study simultaneously applies both QUAIDS and AIDS models to estimate the price and expenditure elasticities of demand for rice and 6 other major food groups in the food basket of Vietnamese consumers. The Vietnam Living Standards Survey (VHLSS) conducted in 2010, one of the most recent nationally representative surveys, is used for this purpose. This research goes beyond existing studies by examining the suitability of QUAIDS over AIDS in fitting Vietnamese consumers' food demand patterns as well as providing up-to-date empirical results on demand elasticities. The analysis is disaggregated in great detail that captures elasticities by quintile class and by urban and rural areas. This disaggregation is important to our understanding of the structural shift in food consumption patterns across different demographic groups of consumers and is useful for medium and long-term food demand projections.

## 2. Background

Food demand studies have shown that food consumption patterns are strongly influenced by income and urbanization (Huang & Bouis, 1996). With regard to income changes, the patterns of food demand would transform in congruence with Bennett's Law and Engel's Law (P. Timmer et al., 1983). The former states that when people have higher incomes, they eat less cereals and more meat, fish, vegetables and dairy products. The latter asserts that the proportion of food expenditure in total income declines as income increases, although the total spending on food may still rise. In addition, urbanization strongly influences people's tastes and consumption patterns. People in urban areas are exposed to more food choices and their tastes become more westernized, meaning that they tend to eat more wheat-based products such as breads or pastas in place of rice as well more fast foods and pre-packaged foods. Another reason is that people in urban areas have more freedom in what they can buy while those in rural areas normally consume what they grow, especially basic staples such as rice or corn. Rural families depend on the sales of their home-produced foods to purchase other food items (Huang & Bouis, 1996). For these reasons, food consumption patterns in developing countries differ greatly among rural and urban consumers and are also affected by demographic and societal changes such as the migration of people from rural to urban areas and the speed of urbanization in the country.

There is a large body of literature analyzing food consumption patterns and trends in both developed and developing countries. Within this body of literature, QUAIDS appears to have gained popularity over AIDS and other demand models in fitting demand systems. For developing countries, recent examples include the application of QUAIDs to analyze food and nutrient demand in Malawi (Ecker & Qaim, 2011), food demand in urban China (Gould & Villarreal, 2006; Zheng & Henneberry, 2010), food demand in Nigeria (Elijah Obayelu, Okoruwa,

& Ajani, 2009), fish demand in Philippines (Garcia, Mohan Dey, & Navarez, 2005), rice demand in Malaysia (Tey, Shamsudin, Mohamed, Abdullah, & Radam, 2008), food demand in Indonesia (Pangaribowo & Tsegai, 2011), a series of food demand projections using QUAIDS for Ethiopia (Tafere, Taffesse, Tamiru, Tefera, & Paulos, 2011), Bangladesh (Ganesh-Kumar, Prasad, & Pullabhotla, 2012), and India (Ganesh-Kumar, Mehta, et al., 2012) assisted by the International Food Policy Research Institute (IFPRI). Studies for food demand in developed countries are not as burgeoning as for developing countries but several studies of this kind have been conducted such as using QUAIDS to estimate food demand in Switzerland (Abdulai, 2002) or examining unit roots problems in cross-sectional data using UK expenditure surveys (Silva & Dharmasena, 2013). In addition, AIDS and LA/AIDS were employed in a limited number of recent demand studies such as analyses of rice demand in Philippines (Lantican, Sombilla, & Quilloy, 2013), demand for food (Canh, 2008; Linh, 2009) and demand for fruits and vegetables (Mergenthaler, Weinberger, & Qaim, 2009) in Vietnam or food demand in Romania (Cupák, Pokrivčák, Rizov, Alexandri, & Luca, 2014).

It is interesting that most recent studies examining rice demand patterns in Southeast Asia found rice to be a normal good with respect to food expenditure at the national level. For example, the expenditure elasticity of rice demand was found to be positive but highly elastic in Malaysia (0.98) in a study using a 2008/09 household survey (Tey et al., 2008), less elastic in Philippines (0.5) according to results from Lantican et al. (2013)'s study using a 2008/09 survey, highly inelastic in Thailand (0.08) according to Isvilanonda & Kongrith (2008)'s analysis using 2002 household data and also very inelastic in Indonesia (0.06) according to Anton, Kimura, & Ogawa (2014). These studies also found that rice was a necessity good for almost all consumers of different income brackets and different geographic areas in the corresponding country. However, there were exceptions that consumers in the highest income quintile in Thailand and

Indonesia had negative expenditure elasticities, implying that rice was an inferior good for the richest consumers in these countries.

In the context of Vietnam, a number of studies have examined rice consumption and food demand patterns (Table 1). Price and income elasticities of demand for rice were estimated using household data and different demand models such as AIDS (Benjamin & Brandt, 2004; Le, 2008; Minot & Goletti, 2000; Niimi, 2005), LA/AIDS (Linh, 2009) or double-log functional form (Haughton, Fetzer, Lo, & Nguyen, 2004). Two Vietnam Living Standards Surveys (VLSS)[4] 1993 and 1998, and two VHLSSs conducted in 2004 and 2006 were used across these studies. In general, the estimated elasticities of demand for rice at the country-level were estimated to be positive and less than one, implying that rice was a normal and necessity good in Vietnam. Given the fact that the country has undergone massive economic growth in the past 10 years, data and results from the existing literature have failed to reflect recent changes in the country's food consumption patterns. The most recently used VHLSS dates back to 2006 in Linh (2009)'s study while at least two new VHLSS rounds have been available since then. In addition, there is a lack of studies that apply more advanced demand systems such as QUAIDS to capture the possible non-linear Engel relationship.

[4] These are the very first kind of nation-wide and in-depth household surveys in Vietnam and are considered as the pilot projects for the onset of the new and improved VHLSS rounds starting in 2002.

Table 1: Comparisons of expenditure elasticities in the Vietnamese food demand literature

| Author | Method | Survey year | Expenditure | | | Own-price | | |
|---|---|---|---|---|---|---|---|---|
| | | | All | North | South | All | North | South |
| Minot and Goletti, 2000 | AIDS | 1993 | | 0.48 | 0.11 | | -0.2 | -0.38 |
| | | | All | Urban | Rural | All | Urban | Rural |
| Benjamin and Brandt, 2002 | Working-Leser | pooled 1993/98 | | 0.49 - 0.41* | 0.64- 0.63* | | | |
| Haughton et. al, 2004 | Log-log quadratic, national mean | 1998 | 0.12 | 0.11 | 0.10 | | | |
| | Log-log quadratic, rural-urban mean | 1998 | | 0.04 | 0.16 | | | |
| | Log-log quadratic, national mean | 1993 | 0.16 | -0.40 | 0.27 | | | |
| | Log-log quadratic, subgroup mean | 1993 | | -0.43 | 0.19 | | | |
| Niimi, 2004 | Commune-specific unit values | 1993 | 0.62 | | | -0.85 | | |
| | | 1998 | 0.52 | | | -0.72 | | |
| Canh, 2008 | AIDS | 2004 | 0.76 | 0.02 | 0.80 | -0.33 | -0.47 | -0.54 |
| Linh, 2009 | LA/AIDS with communal adjusted price | 2006 | 0.31 | 0.46 | 0.25 | -0.8 | -0.72 | -0.82 |

Source: Compiled. *: numbers are reported for northern and southern region, respectively.

One of the first internationally-recognized studies related to rice consumption in Vietnam is the IFPRI's study on rice market liberalization conducted by Minot & Goletti (2000). The authors used VLSS 1993 and employed AIDS to estimate food demand parameters for rice and 13 other food groups, divided by northern and southern regions. Results showed that the expenditure elasticity of rice demand in the northern region was higher, 0.48, compared to that in the south, 0.11. This is sensible as consumers in the south generally have higher incomes than those in the north. Rice demand was inelastic with respect to price; own-price elasticities were estimated to be -0.2 in the north and -0.38 in the south.

Using a panel data set pooled from VLSSs 1993 and 1998, Benjamin & Brandt (2004) estimated expenditure elasticities of rice demand of the 1993-1998 period using Working-Leser model, which is mainly based on the assumption that budget share is a linear function of per capita expenditure and prices. In addition to rice, their model includes cereals, meat, oils, fish, other protein products, vegetables, fruits and food away from home (FAFH). Unadjusted unit values, which were calculated from dividing expenditure by the corresponding quantity purchased, were used as proxies for market prices. Consistent with previous studies, expenditure elasticities in urban areas were found to be smaller than in rural areas. In particular, the elasticities ranged between 0.41 for urban consumers in the south and 0.49 for those in the north while own-price elasticities varied slightly between 0.63 and 0.64 in northern and southern-rural areas. Between 1993 and 1998, the study showed that expenditure share for rice decreased from 32% to 25% for urban north and from 25% to 23% for urban south. In rural areas, rice budget share declined from 51% to 44% for rural north and 43% to 40% for rural south. Budget shares of other food groups increased but minimally, which seemed to indicate a slow transition from cereals to high-protein products such as meat and fish in the diets of the Vietnamese during this period.

Haughton et al. (2004) employed a double–logarithmic quadratic functional form to estimate the demand curve for rice using VLSSs 1993 and 1998. Interestingly, the study found that rice expenditure elasticity declined at higher income levels and reached zero value at $290 (3.56 million VND), suggesting that rice became an inferior good for richer consumers. However, the results did not show a consistent trend between 1993 and 1998. For example, expenditure elasticities estimated at the national level were negative (-0.4) in urban areas and positive in rural areas (0.3). If this finding were true, rice should continue to be an inferior good for urban consumers in 1998 as the country had shown sustained economic growth. However, the results showed that rice was a normal good for both rural and urban consumers with elasticities of 0.11 and 0.1 in 1998. Inconsistent results persisted even when the authors estimated elasticities separately for urban and rural samples.

Using a panel data set from VLSSs 1993 and 1998, Niimi (2005) applied AIDS to validate different methods of using market prices and unit prices in the demand system. Besides rice, the study also covered other major commodities including other staples, meat, fish, vegetables, fruits, sugar, spice and dairy. Estimated income and price elasticities for rice were 0.62 and -0.85 in 1993 and 0.52 and -0.72 in 1998, respectively. Noting that both price and expenditure elasticities decreased slightly between these two years. Similar to Haughton, Fetzer, Lo, & Nguyen (2004), the results appeared to be inconsistent as other staples, meat, fish and dairy shifted from being a normal good to a luxury good between 1993 and 1998. This seems to be a reversal in consumption patterns given the fact that income had increased, even modestly, between the two survey years.

Among existing studies on food demand in Vietnam, Canh (2008) and Linh (2009) are those that used more recent household surveys. Using AIDS and data from VHLSS 2004, Canh (2008) developed a food demand system of three food groups including (1) rice, (2) non-rice food including vegetables, fruits, drinks and miscellaneous, and (3) meat and fish. The author used price indices averaged from individual prices of selected food items in the survey. At the national level, rice and meat were found to be normal and necessity goods while non-rice food group was a luxury. The expenditure elasticity of rice demand was estimated to be 0.76, the highest compared to results from previous studies. In addition, the expenditure elasticity appeared to be more elastic (0.8) in rural areas while it was very inelastic in urban areas (0.02).At the national average, demand for rice was found to be inelastic with respect to its own price (-0.33). For non-rice food group, however, the compensated own-price elasticity appeared to be positive at the national level. The author asserted that this problem was not uncommon in the demand analysis literature as Deaton & Muellbauer (1980) and Gibson (1995)'s studies also found positive own-price elasticities of demand for non-cereal food groups. In addition to this, another explanation could be aggregation biases as foods were categorized in only three groups in this study. Normally, products are aggregated if they are close substitutes for each other, e.g. rice and wheat, or pork and beef. In this study's non-rice food group, foods of close substitutes such as vegetables and fruits were combined with drinks, which seem to be rather a complement than a substitute for vegetables or foods of the same kind.

To account for unit price biases, which had not been well-treated in the literature on Vietnam's food demand analysis, Linh (2009) applied different methods to adjust prices for spatial and quality differences. LA/AIDS and data from VHLSS 2006 were used to estimated price and expenditure elasticities for rice and other 10 food groups including staples, pork, poultry, other meats, fish, vegetables, fruits, other foods, drinks and food away from home (FAFH). First, the study found that the Cox & Wohlgenant (1986)'s quality-adjusted approach outperformed other methods such as individual unit value, communal unit values or Deaton's technique. Second, the study found that rice and all other food groups were normal goods with elasticities being positive at the national level as well as at different levels of disaggregation. The national expenditure elasticity of rice demand was estimated to be 0.31, smaller than results from Canh (2008) and Niimi (2005), but rice demand was very price elastic with an own price elasticity being -0.8. The expenditure elasticities of other food groups were also very elastic, slightly below or above unity. However, findings of this study exposed some conflicting trends. For example, the mean expenditure elasticity for rural consumers was estimated to be higher than that for urban consumers (0.46 vs. 0.25). In addition, consumers of the 5$^{th}$ quintile, the richest group in the sample, were found to have the highest mean expenditure elasticity (0.55) compared to other income groups. Similarly, the expenditure elasticity in the south was higher than in the north (0.39 vs. 0.22) while the former region, in fact, was generally richer than the later.

While rice remained the focus of the literature on food demand in Vietnam, none of the previous studies have applied rank-three demand systems such as QUAIDS for their analysis. According to (Cirera & Masset, 2010), the rank of a demand system is "the maximum dimension of the function space contained by the Engel curve" and demand systems of this kind have been shown to outperform their counterparts in fitting data and providing projections. This study employs both AIDS and QUAIDS to estimate a food demand system for Vietnam using VHLSS 2010. Empirical tests will be conducted to compare the performance of both models in fitting the data. Conclusions will be drawn accordingly.

In the next section detailed specifications of AIDS and QUAIDS models are presented along with likelihood and Wald test procedures. Section 4 provides an overview of the household survey data used for the analysis. The categorization of composite food groups and demographic variables are defined and descriptive statistics are provided. Section 5 discusses analytical procedures to enumerate unit prices in order to account for quality and spatial biases in the estimation. Section 6 presents the results of the analysis including the assessment of the models' performance in fitting data based on test statistics. The elasticity estimates from the selected model are presented at various disaggregate levels. The last section of this essay summarizes results from the analysis and implications for food policy in Vietnam.

## 3. Model specification

The AIDS model developed by Deaton & Muellbauer (1980) and one of its various extended versions, the QUAIDS model, developed by Banks, Blundell, & Lewbel (1997) are used as the theoretical basis for this study. Based on an indirect utility function, the QUAIDS model has a form as follows:

$$w_i = a_i + \sum_{j=1}^{n} \gamma_{ij} \, lnp_j + \beta_j ln\left[\frac{m}{\alpha(\boldsymbol{p})}\right] + \frac{\lambda_i}{b(\boldsymbol{p})}\left\{ln\left[\frac{m}{\alpha(\boldsymbol{p})}\right]\right\}^2 \quad (1)$$

where $w_i$ is the budget share of household i derived from price, quantity and total expenditure, $w_i = p_i q_i / m$, and satisfies the constraint $\sum_{i=1}^{n} w_i = 1$, $n$ is the number of goods in the system, $p_j$ is the price of good j, $m$ is per capita total food expenditure, $\alpha(\boldsymbol{p})$ and $b(\boldsymbol{p})$ are the price indices, $\boldsymbol{p}$ is the vector of prices and *α, β, γ,* and $\lambda$ are parameters to be estimated. Price indices are defined below:

$$lna(\boldsymbol{p}) = a_0 + \sum_{n=1}^{n} \alpha_i lnp_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} lnp_i lnp_j \quad (2)$$

$$b(\boldsymbol{p}) = \prod_{i=1}^{n} p_i^{\beta_i} \quad (3)$$

All parameters need to satisfy the adding-up condition, homogeneity condition, and Slutsky symmetry restriction:

Adding-up: $\sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} \beta_i = \sum_{i=1}^{n} \gamma_{ij} = 0,$

Homogeneity: $\sum_{i=1}^{n} \gamma_{ij} = 0 \; \forall \, j$

Symmetry: $\gamma_{ij} = \gamma_{ji}$

Expenditure elasticities are obtained from

$$\eta_i = {}^{\mu_i}/_{w_i} + 1 \text{ where } \mu_i = \beta_i + \frac{2\lambda_i}{b(\boldsymbol{p})}\left\{ln\left[\frac{m}{\alpha(\boldsymbol{p})}\right]\right\} \quad (4)$$

Uncompensated price elasticities are given by

$$e_{ij}^{u} = {}^{\mu_{ij}}/_{w_i} - \delta_{ij} \text{ where } \mu_{ij} = \gamma_{ij} - \mu_i\left(\alpha_j + \sum_k \gamma_{jk} lnp_k\right) - \frac{\lambda_i \beta_i}{b(\boldsymbol{p})}\left\{ln\left[\frac{m}{\alpha(\boldsymbol{p})}\right]\right\}^2 \quad (5)$$

Compensated price elasticities are derived from the Slutsky equation:

$$e_{ij}^{c} = e_{ij}^{u} + \eta_i w_i \quad (6)$$

In addition, to account for demographic characteristics of a household, Poi (2013) extended equation 1 using the scaling technique proposed by Ray (1983). Assuming a utility maximizing household with s demographic characteristics, represented by vector **z**, the scaled expenditure function has the form:

$$m_0(\boldsymbol{p}, \boldsymbol{z}, u) = \overline{m_0}(\boldsymbol{z}).\phi(\boldsymbol{p}, \boldsymbol{z}, u) \quad (7)$$

in which $\overline{m_0}(\boldsymbol{z})$ measures the change in a household's expenditure with respect to demographic characteristics holding consumption patterns constant. The second term, $\phi(\boldsymbol{p}, \boldsymbol{z}, u)$, on the other hand, accounts for actual prices and quantities consumed by a household. It is defined by:

$$ln\phi(\boldsymbol{p}, \boldsymbol{z}, u) = \frac{\prod_{j=1}^{k} p_j^{\beta_j} (\prod_{j=1}^{k} p_j^{\eta'_j z} - 1)}{\frac{1}{u} - \sum_{j=1}^{k} \lambda_j ln p_j} \quad (8)$$

QUAIDS with a vector of demographic variables **z** now has the form:

$$w_i = a_i + \sum_{j=1}^{n} \gamma_{ij}\, lnp_j + (\beta_j + \eta_i \boldsymbol{z})\, ln\left[\frac{m}{m_0(\boldsymbol{z})\alpha(\boldsymbol{p})}\right] + \frac{\lambda_i}{b(\boldsymbol{p})c(\boldsymbol{p}, \boldsymbol{z})}\left\{ln\left[\frac{m}{m_0(\boldsymbol{z})\alpha(\boldsymbol{p})}\right]\right\}^2 \quad (9)$$

where $m_0(\boldsymbol{z}) = 1 + \rho' \boldsymbol{z}$ and $c(\boldsymbol{p}, \boldsymbol{z}) = \prod_{j=1}^{k} p_j^{\eta'_j z}$ with $\sum_{j=1}^{k} \eta_{rj} = 0$ (r=1…s) to satisfy adding-up condition. Two additional vectors of demographic parameters $\rho$ and $\eta$ are to be estimated.

It is noted that when $\lambda_i$ = 0 equation 1 becomes the original AIDS model. With a quadratic term $\lambda_i$ in the expenditure $m$, QUAIDS allows a good to change from luxury (expenditure elasticity>1) to necessity (expenditure elasticity<1) as expenditure increases.

Furthermore, likelihood ratio and Wald tests are conducted in the study to examine the suitability of QUAIDS over AIDS. First, Wald tests are used to test whether the quadratic terms $\lambda_i$ in QUAIDS are significantly different from zero in every single equation and for all 7 equations simultaneously. If the test statistics are significant, the expenditure variable *m* should have a quadratic term in the demand system. Second, a likelihood ratio test is employed to check whether QUAIDS performs better than AIDS. The test statistic is simply derived from k=2*(L1-L0) where L1 is the likelihood value of QUAIDS (the unrestricted model) and L0 is the likelihood value of AIDS (the restricted model which has less parameters). The test statistic *k* has an asymptotic $\chi^2_{u-r}$ distribution with *u-r* degrees of freedom, where *u* is the number of parameters in the unrestricted model and *r* is the number of parameters in the restricted model. A significant *t* statistic indicates that QUAIDS fits data better than AIDS.

**4. Data description**

This study uses the household survey conducted by the General Statistics Office of Vietnam in 2010 for analysis. The full survey contains 36,756 households with information on education, health and healthcare, employment and income, expenditure, housing, poverty reduction and socio-demographic characteristics. However, data for this study are mainly obtained from the Income and Expenditure Survey (IES), a subset of VHLSS. IES is a nationally representative sample containing information on income and expenditure on foods and non-foods of 9,399 households from 63 provinces and cities, 687 districts and 3,129 communes. About two thirds of households in the sample lived in rural areas while the remainder lived in urban areas, a reflection of the agriculture-based economy of Vietnam. Interviews were conducted in three quarters from June to December of 2010.

Data on food consumption were collected for purchased, home-produced foods and foods given as gifts covering 54 different food items. The regularity of consumption was divided into holiday (reported on an annual basis) and 30-day period consumption[5] (here defined as regular consumption). Total food expenditure is calculated as the sum of regular and holiday consumption.

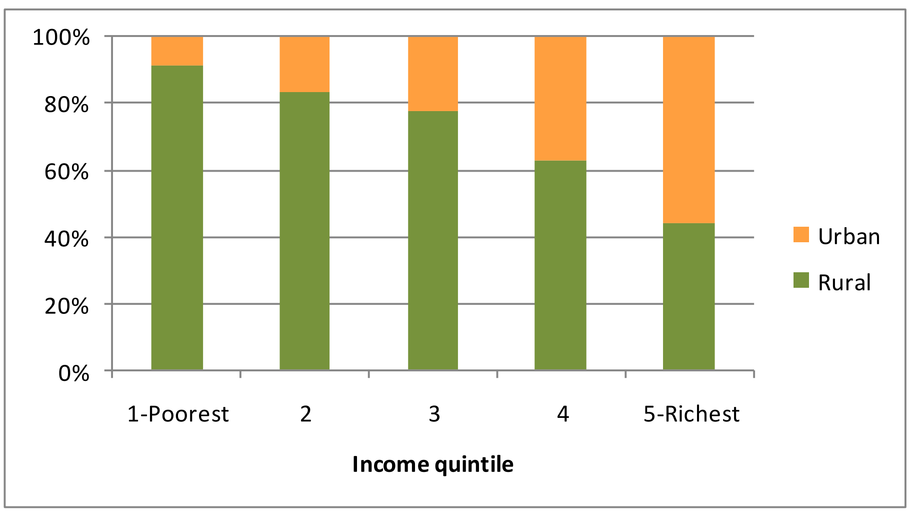
Out of 9,399 households in the sample, 9,319 households are used for analysis. Households that have missing values and negative prices are first removed from the dataset. In

[5] First, the respondent is asked “Which of the following items has your household consumed on festive occasions over the past 12 months?” to report on food consumption on holidays. Then regular consumption is investigated by the following question “Over the past 30 days, which of the following items has your household consumed?”

addition, households are dropped if they either spend 100% of expenditure on only one food group, have the budget share for rice less than 1%, have income per capita exceeding 2 billion VND (about 100 times higher than the average) or have annual rice consumption per capita exceeding 400 kg (about 3 times higher than the average). These could have been caused by measurement errors during the survey interviewing process.

A disaggregation of the sample by income quintile and by urban and rural households is shown in Figure 1. At higher income levels, the proportion of urban-dwellers increases significantly, from 9% at the lowest quintile to 56% at the highest quintile, indicating that people in urban areas are generally much richer than those in rural areas. This population decomposition also suggests that the share of urban households in each income class is expected to increase, especially at higher income brackets, as the economy continues to grow.

Figure 1: Shares of rural and urban households by income quintile




Source: VHLSS 2010

All food items in the sample are aggregated into 7 major food groups including (1) rice, (2) pork, (3) meat and fish, (4) vegetables and fruits, (5) sugar, (6) drinks and (7) miscellaneous food which aggregates all the remaining food items. Table 2 presents in detail the categorization of each group along with corresponding budget shares and annual per cap consumption. Budget share is calculated as the percentage of expenditure on a particular food group in total food expenditure. On average, a household spends half of their total income on food. The average food expenditure per capita was $392 (7.3 million VND) or $33 (611,000 VND) per month, which is similar to GSO's calculations (GSO, 2011b). Among 7 food groups, meat including pork and other kinds of meat accounts for the largest part of a household's food expenditure, 29.8% total, followed by rice (20.3%) and vegetables (11.0%). The proportions of drinks and sugar in total expenditure are small, 4.4% and 2.2%, respectively. However, it should be noted that a portion of a household's total food consumption goes into foods that are consumed out of home. On average, FAFH alone accounts for 14.4% of the household's total food expenditure, or about half of the expenditure on miscellaneous foods.

Table 2: Food item aggregation

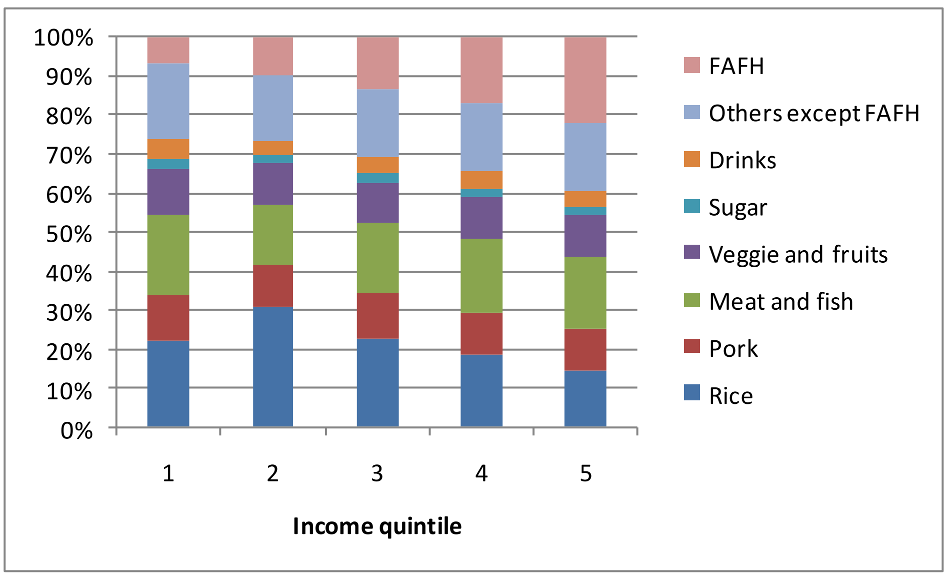
| No | Food group | Constituent food items | Unit | Budget share | Annual per cap consumption |
|---|---|---|---|---|---|
| 1 | Rice | Plain rice, sticky rice | Kg | 20.3% | 124.0 |
| 2 | Pork | Pork | Kg | 11.0% | 13.9 |
| 3 | Meat and fish | Beef, buffalo meat, poultry, fish, shrimps, other processed meats and seafood | Kg | 18.8% | 26.8 |
| 4 | Vegetables and fruits | Beans, peanuts, tofu, vegetables and fruits | Kg | 11.0% | 72.7 |
| 5 | Sugar | Sugar and confectionery | Kg | 2.2% | 5.5 |
| 6 | Drinks | Alcohols, beer, fruit drinks, soft drinks | Liter | 4.4% | 12.0 |
| 7 | Miscellaneous* | Food away from home and other cereals, spices, coffee and tea, eggs, milk and dairy products, seasonings and cooking oil | Index | 32.2% | 24.9 |

Source: VHLSS 2010.

Note: *This group is a combination of disparate food items which have no consistent quantity units. The price of this food group is replaced by 2010 CPI, which is 109.9. More details on the calculation of unit prices are provided in the estimation strategy section.

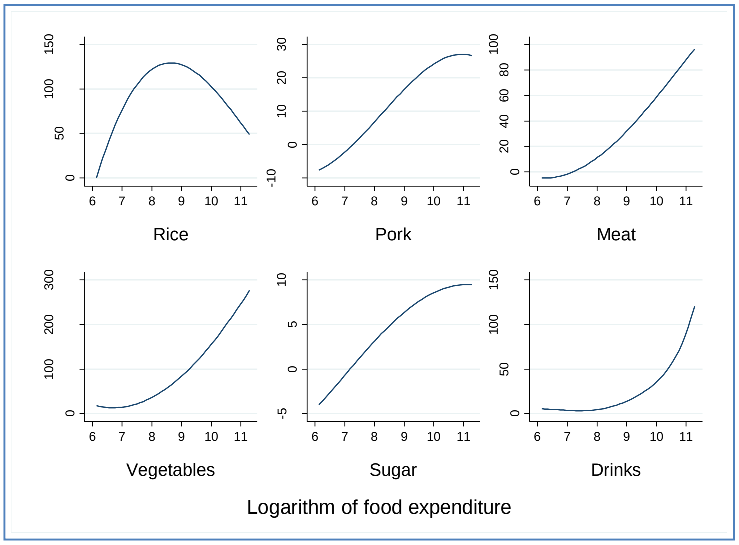
Figure 2 shows that food budget shares are substantially similar across different income levels for most food groups except rice and FAFH. The budget share of rice is highest in the second quintile group and has a declining trend at higher income quintiles. In contrast, the proportion of FAFH in total food expenditure increases considerably as income rises, from about 6% for consumers at the lowest income quintile to 23% for those at the highest income quintile. A clearer picture of how per capita consumption of each food group changes as food expenditures rise is shown in Figure 3. Consistent with Bennett's Law, the per capita consumption of all food groups except rice increases with expenditure. Interestingly, the relationship between per capita rice consumption and logarithm of per capita expenditure has an inverted U-shaped curve, which indicates that per capita rice consumption increases at lower income levels and starts to decline after reaching its maximum point, around the mean expenditure value of $401 (7.3 million VND).

Figure 2: Food budget shares by income quintile




Source: VHLSS 2010

Figure 3: The relationship between quantity consumed and logarithm of food expenditure on a per capita basis for 6 food groups

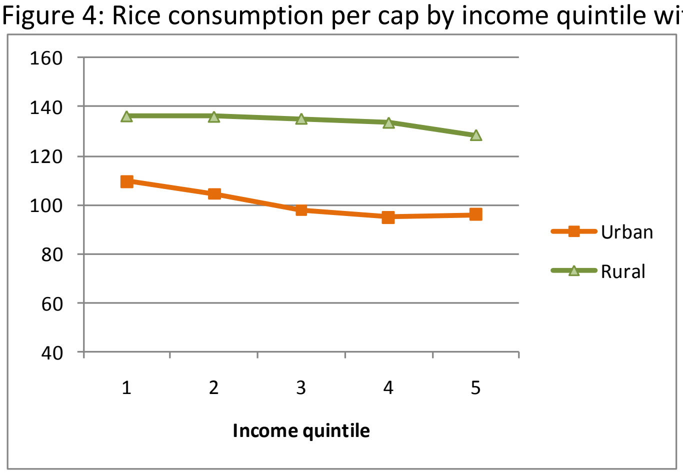



Source: VHLSS 2010.

Note: Non-parametric estimations using Gaussian kernel functions. Quantity and food expenditure are used on a per capita basis. Units of quantity consumed are kg for rice, pork, meat, vegetables, sugar and liter for drinks.

Particularly, annual per capita rice consumption averages 124 kg at the national level in which rural people consume about 134 kg of rice per person on average, 33.5 kg higher than urban consumers. Rice consumption also shows a declining trend at higher income brackets for both rural and urban consumers (Figure 4).

Figure 4: Rice consumption per cap by income quintile within rural and urban areas




Source: VHLSS 2010

In addition, a summary of socio-economic and demographic variables used for analysis is presented in Table 3. The average household size is 4 and average age of the head of a household is 48. The average proportion of kids under 5 years old is 8.5% while the proportion of the people above 60 years old in the household is 12.8%. Dummy variables are reported by the share of households that have the corresponding characteristics. 75% of households are headed by males. About 28% of households live in urban areas and 72% live in rural areas. The share of households that are ethnic minorities is 17%. The educational level of the household head is divided into groups that include those with less than or equivalent to primary school degrees or no degree (44.2%), elementary, high school or vocational school degrees (49.4%), and college or graduate school degrees (6.5%). Provinces are grouped into 8 different regions to reflect geographical differences among households. Mekong River Delta and Red River Delta are the two regions that have the highest proportion of households in the survey, 20.4% and 18.5% respectively. Three dummy variables are created based on the month the survey took place to take into account seasonal differences among households.

Table 3: Summary statistics of household demographic characteristics

| **Demographic variables** | **Mean** |
|---|---|
| Household size | 4.0 |
| Age of the household head | 48.3 |
| Proportion of infants (age<5) | 8.5% |
| Proportion of elders (age >60) | 13.1% |
| ***Share of households with the following demographic characteristics*** | **%** |
| Head of the household is male | 75.2 |
| If the household lives in urban areas | 28.2 |
| Ethnic minority | 17.7 |
| Educational attainment - Primary school, no degree | 44.2 |
| Educational attainment - Elementary, high school or equivalent vocational school | 49.4 |
| Educational attainment - College and university degree and graduate degree | 6.5 |
| Region 1 - Red River Delta | 18.5 |
| Region 2 - North East | 9.1 |
| Region 3 - North West | 11.1 |
| Region 4 - North Central Coast | 10.3 |
| Region 5 - South Central Coast | 11.8 |
| Region 6 - Central Highlands | 6.7 |
| Region 7 - South East | 12.2 |
| Region 8 - Mekong River Delta | 20.4 |
| Season 1 - June, July | 32.8 |
| Season 2 - August, September, October | 33.9 |
| Season 3 - November, December | 33.4 |

Source: VHLSS 2010.

## 5. Estimation strategy

One major problem with VHLSS 2010 is that the survey did not collect price data. Thus, in this study unit prices are derived from dividing expenditure by the corresponding quantity. For households that have missing unit prices due to zero-consumption or omitted quantity[6], missing prices are replaced by mean prices at the commune, district and province level, whichever comes first. Following Linh (2009), all unit prices that are more than five standard deviations from their means are replaced by the mean of unit values of households in the same commune.

In addition, the enumerated unit prices might suffer from quality effects and measurement errors, which are common in household data analysis (Deaton, 1988). Consumers choose quality which is reflected by the price (unit value). When prices change, however, consumers react by changing both quality and quantity. Measurement errors in reported quantities and expenditures also cause inaccuracy in enumerated unit prices. To account for these potential biases, this study employs the communal mean price method originally developed by Cox & Wohlgenant (1986) and later modified by Linh (2009) in his food demand study using VHLSS 2006. Several studies have affirmed the usefulness of this method in eliminating spatial and quality variations in price data (Gibson & Rozelle, 2011; Majumder, Ray, & Sinha, 2012; Niimi, 2005).

First, prices are adjusted for quality differences. The equation has the form as follows:

$$p_i = \alpha\, p_i^c + \beta f_i + \gamma\, x_i + \sum_n \eta_{in} z_{in} + e_i \qquad (10)$$

where i denotes the household i in the dataset, $p_i$ is the unit price of an individual food faced by household i, $p_i^c$ is the mean of unit prices at communal level, $f_i$is the share of food away from home, $x_i$is the household food expenditure per cap and $e_i$ is the error terms. Household

[6] For food group combining disparate types of foods the survey only asked for total expenditure and subjectively ignored quantity.

characteristics $z_{in}$ include household size, urban and region dummy variables, the sex, education and age of the household head.

The residual for every household i in equation 10 is added to the communal mean unit price $p_i^c$ to obtain the quality-adjusted prices $p_i^a$ at the household level.

$$p_i^a = p_i^c + \hat{e_\iota} \quad (11)$$

According to Deaton (1988), household surveys normally collect data from households in the same village at the same time. Thus, it is plausible that these households should face the same price. Taking this insight into consideration, this study assumes that households in the same commune (the smallest geographic unit in the dataset) face the same prices. This communal mean quality-adjusted price of the individual food item is the mean of $p_i^a$ calculated at the communal level.

$$p_i^{c*} = \overline{p_i^a} \quad (12)$$

Except for the group of miscellaneous foods, the composite price of the food group is also computed at the communal level, i.e. households in the same commune face the same unit prices for these composite food groups. Following Niimi (2005), the commune mean budget shares are used as weights.

$$p_g^c = {\sum_{i=1}^{k} p_i^{c*} u_i^c} \Big/ {\sum_{i=1}^{k} u_i^c} \quad (13)$$

where $u_i^c$ is the mean budget share at the communal level of individual food item i, k is the number of food item i in the group, $p_g^c$ is the price of the composite food group g at the communal level. As the miscellaneous food group is a combination of disparate food items with different quantity units, there is no standard unit price for this group. Following Ganesh-Kumar, Prasad, et al. (2012) and Linh (2009), I replaced the price of this group by the 2010 CPI, which is 109.19. The mean prices of each food group along with standard deviations are presented in

Table 4. Zero-consumption is not a problem in this study as the number of non-consuming households is very minimal.

Table 4: Unit prices and shares of consuming households

| Food group | Unit | Mean price (1000 VND) | Standard deviation | Percentage of consuming households (%) |
|---|---|---|---|---|
| Rice | Kg | 9.5 | 1.8 | 99.7 |
| Pork | Kg | 54.2 | 8.2 | 99.1 |
| Meat and fish | Kg | 54.7 | 16.5 | 99.3 |
| Vegetables and fruits | Kg | 11.2 | 3.7 | 99.7 |
| Sugar | Kg | 30.6 | 13.8 | 99.0 |
| Drinks | Liter | 42.0 | 36.8 | 97.8 |
| Miscellaneous | Index | 109.2 | 0.0 | 100.0 |

Source: VHLSS 2010

## 6. Empirical results

### *6.1. Country-level*

Both QUAIDS and AIDS yield consistent and similar results on mean expenditure and price elasticities across 7 food groups as shown in Table 5. Except for rice, all food groups were estimated to have positive expenditure elasticities by both models. Pork appeared to be a necessity with an expenditure elasticity below unity (0.78), while meat and fish group is a luxury good (1.26). This suggests a shift in demand for higher-valued meats away from pork as consumers' incomes increase, which seems sensible as pork is the most popular meat consumed in Vietnam. A shift away from pork consumption highlights consumers' dietary diversification. In addition, drinks and miscallenous foods are found to be luxury goods while vegetables and fruits and sugar are necessities. Studies conducted for other Asian countries such as China also found that drinks were a luxury good (Fan, Wailes, & Cramer, 1995; Huang & Bouis, 1996). Interestingly, the expenditure elasticity for rice is estimated to be positive in QUAIDS (0.05) but negative in AIDS (-0.04) although in terms of absolute values, both results show an inelastic demand curve for rice.

Table 5: QUAIDS and AIDS price and expenditure elasticity estimates

| Food group | QUAIDS | | | AIDS | | |
|---|---|---|---|---|---|---|
| | Expenditure | Own price | | Expenditure | Own price | |
| | | Marshallian | Hicksian | | Marshallian | Hicksian |
| Rice | 0.05 | -0.12 | -0.06 | -0.04 | -0.15 | -0.09 |
| Pork | 0.78 | 0.05 | 0.15 | 0.86 | -0.02 | 0.08 |
| M&F | 1.26 | -0.73 | -0.51 | 1.24 | -0.74 | -0.52 |
| V&F | 0.84 | -0.77 | -0.67 | 0.85 | -0.77 | -0.67 |
| Sugar | 0.65 | -0.57 | -0.55 | 0.65 | -0.56 | -0.55 |
| Drinks | 1.83 | -1.10 | -1.04 | 1.82 | -1.10 | -1.04 |
| Misc. | 1.53 | -1.36 | -0.91 | 1.54 | -1.41 | -0.96 |

Source: Calculated.

At the national level, the estimated Marshallian and Hicksian own-price elasticities are negative for all food groups except pork, which appeared to be a Giffen good with positive own-price elasticities. In the literature, Giffen goods have been shown to be a popular case rather than a paradox in consumer theory (Doi, Iwasa, & Shimomura, 2009; Spiegel, 1994). An example of Giffenity could be that a household chooses between pork and beef as alternative sources of protein. The former is considered cheaper and less preferred while the later is more expensive and tasty. However, if prices of pork soar but food budget remains unchanged, which also means real income declines, the household may have to reduce their consumption of beef and increase their quantity demanded for pork to meet daily nutritional requirements. This should be the case for an average Vietnamese household as the country faced stiff inflation in late 2010 (Bhattacharya, 2013).

In addition, Wald test results show that 5 out of 7 food equations have their quadratic terms $\lambda$ significantly different from zero (Table 6). The null hypothesis that $\lambda_i$ is jointly equal to zero in all 7 equations is rejected at 1% level of significance, which indicates the importance of the quadratic term in the expenditure variable. Moreover, *k* value from the likelihood ratio test is statistically significant at 1% as shown in Table 7. Thus, we reject the null hypothesis that two models are the same. Combining results from both tests, it is plausible to conclude that the expenditure *m* in equation 7 should have a quadratic term and QUAIDS fits data better than AIDS. Estimated parameters from QUAIDS regression are also presented in Table 8 with z-statistics. Out of 193 parameters to be estimated, 123 parameters are statistically significant at 10% level. Among 49 key parameters associated with $\alpha_i$, $\beta_i$, $\gamma_{ij}$, and $\lambda_i$, 39 are estimated to be statistically significant at 1% level.

Table 6: Wald test results

| | Chi-squared | Prob > chi2 |
|---|---|---|
| Rice | 858.04 | 0.00 |
| Pork | 73.24 | 0.00 |
| Meat and fish | 234.12 | 0.00 |
| Vegetables and fruits | 2.36 | 0.12 |
| Sugar | 34.69 | 0.00 |
| Drinks | 0.50 | 0.48 |
| Others | 9.72 | 0.00 |
| H0: All quadratic terms = 0 | 1240.92 | 0.00 |

Source: Calculated.

Table 7: Likelihood ratio test results

| | Log-likelihood | Number of variables |
|---|---|---|
| QUAIDS | 92108.73 | 193 |
| AIDS | 91819.17 | 186 |
| Test statistic, k | 579.13 | |
| Degree of freedom | 7 | |
| Chi-squared at 1% significance level, df=7 | 18.47 | |

Source: Calculated

Table 8: QUAIDS parameter estimates

| Parameters | Food groups (i) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Rice** | **Pork** | **M&F** | **V&F** | **Sugar** | **Drink** | **Misc.** | |
| $\alpha_i$ | 0.30011 | -0.29060 | -0.29104 | 0.08409 | -0.05545 | 0.09610 | 1.15679 | |
| | (9.76) | (-9.16) | (-8.58) | (3.82) | (-7.07) | (6.77) | (21.72) | |
| $\beta_i$ | 0.10123 | -0.11732 | -0.16820 | -0.00531 | -0.02221 | 0.01793 | 0.19387 | |
| | (11.04) | (-10.59) | (-13.76) | (-0.69) | (-8.14) | (3.56) | (10.36) | |
| $\lambda_i$ | 0.02212 | -0.00900 | -0.01856 | 0.00109 | -0.00151 | 0.00033 | 0.00553 | |
| | (29.29) | (-8.56) | (-15.30) | (1.54) | (-5.89) | (0.71) | (3.12) | |
| $\gamma_{ij}$ | 0.16931 | | | | | | | |
| | (23.55) | | | | | | | |
| $\gamma_{ij}$ | -0.06417 | 0.08345 | | | | | | |
| | (-11.09) | (9.88) | | | | | | |
| $\gamma_{ij}$ | -0.09967 | 0.04671 | 0.12705 | | | | | |
| | (-15.60) | (6.34) | (9.99) | | | | | |
| $\gamma_{ij}$ | -0.01291 | -0.00647 | 0.00213 | 0.01815 | | | | |
| | (-4.21) | (-2.11) | (0.51) | (9.78) | | | | |
| $\gamma_{ij}$ | -0.01160 | 0.00043 | 0.00565 | 0.00276 | 0.00641 | | | |
| | (-8.18) | (0.28) | (3.26) | (3.97) | (11.34) | | | |
| $\gamma_{ij}$ | -0.00916 | -0.00712 | -0.00169 | 0.00237 | -0.00028 | 0.00022 | | |
| | (-4.98) | (-3.71) | (-0.62) | (2.95) | (-0.67) | (0.29) | | |
| $\gamma_{ij}$ | 0.02820 | -0.05283 | -0.08017 | -0.00603 | -0.00337 | 0.01566 | 0.09854 | |
| | (3.11) | (-4.38) | (-5.15) | (-1.12) | (-1.31) | (4.78) | (3.99) | |
| **Demographic parameters** | | | | | | | | **ρ** |
| η-age | -0.00007 | 0.00001 | 0.00002 | -0.00002 | 0.00001 | -0.00002 | 0.00007 | -0.0007 |
| | (-1.44) | (0.59) | (0.77) | (-1.90) | (3.31) | (-2.25) | (1.99) | (-0.86) |
| η-male_d2 | 0.00046 | -0.00049 | -0.00101 | 0.00152 | 0.00040 | -0.00294 | 0.00205 | 0.0385 |
| | (0.40) | (-1.56) | (-1.87) | (5.70) | (5.31) | (-15.27) | (2.31) | (1.81) |
| η-share of kids | 0.01205 | -0.00076 | -0.00266 | 0.00022 | -0.00194 | 0.00190 | -0.00881 | -0.1842 |
| | (3.38) | (-0.76) | (-1.49) | (0.26) | (-8.11) | (3.27) | (-3.38) | (-2.87) |
| η-share of elders | 0.00336 | -0.00112 | -0.00292 | -0.00250 | -0.00091 | -0.00001 | 0.00410 | 0.0654 |
| | (1.27) | (-1.66) | (-2.31) | (-4.32) | (-5.70) | (-0.03) | (2.13) | (1.22) |
| η-size | -0.00029 | 0.00074 | -0.00023 | 0.00093 | 0.00020 | 0.00004 | -0.00140 | -0.0150 |
| | (-0.86) | (7.71) | (-1.36) | (11.57) | (8.76) | (0.81) | (-5.73) | (-2.51) |
| η-urban_d2 | -0.00638 | -0.00024 | 0.00440 | -0.00254 | -0.00002 | 0.00169 | 0.00310 | -0.2781 |
| | (-3.70) | (-0.61) | (5.94) | (-7.32) | (-0.22) | (6.89) | (2.32) | (-8.40) |
| η-ethnic_d2 | -0.00597 | 0.00094 | 0.00070 | 0.00096 | 0.00081 | -0.00019 | 0.00274 | 0.0626 |
| | (-3.32) | (2.21) | (0.80) | (2.84) | (8.40) | (-0.80) | (2.41) | (1.69) |
| η-edu_d2 | 0.00193 | -0.00025 | -0.00009 | 0.00005 | -0.00001 | -0.00060 | -0.00104 | -0.0010 |
| | (1.90) | (-0.92) | (-0.17) | (0.20) | (-0.10) | (-3.80) | (-1.42) | (-0.05) |
| η-edu_d3 | 0.00459 | 0.00134 | -0.00313 | -0.00007 | -0.00006 | -0.00142 | -0.00126 | 0.0277 |
| | (2.24) | (2.10) | (-3.19) | (-0.13) | (-0.36) | (-3.74) | (-0.67) | (0.75) |
| η-region_d2 | 0.00323 | 0.00405 | -0.00453 | -0.00028 | 0.00032 | -0.00002 | -0.00277 | 0.0370 |
| | (1.17) | (7.57) | (-3.54) | (-0.61) | (2.65) | (-0.05) | (-1.62) | (0.58) |
| η-region_d3 | 0.0034 | -0.0019 | -0.0028 | 0.0001 | -0.0001 | -0.0007 | 0.0021 | 0.1635 |
| | (1.17) | (-3.23) | (-1.95) | (0.13) | (-0.79) | (-2.28) | (1.27) | (2.31) |
| η-region_d4 | -0.0050 | 0.0057 | -0.0022 | 0.0033 | 0.0000 | 0.0003 | -0.0021 | -0.1218 |
| | (-1.98) | (10.85) | (-1.87) | (8.07) | (-0.39) | (1.13) | (-1.38) | (-2.54) |
| η-region_d5 | -0.0002 | 0.0111 | -0.0044 | 0.0013 | -0.0006 | 0.0009 | -0.0081 | -0.1640 |
| | (-0.09) | (19.06) | (-4.15) | (2.86) | (-4.42) | (3.01) | (-5.40) | (-3.94) |
| η-region_d6 | -0.0073 | 0.0082 | -0.0020 | 0.0002 | -0.0001 | -0.0005 | 0.0014 | -0.1371 |
| | (-2.59) | (12.82) | (-1.57) | (0.34) | (-0.36) | (-1.35) | (0.79) | (-2.74) |
| η-region_d7 | -0.0038 | 0.0082 | -0.0001 | -0.0016 | -0.0008 | 0.0013 | -0.0033 | -0.2800 |
| | (-1.64) | (14.49) | (-0.13) | (-3.31) | (-5.69) | (3.84) | (-1.92) | (-7.41) |
| η-region_d8 | -0.0048 | 0.0112 | -0.0072 | 0.0002 | -0.0019 | 0.0005 | 0.0021 | -0.1657 |
| | (-2.27) | (20.65) | (-7.73) | (0.55) | (-15.39) | (1.61) | (1.38) | (-4.09) |
| η-season_d2 | 0.00179 | 0.00145 | -0.00183 | 0.00059 | 0.00012 | 0.00019 | -0.00231 | 0.0375 |
| | (1.55) | (4.65) | (-3.27) | (2.29) | (1.61) | (1.07) | (-2.76) | (1.68) |
| η-season_d3 | -0.00130 | -0.00014 | 0.00081 | 0.00061 | 0.00034 | 0.00088 | -0.00119 | 0.0195 |
| | (-1.13) | (-0.42) | (1.45) | (2.27) | (4.31) | (4.75) | (-1.37) | (0.90) |

Note: Sample size: 9,319. Parameters are estimated using nonlinear seemingly unrelated regression (NLSUR) procedures satisfying adding-up, homogeneity and symmetry conditions. Numbers in parentheses are z-values. d denotes dummy variables.

*6.2. Urban-rural disaggregation*

In this section, results from QUAIDS are used to analyze the differences in expenditure and own-price elasticities by income class and between rural and urban households within each class. The disaggregated expenditure and own-price elasticities are presented in Table 9 and Table 10. For brevity, only 3 out of 5 income quintiles (the poorest, middle and richest) are reported. Complete results are presented in Table A1 and A2 in Appendix. Cross-price elasticities are also provided in Table A3 in Appendix.

Table 9: QUAIDS expenditure elasticities by income quintile

| Food group | **Country-level** | | | | **Rural** | | | | **Urban** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | Quintile | | | All | Quintile | | | All | Quintile | | |
| | | Q1 | Q3 | Q5 | | Q1 | Q3 | Q5 | | Q1 | Q3 | Q5 |
| Rice | 0.05 | 0.32 | 0.11 | -0.34 | 0.14 | 0.36 | 0.18 | -0.14 | -0.18 | 0.12 | -0.16 | -0.55 |
| Pork | 0.78 | 1.00 | 0.80 | 0.47 | 0.89 | 1.04 | 0.89 | 0.71 | 0.51 | 0.72 | 0.57 | 0.18 |
| M&F | 1.26 | 1.61 | 1.22 | 1.03 | 1.34 | 1.69 | 1.28 | 1.13 | 1.07 | 1.25 | 1.04 | 0.93 |
| V&F | 0.84 | 0.83 | 0.85 | 0.85 | 0.84 | 0.83 | 0.85 | 0.85 | 0.84 | 0.84 | 0.84 | 0.84 |
| Sugar | 0.65 | 0.86 | 0.68 | 0.40 | 0.74 | 0.89 | 0.74 | 0.59 | 0.41 | 0.63 | 0.44 | 0.17 |
| Drinks | 1.83 | 2.03 | 1.76 | 1.62 | 1.76 | 1.97 | 1.81 | 1.56 | 2.00 | 2.44 | 2.01 | 1.60 |
| Misc. | 1.53 | 1.68 | 1.51 | 1.42 | 1.57 | 1.71 | 1.55 | 1.48 | 1.43 | 1.52 | 1.41 | 1.38 |

Source: Calculated.

Table 10: QUAIDS uncompensated own-price elasticities by income quintile

| Food group | **Country-level** | | | | **Rural** | | | | **Urban** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | Quintile | | | All | Quintile | | | All | Quintile | | |
| | | Q1 | Q3 | Q5 | | Q1 | Q3 | Q5 | | Q1 | Q3 | Q5 |
| Rice | -0.12 | -0.60 | -0.26 | 0.67 | -0.34 | -0.64 | -0.39 | 0.09 | 0.43 | -0.23 | 0.34 | 1.36 |
| Pork | 0.05 | -0.11 | 0.07 | 0.34 | -0.03 | -0.18 | -0.03 | 0.21 | 0.24 | 0.03 | 0.12 | 0.58 |
| M&F | -0.73 | -0.88 | -0.74 | -0.60 | -0.79 | -0.91 | -0.77 | -0.70 | -0.56 | -0.62 | -0.51 | -0.53 |
| V&F | -0.77 | -0.74 | -0.78 | -0.78 | -0.76 | -0.74 | -0.77 | -0.77 | -0.78 | -0.78 | -0.78 | -0.78 |
| Sugar | -0.57 | -0.50 | -0.63 | -0.55 | -0.59 | -0.45 | -0.64 | -0.61 | -0.54 | -0.61 | -0.56 | -0.47 |
| Drinks | -1.10 | -1.12 | -1.09 | -1.07 | -1.09 | -1.12 | -1.09 | -1.06 | -1.11 | -1.17 | -1.11 | -1.07 |
| Misc. | -1.36 | -1.49 | -1.35 | -1.27 | -1.40 | -1.51 | -1.38 | -1.32 | -1.28 | -1.35 | -1.26 | -1.23 |

Source: Calculated.

The results show consistent patterns across income classes. Except for rice, all food groups remain normal goods at all five income brackets. Consistent with our expectations, the magnitudes of expenditure elasticities decrease at higher levels of expenditures. Between urban and rural areas, demand for all foods except rice and drinks is more expenditure-elastic in rural areas than in urban areas. For example, the expenditure elasticity of pork demand is 0.51 in urban areas but it is 0.89 in rural areas. Similarly, the expenditure elasticity of meat demand is 1.07 in urban areas but it is 1.34 in rural areas. Across 7 food groups, rice demand appears to be the most inelastic with respect to expenditure while drinks and miscellaneous food groups are the most elastic. These findings are consistent with our expectations that consumers in rural areas are more sensitive to an income change than urban consumers and in general, consumers' demand of non-basic foods such as drinks, FAFH is more sensitive than that of basic foods such as rice and pork. It is noted that meat and fish group switches from a luxury to a necessity good for high-income urban consumers, although just slightly in terms of magnitude, while it remains a luxury good for rural consumers at all income classes.

At all levels of disaggregation and for all foods except rice, own price elasticities are generally less inelastic than the corresponding expenditure elasticities. The demand for rice and pork is most inelastic with respect to their own-prices compared to other foods; nevertheless, they appear to have positive own-price elasticities at high expenditure levels. The case of Giffenity could have been possible for pork due to substitution effects between pork and other higher-priced meats, as explained earlier. Positive own-price elasticities for rice, however, warrant additional examination, which will be left for future work.

Unlike other foods, rice appears to have diverse consumption trends across different income brackets and between urban and rural areas. At the national level, rice is a normal good for consumers at low income quintiles but becomes an inferior good for those at the two highest income quintiles. The national mean expenditure elasticity of rice demand is 0.32 for the poorest quintile while it is -0.34 for the richest. A similar pattern is found when results are disaggregated by urban and rural areas. Rice appears to be an inferior good for urban consumers with an expenditure elasticity of -0.18 while it remains a normal good for rural consumers with an expenditure elasticity of 0.14. Rice is also found to be an inferior good for high-income consumers in both rural and urban areas. In particular, the expenditure elasticity of rice demand is negative (-0.14) for the rural fifth quintile, a group of the richest rural consumers, and for the three highest income quintiles in urban areas (elasticities range from -0.16 to -0.55). In general, the demand for rice is inelastic and tends to be more inelastic with respect to expenditure than to price, which is a reflection of the importance of rice in a household's food basket and the relatively small budget share of rice in total food expenditure.

## 7. Conclusion

This study examines food consumption patterns in Vietnam using 2010 household data. Several conclusions are made from the results of this study. First, Wald test and likelihood ratio test show that the overall performance of QUAIDS is better than AIDS, which suggests that budget shares and food expenditure have a quadratic relationship in the food demand system of Vietnam. Studies that assume a linear Engel curvature may have failed to capture the dynamics of the country's food demand patterns.

Second, the responsiveness of demand for foods varies across income classes and between urban and rural areas, most notably in the case of rice. In general, urban consumers are less expenditure elastic than rural consumers. Similarly, high income consumers, whether living in rural or urban areas, tend to be less expenditure-elastic than those who are low-income. With respect to food expenditure, meat and fish, drinks and miscellaneous food groups were found to be luxury goods while pork, vegetables and fruits, and sugar were necessities at the national level.

In addition, rice consumption patterns differ greatly by income class as well as between rural and urban areas. At the national level, the expenditure elasticity of rice was estimated to be positive but very small in magnitude, 0.05. However, rice appeared to be an inferior good for urban consumers while it is a normal good for rural consumers with expenditure elasticities being -0.18 and 0.14, respectively. Rice was also found to be an inferior good for consumers at higher income quintiles in both rural and urban areas. The expenditure elasticity of rice demand is negative for the richest rural consumers and for the three highest income groups in urban areas. Most previous studies found that rice was a normal good at the national level as well as in rural and urban areas. Findings of this study, however, suggests that rice is in a transition from a normal good to an inferior good for Vietnamese consumers, especially those who live in urban areas. The result is similar to recent findings in Thailand (Isvilanonda & Kongrith, 2008) and Indonesia (Anton et al., 2014), which found that rice was an inferior good for high-income consumers in these countries.

Findings from this study provide strong implications for food, nutrition and poverty policies. Effective policies need to take into consideration the heterogeneity in the patterns of food consumption across income classes and between rural and urban consumers. In the case of rice, per capita consumption will be greatly affected by the trend and speed of urbanization, the structural change of the population as well as the levels of growth in urban and rural consumers' incomes. In addition, it is expected that as the economy continues to grow, people in urban areas will consume less rice and more meat, fish, vegetables, drinks as well as out-of-home foods. Meeting the growing demand of these foods, especially meats, is important for the country to ensure food security.

# APPENDIX

Table A1: QUAIDS estimated expenditure elasticities

| | Rice | Pork | Meat and fish | Vegetables and fruits | Sugar | Drinks | Misc. |
|---|---|---|---|---|---|---|---|
| ***National*** | *0.05* | *0.78* | *1.26* | *0.84* | *0.65* | *1.83* | *1.53* |
| Quintile 1 | 0.32 | 1.00 | 1.61 | 0.83 | 0.86 | 2.03 | 1.68 |
| Quintile 2 | 0.20 | 0.90 | 1.32 | 0.85 | 0.73 | 1.92 | 1.58 |
| Quintile 3 | 0.11 | 0.80 | 1.22 | 0.85 | 0.68 | 1.76 | 1.51 |
| Quintile 4 | -0.06 | 0.72 | 1.13 | 0.84 | 0.57 | 1.82 | 1.46 |
| Quintile 5 | -0.34 | 0.47 | 1.03 | 0.85 | 0.40 | 1.62 | 1.42 |
| ***Rural*** | *0.14* | *0.89* | *1.34* | *0.84* | *0.74* | *1.76* | *1.57* |
| Quintile 1 | 0.36 | 1.04 | 1.69 | 0.83 | 0.89 | 1.97 | 1.71 |
| Quintile 2 | 0.25 | 0.96 | 1.38 | 0.85 | 0.79 | 1.82 | 1.60 |
| Quintile 3 | 0.18 | 0.89 | 1.28 | 0.85 | 0.74 | 1.81 | 1.55 |
| Quintile 4 | 0.03 | 0.83 | 1.20 | 0.85 | 0.70 | 1.67 | 1.50 |
| Quintile 5 | -0.14 | 0.71 | 1.13 | 0.85 | 0.59 | 1.56 | 1.48 |
| ***Urban*** | *-0.18* | *0.51* | *1.07* | *0.84* | *0.41* | *2.00* | *1.43* |
| Quintile 1 | 0.12 | 0.72 | 1.25 | 0.84 | 0.63 | 2.44 | 1.52 |
| Quintile 2 | 0.03 | 0.62 | 1.12 | 0.83 | 0.48 | 2.16 | 1.45 |
| Quintile 3 | -0.16 | 0.57 | 1.04 | 0.84 | 0.44 | 2.01 | 1.41 |
| Quintile 4 | -0.35 | 0.43 | 0.99 | 0.84 | 0.34 | 1.82 | 1.38 |
| Quintile 5 | -0.55 | 0.18 | 0.93 | 0.84 | 0.17 | 1.60 | 1.38 |

Table A2: QUAIDS estimated own-price elasticities

| | Rice | Pork | Meat and fish | Vegetables and fruits | Sugar | Drinks | Misc. |
|---|---|---|---|---|---|---|---|
| ***National*** | *-0.12* | *0.05* | *-0.73* | *-0.77* | *-0.57* | *-1.10* | *-1.36* |
| Quintile 1 | -0.60 | -0.11 | -0.88 | -0.74 | -0.50 | -1.12 | -1.49 |
| Quintile 2 | -0.41 | -0.12 | -0.76 | -0.77 | -0.60 | -1.11 | -1.40 |
| Quintile 3 | -0.26 | 0.07 | -0.74 | -0.78 | -0.63 | -1.09 | -1.35 |
| Quintile 4 | 0.02 | 0.06 | -0.67 | -0.77 | -0.59 | -1.09 | -1.31 |
| Quintile 5 | 0.67 | 0.34 | -0.60 | -0.78 | -0.55 | -1.07 | -1.27 |
| ***Rural*** | *-0.34* | *-0.03* | *-0.79* | *-0.76* | *-0.59* | *-1.09* | *-1.40* |
| Quintile 1 | -0.64 | -0.18 | -0.91 | -0.74 | -0.45 | -1.12 | -1.51 |
| Quintile 2 | -0.51 | -0.09 | -0.81 | -0.76 | -0.59 | -1.10 | -1.42 |
| Quintile 3 | -0.39 | -0.03 | -0.77 | -0.77 | -0.64 | -1.09 | -1.38 |
| Quintile 4 | -0.23 | -0.05 | -0.76 | -0.77 | -0.63 | -1.08 | -1.34 |
| Quintile 5 | 0.09 | 0.21 | -0.70 | -0.77 | -0.61 | -1.06 | -1.32 |
| ***Urban*** | *0.43* | *0.24* | *-0.56* | *-0.78* | *-0.54* | *-1.11* | *-1.28* |
| Quintile 1 | -0.23 | 0.03 | -0.62 | -0.78 | -0.61 | -1.17 | -1.35 |
| Quintile 2 | 0.00 | 0.19 | -0.62 | -0.78 | -0.53 | -1.13 | -1.29 |
| Quintile 3 | 0.34 | 0.12 | -0.51 | -0.78 | -0.56 | -1.11 | -1.26 |
| Quintile 4 | 0.71 | 0.27 | -0.54 | -0.78 | -0.53 | -1.09 | -1.24 |
| Quintile 5 | 1.36 | 0.58 | -0.53 | -0.78 | -0.47 | -1.07 | -1.23 |

Table A3: QUAIDS estimated cross-price elasticities

| | Rice | Pork | M&F | V&F | Sugar | Drinks | Misc |
|---|---|---|---|---|---|---|---|
| Rice | -0.12 | -0.20 | -0.17 | -0.02 | -0.04 | -0.02 | 0.53 |
| Pork | -0.76 | 0.05 | 0.01 | -0.12 | -0.11 | -0.03 | 0.17 |
| Meat and fish | -0.36 | -0.07 | -0.73 | -0.01 | -0.04 | 0.03 | -0.09 |
| Vegetables and fruits | -0.18 | -0.07 | 0.06 | -0.77 | 0.03 | 0.04 | 0.04 |
| Sugar | -0.56 | -0.44 | -0.24 | 0.25 | -0.57 | 0.08 | 0.85 |
| Drinks | -0.71 | -0.22 | 0.16 | 0.10 | 0.04 | -1.10 | -0.10 |
| Misc | 0.01 | -0.03 | -0.11 | -0.06 | 0.03 | -0.01 | -1.36 |

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# FOOD DEMAND IN VIETNAM: STRUCTURAL CHANGES AND PROJECTIONS TO 2030

## 1. Introduction

Knowing how much food we need to feed people, especially the poor, is important but difficult. Policy analysts often do not agree on how quickly food demand will grow in the future due to differences in methods and assumptions used in their projections. However, the general consensus is that the structure of food demand changes through time, depends largely on income levels, and differs between developed and developing countries as well as rural and urban groups, especially in fast-growing economies.

In a country that is undergoing a significant structural economic transition like Vietnam, predicting changes in food demand becomes even more challenging. Demand for food is known to be influenced by a vast array of intertwining factors. Those include consumers' income levels, dietary habits, whether the person resides in rural or urban areas, the availability of supermarkets, restaurants and fast-food vendors, etc. At the country level, the trends and patterns of food demand, especially basic staples such as rice, also depend largely on different stages of economic development. As Huang & David (1993) indicated, per capita rice consumption across Asia tends to increase in low-income countries while it decreases in richer ones as people of these countries have higher incomes. Their study also found that urbanization had negative effects on rice consumption, meaning that people eat less rice as they are more urbanized. In this regard, Pingali (2007) asserted that the patterns of food demand in Asian countries tend to follow these paths : (1) lower consumption of rice and increases in the consumption of wheat and wheat-based products on a per capita basis, (2) increases in per capita consumption of high-calorie foods such as meat, fish, and dairy products, and (3) increases in the consumption of fast foods and beverages. These structural shifts are mainly induced by two major factors: (1) increased incomes, and (2) urbanization. The latter is often associated with a more westernized life style and dietary habits (Huang & Bouis, 1996; Huang & David, 1993; P. Pingali, 2007).

Food demand patterns of urban people differ from those in rural areas, as urban people are exposed to more food availability, ready-to-eat foods, fast-food restaurants and street vendors. The emergence of supermarkets, which have grown rapidly in Vietnam's urban centers in recent years (Cadilhon, Moustier, Poole, Tam, & Fearne, 2006; Mergenthaler et al., 2009; Moustier, Tam, Anh, Binh, & Loc, 2010), is believed to have greatly affected traditional food supply systems and the consumption patterns of urban consumers. In addition, urban people have different calorie requirements as they tend to be more sedentary (Huang & Bouis, 1996). Urban people also have better access to media outlets and thus, become more influenced by advertisements and promotions of western cultures, which are often stylized by the consumption of fast-foods (P. Pingali, 2007). It should be noted that the per capita consumption of rice is expected to decline but the demand for high quality rice may rise as consumers get richer and more urbanized (P. L. Pingali, Hossain, & Gerpacio, 1997). In addition, meat and dairy products are expected to continue to be the major source of growth in food consumption, especially in the developing world (Delgado, 2003; Keyzer, Merbis, Pavel, & van Wesenbeeck, 2005).

With regard to food demand projections, Cirera & Masset (2010) argued that the structural changes in income distribution vary across households and through time but most existing food demand models failed to account for this change, leading to possible biased projections, especially in the long run. In light of this, projections based on household data could provide a cure. However, those kinds of projections are limited in the literature compared to those based on time-series. One of the major reasons might be that household data are more difficult and expensive to collect. Surveys are often conducted in 2 or 4 year intervals, which prevents researchers from getting up-to-date data.

In the literature, rank-three[1] models such as the Quadratic Almost Ideal Demand System (QUAIDS) have been recognized to outperform other complete demand systems for projections owing to their Engel flexibility, i.e. the relationship between budget shares and total expenditure is non-linear (Cirera & Masset, 2010; Cranfield, Eales, Hertel, & Preckel, 2003; Yu, Hertel, Preckel, & Eales, 2004). Recently, a growing number of studies have attempted to use high-ordered demand systems to provide medium and longer term projections for cereal consumption in developing countries such as India, Bangladesh, Ethiopia, Pakistan and Nepal (Ganesh-Kumar, Mehta, et al., 2012; Ganesh-Kumar, Prasad, et al., 2012; Nazli, Haider, & Sheikh, 2012; Prasad, Pullabhotla, & Ganesh-Kumar, 2011; Tafere et al., 2011). In these studies, the effect of urbanization on food demand was generally ignored, as per capita food consumption projections were based on the assumption that prices and urbanization rates are held constant. Per capita demand for major food groups was estimated using budget shares projected directly by QUAIDS or Linear Approximated AIDS (LA/AIDS) under different income growth scenarios. Although the accuracy of these projections has not yet been assessed, using household data for food demand projections appeared to be useful as researchers can examine the structural changes in food demand at a more disaggregated level.

To contribute to that line of literature, this study projects the patterns of at-home food demand in Vietnam through the years 2020 and 2030 using the QUAIDS model estimated by Hoang (2014) and adding the effects of urbanization and shifting of income groups. In particular,

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[1] "The rank of a demand system is the maximum dimension of the function space contained by the Engel curve", Cirera and Masset, 2014, pg. 2824

the model is used to project the consumption of six major food groups including (1) rice, (2) pork, (3) meat and fish, (4) vegetables and fruits, (5) sugar and (6) drinks under 6 different scenarios concerning alternative growth rates in food expenditures, food prices and urbanization. To account for demographic and income differences, the sample is divided into 5 income quintiles. Rural and urban households are separated within each quintile, making a total of 10 demographic groups. Although the projections are provided for at-home food consumption only, the results are useful, as they account for changes in the distribution of expenditures at the household level and the impacts of urbanization at the national level over time. Both of these factors are vital to our understanding of possible structural changes of food demand in the long run. Conclusions from the projections will be drawn accordingly.

## 2. Past trends and patterns of food demand

To assess the trends and patterns of food demand in the past, data from VHLSS 2002 were used to compare with results from VHLSS 2010 in terms of group-wise budget shares and prices. VHLSS 2002 was chosen because it is the first survey available from the improved household survey round to which VHLSS 2010 belongs. The similarity and consistency in the methods used in these surveys allow the data to be more comparable. Furthermore, the 8-year difference between 2002 and 2010 is reasonably long enough for us to evaluate changes in the demand for food and in the structure of the population in the medium term as well as provides us insights on the possible changes, at least, for the next 10 years.

From 2002 to 2010, per capita food expenditures increased at an annual compound rate of 9.8%, from $226.4 (1,723,000 VND) to $392.4 (7,304,000 VND)[2] in 2010 constant prices. As shown in Table 1, budget shares changed most significantly for rice and miscellaneous food

[2] Exchange rates is 15,297VND/$ in 2002 and 18,162VND/$ in 2010.

group from 2002 and 2010. Rice budget shares declined from 30.7% to 20.4% and per capita consumption also declined significantly from 143.4 kg to 124.5 kg, or by about 19 kg. Budget shares of miscellaneous food group, of which food away from home (FAFH) accounts for about a half, increased considerably from 26.2% in 2002 to 32.1% in 2010. Other groups whose budget shares declined, although just slightly, include pork (11.4% to 11.0%) and sugar (2.3% to 2.2%).

Table 1: Budget share and quantity consumed, 2002 and 2010

| Food group | Budget share | | | Per capita consumption | | |
|---|---|---|---|---|---|---|
| | 2002 | 2010 | Change | 2002 | 2010 | Annual growth rate |
| Rice | 30.7% | 20.4% | -10.3% | 143.4 | 124.5 | -1.7% |
| Pork | 11.4% | 11.0% | -0.4% | 10.0 | 13.9 | 4.9% |
| M&F | 16.6% | 18.8% | 2.2% | 19.0 | 26.9 | 5.2% |
| V&F | 10.1% | 11.0% | 0.9% | 45.7 | 72.7 | 7.4% |
| Sugar | 2.3% | 2.2% | -0.1% | 4.0 | 5.5 | 4.7% |
| Drinks | 2.7% | 4.4% | 1.7% | 7.2 | 12.0 | 8.5% |
| Misc. | 26.2% | 32.1% | 5.9% | - | - | - |

Source: VHLSS 2010.

Note: Per capita consumption and price growth rate of the miscellaneous group are not reported as this group comprises of disparate food items. Per capita consumption for rice, pork, meat and fish (M&F), vegetables and fruits (V&F), and sugar are in kilograms except for drinks, which is in liters.

In terms of per capita consumption, the consumption of pork increased but at a slower rate than meat and fish food group (4.9% vs. 5.2%). This trend indicates a shift in the demand for non-pork meats and seafood as consumers' incomes increase. The fastest growth came from the consumption of drinks, 8.5% per annum, which is consistent with observations that the consumption of beverages increased significantly with incomes in Asian countries (Fan et al., 1995; Huang & Bouis, 1996; P. Pingali, 2007). Interestingly, the per capita consumption of vegetables increased much faster than most other foods (7.4%) while their budget shares did not increase very much from 2002 to 2010 (10.1% to 11.0%). One possible reason for this significant growth in the demand for vegetables and fruits is the price effect. Between 2002 and

2010, the prices of vegetables and fruits grew much less than other foods and only somewhat more than pork (Table 2). Thus, for the same level of expenditure increase, consumers can buy more vegetables than other higher-priced foods such as meat or drinks.

Table 2: Food price and expenditure growth rates, 2002-2010

| Food group | Unit | Price (1000VND) | | Real price growth rate* | Real expenditure growth rate* |
|---|---|---|---|---|---|
| | | 2002 | 2010 | | |
| Rice | Kg | 3.0 | 9.5 | 5.7% | 3.8% |
| Pork | Kg | 20.7 | 54.2 | 3.4% | 7.9% |
| Meat and fish | Kg | 16.6 | 54.7 | 6.4% | 11.2% |
| Vegetables and fruits | Kg | 3.9 | 11.1 | 4.4% | 10.7% |
| Sugar | Kg | 10.5 | 30.6 | 4.8% | 8.4% |
| Drinks | Liter | 7.8 | 42.0 | 13.1% | 15.5% |
| Misc. | Index | - | - | - | 12.5% |

Source: VHLSS 2010 and 2002.

Note: * Calculated as annual compound growth rates.

Disaggregated by income quintile and rural and urban groups (within each quintile), food consumption showed consistent patterns (Table 3). In general, richer consumers spent larger budget shares for non-pork meats, drinks, and miscellaneous foods including FAFH than poorer consumers while the reverse trend applied for rice and pork. Within the same income class, urban consumers spent a smaller share of expenditure on rice and more on other food groups than those living in rural areas. In terms of per capita consumption, urban consumers consumed much less rice, slightly less drinks and pork, and more of other foods than rural consumers. Consistent with findings from Huang & David (1993), richer and more urbanized consumers ate less rice. For example, the difference between urban and rural consumers of the first quintile was about 20 kg, but that of the fifth quintile was nearly 33 kg. The differences in other food groups were not as proportionate as for rice, but for all other food groups except rice per capita consumption increased with income in both rural and urban areas.

Table 3: Budget share and quantity consumed in 2010 by demographic group

| | Rice | Pork | M&F | V&F | Sugar | Drinks | Misc. |
|---|---|---|---|---|---|---|---|
| **Budget share** | | | | | | | |
| Urban -Quintile 1 | 25.7% | 12.1% | 16.9% | 11.7% | 2.6% | 3.1% | 27.8% |
| Quintile 2 | 19.4% | 11.5% | 18.2% | 11.2% | 2.3% | 3.6% | 33.8% |
| Quintile 3 | 15.9% | 10.7% | 18.5% | 11.7% | 2.1% | 4.0% | 37.1% |
| Quintile 4 | 13.2% | 9.9% | 19.5% | 11.4% | 1.9% | 4.3% | 39.8% |
| Quintile 5 | 9.2% | 8.4% | 19.9% | 11.4% | 1.8% | 5.1% | 44.3% |
| Rural- Quintile 1 | 32.7% | 11.2% | 16.1% | 10.7% | 2.2% | 3.7% | 23.5% |
| Quintile 2 | 24.7% | 12.0% | 18.6% | 10.9% | 2.4% | 4.1% | 27.1% |
| Quintile 3 | 20.3% | 11.7% | 19.6% | 10.8% | 2.5% | 4.6% | 30.6% |
| Quintile 4 | 16.9% | 11.5% | 20.0% | 10.9% | 2.3% | 5.0% | 33.4% |
| Quintile 5 | 13.8% | 10.7% | 20.4% | 10.8% | 2.3% | 5.8% | 36.3% |
| **Quantity consumed** | | | | | | | |
| Urban- Quintile 1 | 115.3 | 10.6 | 16.2 | 51.2 | 4.1 | 5.7 | |
| Quintile 2 | 108.2 | 11.9 | 19.9 | 59.0 | 4.6 | 7.6 | |
| Quintile 3 | 102.7 | 13.0 | 23.8 | 72.5 | 4.8 | 10.9 | |
| Quintile 4 | 99.9 | 15.1 | 29.1 | 83.3 | 5.0 | 13.4 | |
| Quintile 5 | 95.4 | 18.1 | 40.5 | 113.7 | 6.3 | 21.5 | |
| Rural- Quintile 1 | 135.9 | 8.7 | 15.1 | 45.4 | 3.6 | 6.4 | |
| Quintile 2 | 136.1 | 12.0 | 21.7 | 58.7 | 5.1 | 8.4 | |
| Quintile 3 | 134.0 | 14.2 | 27.4 | 68.3 | 6.1 | 10.4 | |
| Quintile 4 | 131.7 | 16.8 | 32.3 | 80.1 | 6.5 | 14.2 | |
| Quintile 5 | 127.9 | 19.0 | 40.0 | 101.9 | 7.9 | 20.6 | |

Source: VHLSS 2010.

Note: Per capita consumption for rice, pork, meat and fish (M&F), vegetables and fruits (V&F), and sugar are in kilograms except for drinks, which is in liters.

From 2002 to 2010, the share of urban people within each income quintile also increased at an average rate of about 5% per annum. Notably, urbanization rates were highest for the three middle quintiles, ranging from 4.6% to 6%, while lowest for both income ends, which had a same rate of 3.8% (Table 4). This seemed to reflect the fast growth of the middle class in the country during these years.

Table 4: Urban and rural population shares by income class

| | | Quintile 1 | Quintile 2 | Quintile 3 | Quintile 4 | Quintile 5 |
|---|---|---|---|---|---|---|
| 2002 | Urban | 5.1% | 11.2% | 17.7% | 30.9% | 52.1% |
| | Rural | 94.9% | 88.8% | 82.3% | 69.1% | 47.9% |
| 2010 | Urban | 8.9% | 16.7% | 22.3% | 37.0% | 55.9% |
| | Rural | 91.1% | 83.3% | 77.7% | 63.0% | 44.1% |
| 2010-2002 change | Urban | 3.8% | 5.5% | 4.6% | 6.0% | 3.8% |
| | Rural | -3.8% | -5.5% | -4.6% | -6.0% | -3.8% |

Source: VHLSS 2010 and 2002.

In the next section, the QUAIDS model estimated by Hoang (2014) is used to project demand for 6 major food groups through the years 2020 and 2030. QUAIDS (Banks et al., 1997) is among very few rank-three demand systems extended from the Almost Ideal Demand System (AIDS) (Deaton & Muellbauer, 1980). According to Cirera & Masset (2010), an appropriate demand system used for projection purposes needs to be able to account for changes in consumers' consumption patterns. In particular, the model should have the ability to allow a good to change from a luxury to a necessity at higher income levels. It appeared that only rank-three demand systems such as QUAIDS and the implicit additive demand system (AIDADS) have these important properties (Cirera & Masset, 2010; Cranfield et al., 2003, Yu et al., 2004).

As an extension from AIDS, QUAIDS is similar to AIDS in the sense that it is a demand function in budget share form and retains the essential restrictions on the parameters, i.e. adding-up, homogeneity and symmetry. However, budget share in QUAIDS has an additional quadratic term with respect to total expenditure, which allows expenditure elasticities to change from being larger than 1 to less than 1 at higher expenditure levels. It is noted that the elasticities are estimated with respect to changes in total food expenditure, not total income. The Hoang (2014) study using QUAIDS to estimate expenditure elasticities of demand for food in Vietnam has shown that rice and other food groups were normal goods at the national level.

The expenditure elasticity of rice demand was estimated to be very inelastic (0.05) while those of non-rice foods were more elastic, ranging from 0.65 to 1.83. Meat and fish, drinks and miscellaneous food group were found to be luxury goods, both at the national level and for rural and urban consumers. However, rice showed a different pattern as it was estimated to be an inferior good for urban consumers and a normal good for rural consumers with expenditure elasticities being -0.18 and 0.14, respectively. The opposite patterns of demand for rice and non-rice foods have stressed the importance of using demand systems with Engel flexibility. Obviously, a demand system without appropriate Engel flexibility will not be able to capture the change in marginal budget shares at higher expenditure levels, leading to possible biases in its projections.

### 3. Model validation

Following Ganesh-Kumar, Prasad, et al. (2012), the prediction performance of QUAIDS is validated using two sets of data: actual data from VHLSS 2010, the base year, and VHLSS 2002. The validation procedure is described as follows. First, food budget shares are predicted using the actual food expenditure of 2010. Per capita demand for each food group is calculated using the predicted food budget shares and actual 2010 prices. Second, a backward forecast is generated assuming food expenditure and prices of each food group decline to the 2002 level in real terms. Similar procedures are applied to obtain the predicted per capita demand for each food group at the household level.

The results, reported at the sample mean, showed that the predicted budget shares using 2010 data are similar to the actual values and the predicted quantities are just slightly different from the actual levels (Table 5). The backward predictions for the year 2002 are quite consistent with our expectations that the budget share for rice increases while those for other food groups, except for vegetables and fruits, decrease in response to a lower expenditure level.

In terms of quantities, the prediction errors are larger for vegetables and drinks compared to other food groups, mainly due to the upwardly predicted budget shares coupled with comparatively low prices, especially for vegetables. Existing studies using QUAIDS and LA/AIDS for backward forecasts found even larger prediction errors, ranging from 20% to more than 100%, particularly for food groups that are aggregations of different food items (Ganesh-Kumar, Prasad, et al., 2012; Prasad et al., 2011). Thus, the performance of this model seems very satisfactory.

Table 5: Predicted 2010 and 2002 budget shares and per capita consumption

| | | Rice | Pork | M&F | V&F | Sugar | Drinks | Misc. |
|---|---|---|---|---|---|---|---|---|
| 2010 | Actual budget share | 20.4% | 11.0% | 18.8% | 11.0% | 2.2% | 4.4% | 32.1% |
| | Predicted budget share | 20.4% | 11.0% | 18.8% | 11.0% | 2.2% | 4.4% | 32.1% |
| | Actual quantity | 124.5 | 13.9 | 26.9 | 72.7 | 5.5 | 12.0 | - |
| | Predicted quantity | 124.2 | 14.0 | 27.0 | 73.6 | 5.5 | 12.2 | - |
| | *Quantity prediction errors* | *-0.2%* | *1.0%* | *0.4%* | *1.2%* | *0.6%* | *1.6%* | - |
| 2002 | Actual budget share | 30.7% | 11.4% | 16.6% | 10.1% | 2.3% | 2.7% | 26.2% |
| | Predicted budget share | 32.6% | 11.2% | 15.4% | 12.0% | 2.5% | 3.5% | 23% |
| | Actual quantity | 143.4 | 10.0 | 19.0 | 45.7 | 4.0 | 7.2 | - |
| | Predicted quantity | 154.0 | 9.3 | 17.6 | 53.0 | 4.0 | 8.4 | - |
| | *Quantity prediction errors* | *7.4%* | *-6.6%* | *-7.3%* | *16.0%* | *0.9%* | *17.5%* | - |

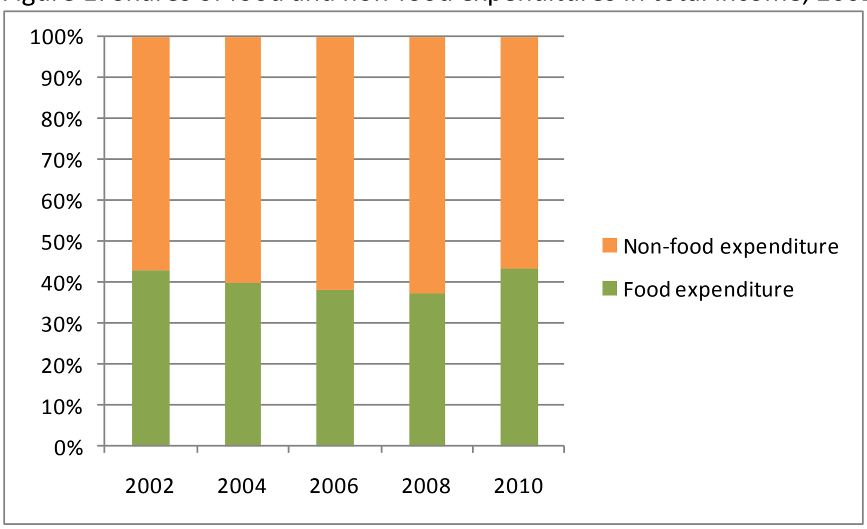
Source: VHLSS 2010 and 2002.

Note: Per capita consumption for rice, pork, meat and fish (M&F), vegetables and fruits (V&F), and sugar are in kilograms except for drinks, which is in liters.

### 4. Scenarios and projection results

As already mentioned, this study will not only use the QUAIDS model to project future consumption patterns. It will also conduct scenario analysis to estimate the effects of continuing urbanization and of differing real price and expenditure growth paths. Thus, two major sets of assumptions are laid out concerning (1) the status of the economy, represented by alternative changes in real food expenditures and prices, and (2) urbanization growth. During the 2002-2010 period, the share of food expenditures in total income declined slightly and steadily from 43% in 2002 to 37.5% in 2008, but bounced back to 43% in 2010 (Figure 1), possibly due to increased food prices as Vietnam faced high inflation in 2008 and late 2010 (Bhattacharya, 2013). Given the main purpose of this study is to employ the unique capacity of QUAIDS in predicting the structural changes of food demand, we made the assumption that food expenditures will grow at the same rate with income in the projection periods.

Figure 1: Shares of food and non-food expenditures in total income, 2002-2010




Source: GSO, (2011)

Since 2008, the economic growth of Vietnam has slowed down significantly (Cuong, Hung, & Tung, 2010). It is expected that the economy will continue to be sluggish, at least in the next few years, which will result in a slower rate of income growth as well as a slower rate of urbanization growth. In 2015, Vietnam is projected to grow at a rate of 5.4-5.6% in GDP (ADB, 2014; IMF, 2014). Thus, in this study we assume an expenditure growth rate of 6% per annum as the base. Two scenarios expanding from this base assumption include (1) an optimistic scenario where real food expenditure grows at 8% and real price grows at 1% per annum, and (2) a pessimistic scenario where real food expenditure grows at 4% and real price grows at 2% per annum. The former mirrors the economy in good times when real incomes grow fast and real prices of foods increase slowly while the latter imitates the opposite outlook (Table 6).

Table 6: Scenario assumptions

| *Economy* | *Real food expenditure growth rate* | *Real price growth rate* |
|---|---|---|
| Optimistic | 8% | 1% |
| Pessimistic | 4% | 2% |
| *Urbanization in 2020* | *Urban share* | *Rural share* |
| 2010 level | 28% | 72% |
| High | 38% | 62% |
| Low | 33% | 67% |
| *Urbanization in 2030* | | |
| 2010 level | 28% | 72% |
| High | 45% | 55% |
| Low | 40% | 60% |

Source: Calculated.

In addition, there are three scenarios of urbanization growth for each projection year. In the base cases of the years 2020 and 2030, the urbanization rate for each demographic group is held fixed as in 2010. This no-urbanization-effect scenario is to replicate how most studies of this kind have been conducted without considering continued urbanization. However, the urbanization rate in Vietnam is projected to be nearly 40% in 2020 and between 40% to 45% in 2030 according to the United Nations and the General Statistics Office of Vietnam (GSO, 2011a; United Nations, 2014). Taking these projections into consideration, two other urbanization scenarios in addition to the base scenario for the year 2020 assume (1) high urbanization rate in which the share of urban population accounts for 38% of the total population, equivalent to United Nations' current projections, and (2) low urbanization rate in which the urban share accounts for 33% of the total population. Similarly, two other scenarios for the year 2030 include (1) high urbanization rate in which the urban share accounts for 45% of the population, and (2) low urbanization rate in which the rural share accounts for 40% of the population. The detailed decomposition of the share for each demographic group is presented in Table 7. Following the past trend, the middle-income groups are projected to grow at a slightly faster rate, up by 1%, compared with those at the two income extremes.

Table 7: Scenario changes in the urbanization structure by demographic group (%)

| No. | | Country-level | | Quintile 1 | | Quintile 2 | | Quintile 3 | | Quintile 4 | | Quintile 5 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Urban | Rural | Urban | Rural | Urban | Rural | Urban | Rural | Urban | Rural | Urban | Rural |
| 1 | 2010 level | 28 | 72 | 9 | 91 | 17 | 83 | 22 | 78 | 37 | 63 | 56 | 44 |
| | **2020 scenarios** | | | | | | | | | | | | |
| 2 | High | 38 | 62 | 18 | 82 | 27 | 73 | 32 | 68 | 47 | 53 | 65 | 35 |
| | *Change (2)-(1)* | | | 9 | -9 | 10 | -10 | 10 | -10 | 10 | -10 | 9 | -9 |
| 3 | Low | 33 | 67 | 13 | 87 | 22 | 78 | 27 | 73 | 42 | 58 | 60 | 40 |
| | *Change (3)-(1)* | | | 4 | -4 | 5 | -5 | 5 | -5 | 5 | -5 | 4 | -4 |
| | **2030 scenarios** | | | | | | | | | | | | |
| 4 | High | 45 | 55 | 25 | 75 | 34 | 66 | 39 | 61 | 54 | 46 | 72 | 28 |
| | *Change (4)-(1)* | | | 16 | -16 | 17 | -17 | 17 | -17 | 17 | -17 | 16 | -16 |
| 5 | Low | 40 | 60 | 20 | 80 | 29 | 71 | 34 | 66 | 49 | 51 | 67 | 33 |
| | *Change (5)-(1)* | | | 11 | -11 | 12 | -12 | 12 | -12 | 12 | -12 | 11 | -11 |

Source: Calculated.

The projection procedures take the following steps: (1) Budget shares are predicted by QUAIDS under food expenditure growth assumptions, (2) Per capita consumption of each food group is estimated at the household level using the predicted budget shares and assumed price growth rates, (3) The national average per capita consumption is derived from the mean per capita consumption of each demographic group using the shares of population as weights.

Table 8 presents projected budget shares under two different food expenditure growth scenarios. Consistent with our past observations, consumers' demand for rice and miscellaneous food group is more responsive to an increase in food expenditure than other food groups. Rice budget shares keep declining at higher levels of food expenditures, from 20.4% in 2010 to 15.4% in 2020 and to 11.2% in 2030 assuming food expenditures grow at an annual rate of 4%. In contrast, the budget shares of the miscellaneous group, in which FAFH accounts for a large share, are projected to increase from 36.9% to 41.7% in 2020 and 2030, respectively. The budget shares for pork, vegetables and fruits, and sugar are projected to decline while those for meat and fish and drinks increase. Changes in the projected budget shares of these food groups across different food expenditure growth scenarios are modest.

Table 8: Projected food budget shares at different food expenditure growth rates

| Food group | 2010 | 2020 | | 2030 | |
|---|---|---|---|---|---|
| | | 4% | 8% | 4% | 8% |
| Rice | 20.4% | 15.4% | 11.3% | 11.2% | 6.0% |
| Pork | 11.0% | 10.6% | 9.9% | 9.9% | 8.3% |
| Meat and fish | 18.8% | 19.7% | 20.1% | 20.1% | 19.6% |
| Vegetables and fruits | 11.0% | 10.5% | 10.0% | 10.0% | 9.1% |
| Sugar | 2.2% | 2.1% | 1.8% | 1.8% | 1.4% |
| Drinks | 4.4% | 4.9% | 5.3% | 5.4% | 6.1% |
| Misc. | 32.1% | 36.9% | 41.5% | 41.7% | 49.6% |

Source: Calculated.

The consistent trends in the projected food budget shares reinforce our confidence in the capacity and flexibility of the QUAIDS model in capturing the structural changes in food demand with respect to a change in income (or more directly, food expenditure). In addition, it also suggests an obvious trend in the food consumption patterns of Vietnamese consumers that the two most popular table foods, rice and pork, will become less important in the food basket while higher-valued foods such as meats and seafood, and very likely, FAFH, will be more preferred as consumers' income increase. On a per capita basis, the consumption of all food groups except rice is projected to increase in 2020 from the 2010 level and continue to increase in 2030 (Table 9).

Table 9: Projected household food demand, 2020 and 2030 (per person/year)

| Food group | 2010 | Scenarios | 2020 | | 2030 | |
|---|---|---|---|---|---|---|
| | | | Optimistic | Pessimistic | Optimistic | Pessimistic |
| Rice | *124.5* | **No urbanization effect** | **120.9** | **108.8** | **102.0** | **89.8** |
| | | ***Annual growth rate*** | ***-0.3%*** | ***-1.3%*** | ***-0.9%*** | ***-1.4%*** |
| | | Low urbanization | 119.1 | 107.3 | 98.3 | 86.4 |
| | | High urbanization | 117.1 | 105.6 | 96.8 | 84.9 |
| Pork | *13.9* | **No urbanization effect** | **22.2** | **15.6** | **28.7** | **16.7** |
| | | ***Annual growth rate*** | ***6.0%*** | ***1.2%*** | ***5.3%*** | ***1.0%*** |
| | | Low urbanization | 22.1 | 15.5 | 27.8 | 16.4 |
| | | High urbanization | 21.9 | 15.5 | 27.4 | 16.3 |
| M&F | *26.9* | **No urbanization effect** | **50.8** | **32.6** | **82.0** | **38.2** |
| | | ***Annual growth rate*** | ***8.9%*** | ***2.1%*** | ***10.2%*** | ***2.1%*** |
| | | Low urbanization | 50.5 | 32.4 | 80.1 | 37.7 |
| | | High urbanization | 50.2 | 32.3 | 79.3 | 37.5 |
| V&F | *72.7* | **No urbanization effect** | **122.8** | **82.5** | **189.6** | **92.4** |
| | | ***Annual growth rate*** | ***6.9%*** | ***1.3%*** | ***8.0%*** | ***1.4%*** |
| | | Low urbanization | 123.1 | 82.7 | 190.2 | 93.0 |
| | | High urbanization | 123.5 | 83.0 | 190.5 | 93.3 |
| Sugar | *5.5* | **No urbanization effect** | **8.0** | **5.9** | **9.6** | **6.0** |
| | | ***Annual growth rate*** | ***4.6%*** | ***0.7%*** | ***3.7%*** | ***0.5%*** |
| | | Low urbanization | 7.9 | 5.8 | 9.2 | 5.8 |
| | | High urbanization | 7.8 | 5.8 | 9.0 | 5.7 |
| Drinks | *12* | **No urbanization effect** | **26.3** | **15.6** | **50.3** | **19.9** |
| | | ***Annual growth rate*** | ***11.9%*** | ***3.0%*** | ***16.0%*** | ***3.3%*** |
| | | Low urbanization | 26.5 | 15.7 | 50.6 | 20.1 |
| | | High urbanization | 26.6 | 15.7 | 50.7 | 20.2 |

Source: Calculated.

Note: Per capita consumption for rice, pork, meat and fish (M&F), vegetables and fruits (V&F), and sugar are in kilograms except for drinks, which is in liters.

Without urbanization effects, the per capita consumption of rice is projected to decline from the 2010 level. In the optimistic scenario, which assumes real food expenditures grow at 8% and real prices grow at 1%, the per capita consumption of rice is projected to decline from 124 kg in 2010 to 121 kg in 2020 and to 102 kg in 2030, or at an annual rate of 0.3% and 0.9%, respectively. In the pessimistic case, which assumes real food expenditures grow at 4% and real prices grow at 2%, per capita consumption continues to decline to 109 kg in 2020 and to 90 kg in 2030, or at an annual rate of 1.3% and 1.4%, respectively. These growth rates are slightly lower than the 2002-2010 level, which was 1.7% (see Table 2).

In contrast, without urbanization effects, the per capita consumption of the remaining food groups is projected to increase from the 2010 level. Consumption increases significantly in the optimistic scenario while modestly in the pessimistic scenario. Notably, the consumption of meat and fish and drinks appears to grow faster than other food groups. For example, the per capita consumption of meat and fish is projected to increase from 27 kg in 2010 to 50.8 kg in the optimistic scenario but just 32.6 kg in the pessimistic scenario of 2020, equivalent to an annual growth rate of 8.9% and 2.1% respectively. The per capita consumption of pork is projected to grow as well, but at growth rates of 6% and 1.2% for both scenarios of 2020, which are slightly lower than those of meat and fish. In 2030, the growth rates of per capita consumption are slightly higher for meat and fish, vegetables and drinks compared to the corresponding 2020 levels. It is noted that the 2002-2010 actual growth rates of the consumption of non-rice food groups are within the range of the growth rates projected in the optimistic and pessimistic scenarios.

Interestingly, the effects of urbanization appear to be very modest for the consumption of non-rice foods, about less than 1 unit of measurement. The difference is most remarkable for rice, about 3-5 kg among three urbanization scenarios. For example, in the optimistic scenario of 2020, the consumption of rice is projected to be 117 kg under high urbanization assumption, which is about 4 kg lower than without urbanization effects. Similarly, in the pessimistic scenario of 2030, the consumption of rice is projected to be 84.9 kg under high urbanization assumption, which is about 3.5 kg lower than without urbanization effects. While changes in food expenditures and prices ultimately affect the consumption at the household level as well as at the food-group level, the disparity in the effect of urbanization structure on food demand emphasizes the fact that the changes across demographic groups are less proportionate for rice than non-rice foods, leading to a significant change in the nationally weighted level of projected rice demand on a per capita basis.

In addition, total household demand is derived by multiplying per capita demand with population (Table 10). According to the United Nations (2014), Vietnam's population in 2002 and 2010 were 82.5 and 89 million people, respectively. Population is projected to reach 97 million people in 2020 and about 101.8 million people in 2030, which are equivalent to annual growth rates of 0.9% and 0.7%, respectively.

Table 10: Projected total household food demand and annual growth rates, 2020 and 2030

| Food group | Unit | 2002 | 2010 | 2020 | | 2030 | |
|---|---|---|---|---|---|---|---|
| | | | | Optimistic-Low | Pessimistic-High | Optimistic-Low | Pessimistic-High |
| Rice | Million MT | 11.8 | 11.1 | 11.6 | 10.3 | 10.0 | 8.6 |
| | Growth rate | | | 0.5% | -0.7% | -0.5% | -1.1% |
| Pork | Million MT | 0.8 | 1.2 | 2.1 | 1.5 | 2.8 | 1.7 |
| | Growth rate | | | 7.3% | 2.1% | 6.4% | 1.7% |
| M&F | Million MT | 1.6 | 2.4 | 4.9 | 3.1 | 8.2 | 3.8 |
| | Growth rate | | | 10.5% | 3.1% | 12.0% | 3.0% |
| V&F | Million MT | 3.8 | 6.5 | 12.0 | 8.1 | 19.4 | 9.5 |
| | Growth rate | | | 8.5% | 2.4% | 10.0% | 2.3% |
| Sugar | Million MT | 0.3 | 0.5 | 0.8 | 0.6 | 0.9 | 0.6 |
| | Growth rate | | | 5.7% | 1.4% | 4.6% | 1.0% |
| Drinks | Million liters | 0.6 | 1.1 | 2.6 | 1.5 | 5.1 | 2.1 |
| | Growth rate | | | 14.0% | 4.3% | 19.1% | 4.6% |

Source: Calculated.

Two extreme scenario combinations, optimistic (economy) –low (urbanization) and pessimistic (economy) –high (urbanization), are selected to present in comparison with 2002 and 2010 levels for the sake of brevity. Total household demand for rice is projected to vary from 10.3 to 11.6 million tons in 2020 and 8.6 to 10 million tons in 2030. Except for the optimistic-low scenario of 2020, other scenarios show that rice demand is projected to decline from the 2010 level despite of population growth. This is consistent with a declining trend in rice consumption observed in the 2002-2010 period. The declining rates, however, are modest, ranging from 0.5% to 1.1% per annum. The demand for non-rice food groups is projected to increase but at more varying degrees. For example, the demand for meat and fish is projected to be in between 3.1 to 4.9 million tons in 2020, or grow at an annual rate of 3.1% to 10.5%. Similarly, demand for vegetables and fruits is projected to vary from 8.1 to 12 million tons in 2020, or at an annual growth rate of 2.4% and 8.5%. Projected demand in 2030 shows a similar pattern for respective food groups and scenarios.

## 5. Conclusion

This study employs the QUAIDS model to generate projections of the demand for 6 major food groups including rice, pork, meat and fish, vegetables and fruits, sugar, and drinks under scenarios that account for alternative growth rates in food expenditures, prices and urbanization. The results have confirmed the flexibility of QUAIDS in allowing food budget shares to change, even in an opposite direction, at different expenditure levels. As expected, the budget shares of rice decline significantly while those for meat and fish, drinks and most notably, miscellaneous food group, increase at higher levels of food expenditures.

On a per capita basis, the demand for rice shows a fall in 2020 from the 2010 level and continues to decline in 2030. The per capita demand for pork continues to increase at higher levels of food expenditures but its growth rate is slower than that of meat and fish, suggesting consumers' high preference for non-pork meats and seafood as their incomes grow. Similarly, the demand for drinks and miscellaneous food group, of which FAFH accounts for a half, increases as expenditures increase.

At the national level, the projections have shown that the effect of urbanization is more remarkable for rice while it is quite modest for the remaining food groups, mainly due to the fact that changes in the per capita consumption of rice are much less proportionate across different demographic groups. This finding is consistent with observations across countries that the demand for basic staples is one of the most sensitive to an income change and varies greatly between rural and urban consumers. Over time, it is projected that rice demand in Vietnam will decline both on a per capita basis and in total. In addition, consumers will consume more higher-valued foods, particularly more non-pork meats and vegetables, as their incomes increase. Although this study concerns at-home consumption only, the projections have shed some light on our understandings of the possible changes in the patterns and trends of food demand in the medium and long term. Similar approaches using household data can be replicated for other countries to examine the effects of income distribution, urbanization and changes in consumers' preferences for foods over time, which would help us to provide better long-run projections.

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# VITA

Hoa Hoang was born in Thanh Hoa province, Vietnam. After completing her school work at Dao Duy Tu high school in Thanh Hoa in 2002, Hoa entered the Foreign Trade University in Hanoi to study international economics and graduated in 2006. After few years of working in Vietnam, she came to the United States in August 2008 for her Master's degree in Social and Applied Economics at Wright State University in Dayton, Ohio. She finished the Master's program in December 2009 and continued with the PhD program at the University of Missouri in the fall of 2010. She was the president elect of the Vietnamese Student Association at MU during her first academic year. She enjoyed organizing events for Vietnamese students to grow together.

Hoa is married to Hien Nguyen, who is also a graduate student at MU and they have one daughter, Dieu-Anh (Anna), born in September 2013. Hoa and her husband like traveling. Together they have traveled to over 30 states in the US, Ecuador and Peru, several Asian countries and Vietnam. In their spare time, they like to write to share knowledge, meet people and join community projects to help the Vietnamese youth. Hoa has been a long time contributor of *USGuide.com.vn* and *DotChuoiNon.com*.